ATTACHMENT L

Bad River Band of Lake Superior Chippewa
Mashkiiziibii Natural Resources Department
72682 Maple Street
Odanah, WI 54861
715-682-7123

BAKAAN INGOJI GAA ONDAADAG (NON-LOCAL BEINGS) PROGRAM REPORT

Jacob Slattery, MNRD Non-local Being Program Manager

March 22, 2022

I. INTRODUCTION

This report was prepared by Jacob Slattery, the Non-local Beings Program Manager for the Mashkiiziibii Natural Resources Department ("MNRD"). This report concerns the United States Army Corps of Engineers ("Corps") Public Notice on the permit application for the Enbridge Line 5 Wisconsin Segment Relocation Project ("project").

The responsibilities of the Bakaan ingoji gaa ondaadag (non-local beings) program (NLBP) manager in the project review process are to evaluate projects proposed and implemented on Reservation and Ceded Territory land and water for: (1) cumulative impacts to pristineness and biodiversity of floral and faunal communities, (2) steps, processes, and best management practices (BMPs) toward blocking invasive species pathways and vectors of introduction, (3) monitoring and management plans for enacting early detection and rapid response to established populations of aquatic and terrestrial invasive species (AIS and TIS) in accordance with the tribe's invasive species management plan, (4) administration to meet compliance and cooperation with the Bands inspection process, (5) a basic understanding of AIS and TIS threats in the scope of the work being performed.

II. RELEVANT DATA

- Field work data based on the following priority target species of known establishment and spread throughout tribal terrestrial and aquatic areas:
  - Hybrid and exotic cattail (typha spp.)
  - Phragmites (common reed)
  - Purple loosestrife (Lythrum)
  - Garlic mustard
  - Buckthorn
  - Wild parsnip
  - Other noxious weeds (spotted knapweed, giant hogweed, leafy spurge)
  - Sea lamprey, rusty crayfish, spiny waterflea
  - Exotic mussels (e.g. quagga, zebra), exotic snails (i.e. chinese mystery snail)
- Peer reviewed published original research, reviews, and expert reports denoted in the references with respect to topics of concern.

III. REVIEW

NLBP staff reviewed the Corps' Public Notice for the Project, Enbridge's application materials, and the Wisconsin Department of Natural Resources Draft Environmental Impact Statement ("DEIS").

IV. FINDINGS

The Corps should prepare a federal EIS and consider this project's impacts on local species through non-local beings transport this project will create. The State of Wisconsin has done a woefully inadequate job analyzing the issue of non-local beings which underscores the need for a federal EIS. These criticisms are included here.

(1) Raw data deficit (relevant areas reviewed: none identified, relevant areas not provided)

As a reminder, Enbridge has their own invasive and noxious species management plan. An example of how this was used in a Line 3 replacement project is provided as **Attachment 1**.

While this document better outlines a more holistic approach to monitoring and management, another key omission include standards and best management practices in terms of spatial data requirements when reporting invasive species populations introduced, established, treated, or suppressed/eradicated. We recommend Enbridge consider adopting spatial data best management practices (BMPs) for aquatic and terrestrial invasive species monitoring, control and treatment, management, and prevention activities. Two reliable and similar sets of spatial data and mapping standards are provided in the links below and attached to this expert report **(*see* Attachments 2 & 3)**. The Bad River Tribe requires that a set of mapping standards particular to invasive species control and management activities be provided. Such standards have not been provided outside of the latest DEIS; they must be provided to afford the public, government agencies and entities, and concerned stakeholders an opportunity to comment.

(I) https://naisma.org/wp-content/uploads/2019/06/NAISMA_Mapping_Standards.pdf → North American Invasive Species Management Association (est. adopted 2018) **(Attachment 2)**

(II) https://dnr.wi.gov/maps/gis/documents/loc_data_std.pdf → WI DNR Location Data Standards (est. adopted 2000) **(Attachment 3)**

In addition, the Band has concerns that the proposed Enbridge Line 5 reroute alternatives will mobilize and magnify the existing aquatic invasive species concerns throughout the Marengo Watershed and Copper Falls. Invasive species such as garlic mustard and purple loosestrife are currently being actively monitored and managed in these areas. The immense presence of construction crews, equipment and the amount of time that such equipment, personnel and other heavy transport equipment such as trailers and dump trucks will have in the area over an extensive period of time presents a dangerous opportunity for invasive species to spread even more out of control.

(2) Lacks administration, transparency and BMPs for invasive species management and monitoring (relevant areas reviewed: DEIS pp. 24-28; 45-46; 52; 117-119; 214; 223-225; 253; Appendix C)

Three specific concerns are noteworthy and applicable to the NLBP in the DEIS with respect to the lack of data administration information: (1) there's no protocol for sharing data with the Band's NLBP with respect to introduced and established populations of aquatic and terrestrial species, (2) there is lacking data with respect to invasive species control and management with respect to monitoring and prevention at additional temporary workspace (ATWS) sites, and (3) concerns over native seed mixes (DEIS pp. 54-56; 201; 212-214; 246; Appendix C section 21.0).

The adoption of Wisconsin Department of Natural Resources ("WDNR") best management practices seems to be the prevalent method for invasive species monitoring management, prevention, and suppression, however, this detail is not spelled out clearly or concisely. Furthermore, if BMPs are to be adopted and implemented, steps to administrate the practices and share data must be entered into the DEIS, and to communicate and present the data in a practical manner in consultation with the Band and the NLBP. Section 2.7.4 (Invasive Species Management) and 5.15 (Invasive Species) present limited information on invasive species prevalent throughout the state of WI, but the data are not provided in a map with spatial context. In addition, the steps Enbridge is taking are to focus on restricted species and not prohibited species. The biggest concern is that Enbridge has stated they have conducted surveys for terrestrial invasive plant species "...in proposed workspaces including (the) mainline workspaces, access roads, valve areas and pipe yards" (DEIS p. 118), but these data are not available. From the public eye this is a concern for invasive species because Enbridge supposedly has collected (some) data on terrestrial invasive species but has not presented maps of the corridors or areas it stipulated it has surveyed, leaving readers and reviewers left to speculate about the current and forecasted extent of invasive species-specific populations introduced and established and treatment methods and extent of monitoring. Furthermore, absent data disallows the public from looking at sources of error and success metrics as it relates to potential removal and treatment methods proposed for controlling and suppressing aquatic and terrestrial plants.

The construction and use of additional temporary workspaces (ATWS) are likely to see high amounts of incoming and outgoing traffic of not just personal vehicles but heavy equipment, trailers, watercraft, pass through equipment etc. These are likely to be the most opportunistic "hot-zones" for invasive species introduction and establishment. There needs to be an organized and transparent explanation of how contractors, supervisors, and workers, will coordinate, train, implement, monitor and manage invasive species. As it appears in the DEIS, Appendix C sections 2, 4 and 20 and DEIS pp. 24, 53-54 should address these concerns. Supervisors and managers conducting construction and installation must enact documentation, safety, compliance, and auditing standards and report all instances of non-compliance to ensure the tribe and local invasive species authorities can intervene to reduce the likelihood of invasive species introductions through early detection and rapid response. In a similar vein, the, the Corps must better emphasize that native seed mixes are in WI state compliance by ensuring that all production, transportation and use of seed, forage, gravel, mulch, and hay are certified weed free. The NLBP requires that this correction be made as well, in the interest of protecting native species communities and biodiverse assemblages in sensitive and otherwise likely areas to see dense human development and disturbance.

(3) Lacking understanding of cumulative impacts

Cumulative impacts are likely to be one of the more prevalent and voluminous criticisms in this permitting process. In the scope of the NLBP, this document fails to explain the cumulative impacts relevant to species of plants, fish and wildlife widely considered to be non-native to terrestrial lands, waters, wetlands, and other riverine and mixed land-cover areas occupied by the Bad River Reservation and the Bad River watershed.

A simple scan and content analysis of the rhetoric and justifications provided in the DEIS in the sections denoted above shows a consistent use of the phrase "cumulative impacts are not anticipated" across a range of main and sub-topics like soils, water and groundwater, wells, bedrock, HDD drilling, geology, bird, ecological landscapes, and sensitive ecological communities. Each of these sections does not contain sufficient evidence to justify the relaxed concerns of cumulative impacts associated with the Enbridge Line 5 reroute. The phrases "cumulative impact" and "cumulative impacts" are referenced 33 and 29 times in the DEIS respectively, including a provided definition on p. 71 with no reliable peer reviewed published resource on it and other relevant impact(s) related concepts.

This is an environmental review. The core purpose of this document and process is made concisely, shown in the DEIS on page I (PDF p.3). EISs serve both a *descriptive* and *normative* purpose to inform the public, stakeholders, and decision-makers on the potential adverse environmental impacts of a proposed project, a descriptive purpose about what the purpose "is". But this goal also contains another purpose, to intensively examine and evaluate measures to minimize impacts and consider the direct and indirect effects of specified project alternatives. The effects and scope of these impacts associated with project alternatives is a vital task, whereas suggesting alternatives with minimal environmental impacts "ought" to be the priority. Examining and communicating alternatives is a normative objective and claim, seeking what ought to be done. Starting from this point we can begin to look intensively at the rhetoric of the DEIS and evaluate it for inconsistencies with respect to impartiality and comprehensiveness of the evidence presented.

Using cumulative impacts as an example – an important example since the evaluation of cumulative impacts considers the environmental legacy impacts of successive additions and respective additional "cumulative" additions of pollutant loads and sources of pollution (Pratt, 2000; **Attachment 4**) – the DEIS makes misleading and discreditable statements associated with cumulative impacts, likely to lead undertrained reviewers, anyone unskilled in the complexities of evidence based ethics and policy, to make critical errors while rendering their evaluations of this DEIS. This evidence indicates a cognitive bias committed by the authors known as the narrative fallacy. Furthermore, such bias is linked to particularly negative effects associated with the illusion of truth effect. This effect negatively influences readers into adopting distorted evidence, allowing them to be unintentionally persuaded into validating factual statements. In short, repetitive statements are reexperienced as more fluent and familiar (Ozubko & Fugelsong, 2011; **Attachment 5**), capable of manipulating language to increase perceived validity of statements retrieved from memory.

The repetitive "mimicked" language folded into this DEIS with respect to cumulative impacts "not anticipated" are indicative of a cognitive bias committing a narrative fallacy, an "erroneous heuristic" (Menashe & Shamash, 2006) used to manipulate and manufacture an argument based on a false narrative. This effort to mask the real story, the best and widely accepted truth as to environmental impacts of Line 5 and Line 5 alternative routes proposed in the Bad River watershed and adjacent watersheds, are linked to confirmation bias, distorting the higher mental capacities of readers and reviewers to question the credibility and accuracy of the data or argument as presented (Taleb, 2007; Tversky & Kahnemann, 1974, **Attachment 6**). One product of this cognitive bias is for readers and reviewers to adopt these masked arguments with limited cognitive capacities and accept them as compelling and explanatory, persuaded by the author's impression of understanding. This process of persuasion can also be seen in the illusion of truth effect, where consistently repeating a singular phrase in succession increasingly causes people to validate and believe that statement as the truth (Begg, Anas, & Faranacci, 1992; Moons, Mackie, & Garcia-Marques, 2009; Newman et al., 2020; **Attachments 7, 8, & 9**) since it's mainly easier for the human brain to process a simple and uncomplex idea repeated over and over again compared to competing ideas. Overall, the glossiness of the cumulative impacts language is likely to lead reviewers to misconstrue the high stakes impacts associated with Line 5 and Line 5 alterative reroutes proposed in the Bad River Watershed and adjacent watersheds in the Lake Superior basin.

(4) Lacking understanding of non-economic losses (relevant areas reviewed: relevant areas not provided)

Besides shortcomings in the economic benefits section explained later, the DEIS glosses over significant impacts that pipelines have on tribal member's oral histories, traditional practices, sense of place prophecies. Denoted in Dooper et al. (2018), the report "A*ssessing Potential Non-Economic Loss & Damage from Climate Change, Partnership with the Bad River Band of the Lake Superior Chippewa Indians*" (or NELD report) **(Attachment 10)** is one of the Bad River Band's cornerstone literatures that provides qualitative evidence in the form of semi-structured oral interviews on traditional practices and teachings associated with tribal member reciprocal relationships with the natural environment. Even though there are 1,700 registered tribal members that live on the reservation, there are over 8,000 registered members of the Bad River Band of Lake Superior Chippewa (Dooper et al., 2018, **Attachment 10**) whose land stewardship practices, and culture go back centuries prior to European settler histories. Based on these oral traditions and histories attributed to potential non-economic losses as demonstrated in Dooper et al. (2018) **(Attachment 10)**, the NLBP and Bad River Band oppose Line 5 and the Enbridge Line 5 reroute around the reservation within the Bad River Watershed, as this pipeline and its alternative routes propose decades of environmental harm and significant non-economic loss and damage to the Bad River Tribe. The NELD report is additionally attached to this expert report so that the absence of non-economic losses associated with the Enbridge Line 5 reroute will be corrected for this critical omission in the DEIS.

Holistically, the NLBP strongly urges the Corps to conduct its own independent environmental assessment, specifically a federal EIS. The absence of reliable and comprehensive raw data on the following concerns explained above makes the provision of meaningful comments and review a heavy task:

1. Raw data deficit in terms of invasive species and invasive species monitoring, control, and long-term management practices of the Line 5 and Line 5 reroute corridor(s).
2. Lacking data transparency and administration information.
3. The absence of comprehensive understanding of cumulative impacts.
4. The absence of comprehensive understanding of non-economic losses and environmental justice.

V. FURTHER INFORMATION REQUIRED

1. Maps and spatial data of current Line 5 and Line 5 reroute alternatives with introduced and established invasive species.

2. Proper protocol for spatial data best management practices with respect to invasive species (see attachments provided).
3. Proper protocol for implementing, documenting and auditing invasive species monitoring and control activities.
4. Holistic and comprehensive assessment of cumulative impacts that considers scientific, peer reviewed and published research.
5. Assessment of non-economic losses associated with Line 5 and Line 5 reroute alternatives, acknowledging and recognizing threats and concerns to tribal treaty rights on reservation and off reservation lands in the Bad River watershed.

No direct review can be made on these topics since these resources, data and information have not yet been made available for public input. The Corps must conduct a federal EIS to address these concerns discussed earlier by collecting scientific, peer reviewed, published information, data, maps, and proprietary information to evaluate and understand the potential environmental effects of the proposed project. An independent federal EIS under the National Environmental Policy Act. The Corps must hold a public hearing on the scoping of a federal EIS.

The Mashkiiziibii Natural Resources Department reserves the right to update this report once additional, and more accurate, data becomes available.

VI. REFERENCES & ATTACHMENTS

References

- U.S. Army Corps of Engineers, Public Notice MVP-2020-00260-WMS, (Jan. 6, 2022).
- Enbridge Energy, LP, Permit Application Materials to U.S. Army Corps of Engineers.
- Wisconsin Dep't of Natural Resources, Draft Environmental Impact Statement: Proposed Enbridge Line 5 Relocation Project (Dec. 2021).
- Menashe, D., & Shamash, M. E. (2006). The narrative fallacy. *International Commentary on Evidence*, *3*(1).
- Taleb, N. N. (2008). *The Impact of the Highly Improbable*. Penguin Books Limited.

Attachments

Attachment 1. Enbridge Energy, LP, Appendix B: Invasive and Noxious Species Management Plan to Line 3 Replacement Project: Environmental Protection Plan (Jan. 2020), available at https://www.mvp.usace.army.mil/Enbridge_Line3/.

Attachment 2. NAISMA, Mapping Standards for Program Managers (Oct. 17, 2018), available at https://naisma.org/wp-content/uploads/2019/06/NAISMA_Mapping_Standards.pdf.

Attachment 3. Wisconsin Dep't of Natural Resources, Locational Data Standards, V.1.1 (2001), available at https://dnr.wi.gov/maps/gis/documents/loc_data_std.pdf.

Attachment 4. Pratt, G. C. (2000). Cumulative impact. *Environmental Health Perspectives*, *108*(4), A162-A162.

Attachment 5. Ozubko, J. D., & Fugelsang, J. (2011). Remembering makes evidence compelling: Retrieval from memory can give rise to the illusion of truth. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *37*(1), 270-276.

Attachment 6. Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases: Biases in judgments reveal some heuristics of thinking under uncertainty. *science*, *185*(4157), 1124-1131.

Attachment 7. Begg, I. M., Anas, A., & Farinacci, S. (1992). Dissociation of processes in belief: Source recollection, statement familiarity, and the illusion of truth. *Journal of Experimental Psychology: General*, *121*(4), 446.

Attachment 8. Moons, W. G., Mackie, D. M., & Garcia-Marques, T. (2009). The impact of repetition-induced familiarity on agreement with weak and strong arguments. *Journal of Personality and Social Psychology*, *96*(1), 32.

Attachment 9. Newman, E. J., Jalbert, M. C., Schwarz, N., & Ly, D. P. (2020). Truthiness, the illusory truth effect, and the role of need for cognition. *Consciousness and Cognition*, *78*, 102866.

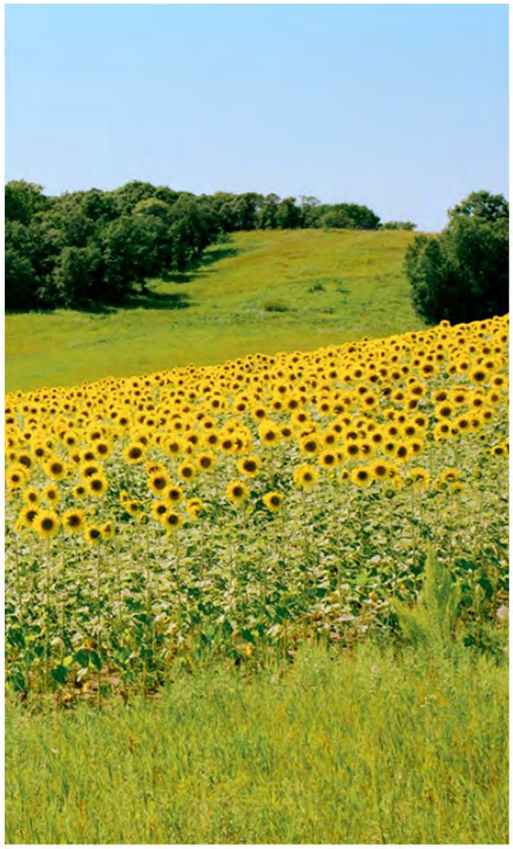
Attachment 10. Dooper, S., Proudman, K., Osielski, A., Swanz, S., & Zaman, A. (2018). Assessing Potential Non-Economic Loss & Damage from Climate Change, Partnership with the Bad River Band of the Lake Superior Chippewa Indians.

MNRD NON-LOCAL BEINGS REPORT

ATTACHMENT 1

Appendix B

Invasive and Noxious Species Management Plan



Invasive and Noxious Species Management Plan

Enbridge Energy, Limited Partnership • Line 3 Replacement Project

January 2020

ENBRIDGE®

Attachment 1 to MNRD Non-Local Beings Report

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

BMPs	best management practices
Enbridge	Enbridge Energy, Limited Partnership
EPP	Environmental Protection Plan
FDL	Fond du Lac Band of Lake Superior Chippewa
HDD	horizontal directional drill
INS	invasive and noxious species
L3R or Project	Line 3 Replacement Project
MDA	Minnesota Department of Agriculture
MDNR	Minnesota Department of Natural Resources
NDDA	North Dakota Department of Agriculture
Plan	Invasive and Noxious Species Management Plan
USDA	U.S. Department of Agriculture

1.0 INTRODUCTION

Enbridge Energy, Limited Partnership ("Enbridge") is committed to minimizing the spread of invasive and noxious species ("INS") as defined by law or regulation (Attachment A), including invasive and noxious terrestrial plants, invasive aquatic species, and tree pests, along the construction right-of-way and associated access roads and haul routes where improvements are needed due to construction of the Line 3 Replacement Project ("L3R" or "Project"). The L3R route extends approximately 330 miles across the state of Minnesota, and an additional 12 miles in North Dakota. As proposed, of the majority of the route is co-located with Enbridge's existing mainline system, foreign utilities, or transportation corridors (e.g., road, railroad).

1.1 PURPOSE OF THE PLAN

The goal of this Invasive and Noxious Species Management Plan ("Plan") is to outline the INS management strategies that will be used to minimize the spread of INS identified within the Project construction workspace [1], access roads, and improved haul routes in compliance with law or regulation. Management strategies will be implemented where applicable and appropriate prior to construction, and during Project construction, restoration, and post-construction monitoring phases. Existing INS occurrences will be documented throughout the construction workspace, access roads, and improved haul routes, through pre-construction surveys, publicly available datasets, or monitoring.

Management strategies for INS on the Project are outlined below by INS group: terrestrial plant species, aquatic species, and tree pests (including oak wilt).

2.0 TERRESTRIAL PLANT INVASIVE AND NOXIOUS SPECIES

This Plan defines terrestrial plant INS as any species that is listed by the U.S. Department of Agriculture ("USDA") as Noxious; or Minnesota Department of Agriculture ("MDA") as Prohibited Noxious Weeds; or North Dakota Department of Agriculture ("NDDA") and/or Pembina County, North Dakota as Noxious; or species otherwise determined to be invasive by the Minnesota Department of Natural Resources ("MDNR") on MDNR-Administered Lands or Fond du Lac Band of Lake Superior Chippewa ("FDL") within the exterior boundaries of the FDL Reservation (see Attachment B).

2.1 MINNESOTA REGULATIONS

In Minnesota, the management objectives for INS within the Project area are to minimize the spread of documented occurrences of terrestrial plant INS that are: 1) listed as Noxious by the

[1] The terms "construction right-of-way," "temporary construction right-of-way," "construction workspace," and "temporary construction workspace" define the primary mainline workspace area required for installation of L3R. For clarity, Enbridge will generically use "construction workspace" instead of "temporary construction right-of-way," temporary construction workspace," or "construction right-of-way" as the terminology for 1) the permanent right-of-way; and 2) the temporary construction area (which includes the following defined terms: Temporary Workspace and Additional Temporary Workspace). Additional Temporary Workspace is temporary construction workspace needed when encountering environmental features that require special construction methods. All construction equipment and vehicles will be confined to this approved construction workspace.

USDA; or 2) listed as "eradicate"[2] or "control"[3] (see Table 2.1-1) under the "Prohibited Noxious Weed" category by the MDA.

Table 2.1-1
Minnesota Department of Agriculture Prohibited Noxious Weeds

Eradicate List		Control List	
Species	**Common Name**	**Species**	**Common Name**
Amaranthus palmeri	Palmer Amaranth	*Berberis vulgaris*	Common Barberry
Celastrus orbiculatus	Oriental Bittersweet	*Cardamine impatiens*	Narrowleaf Bittercress
Centaurea diffusa	Diffuse Knapweed	*Carduus acanthoides* [a]	Plumeless Thistle
Centaurea jacea [a]	Brown Knapweed	*Centaurea stoebe* [a]	Spotted Knapweed
Centaurea solstitialis	Yellow Starthistle	*Cirsium arvense* [a]	Canada Thistle
Centaurea x moncktonii	Meadow Knapweed	*Euphorbia esula* [a]	Leafy Spurge
Conium maculatum	Poison Hemlock	*Lythrum salicaria* [a]	Purple Loosestrife
Cynanchum louiseae	Black Swallow-wort	*Pastinaca sativa* [a]	Wild Parsnip
Digitalis lanata	Grecian Foxglove	*Tanacetum vulgare* [a]	Common Tansy
Dipsacus fullonum	Common Teasel		
Dipsacus laciniatus	Cutleaf Teasel		
Heracleum mantegazzianum [b]	Giant Hogweed		
Humulus japonicus	Japanese Hops		
Linaria dalmatica	Dalmatian Toadflax		

Notes:
[a] Indicates species that have been documented in the Project area based on pre-construction surveys.
[b] This species is also listed as noxious by the USDA.

On MDNR-Administered Lands, the INS management objectives are to minimize the spread of documented occurrences of terrestrial plant INS that are: 1) listed as Noxious by the USDA; 2) listed as "Prohibited Noxious Weeds," "Restricted Noxious Weeds," or "Specially Regulated Plants" by the MDA; or 3) listed as invasive by MDNR Operational Order 113 (see Attachment B). In addition, Enbridge will adhere to the requirements set forth by the MDNR licenses and lease agreements.

On the FDL Reservation, the INS management objectives are to minimize the spread of documented occurrences of INS that are: 1) listed as Noxious by the USDA; 2) listed as "Prohibited Noxious Weeds," "Restricted Noxious Weeds," or "Specially Regulated Plants" by the MDA; 3) listed as invasive by MDNR Operational Order 113; or 4) listed as invasive by the Minnesota Invasive Species Advisory Council or the Minnesota Invasive Terrestrial Plants and Pests Center as requested by the FDL. Enbridge will coordinate with the FDL regarding ongoing terrestrial plant INS prevention and control efforts per the requirements of FDL permits.

[2] Prohibited noxious weeds placed on the noxious weed eradicate list are plants that are not currently known to be present in Minnesota or are not widely established. These species must be eradicated (Minnesota Statute §18.771 (b)(1)).

[3] Prohibited noxious weeds placed on the noxious weed control list are plants that are already established throughout Minnesota or regions of the state. Species on this list must be controlled (Minnesota Statute §18.771 (b)(1)).

2.2 NORTH DAKOTA REGULATIONS

In North Dakota, the INS management objectives are to minimize the spread of documented occurrences of terrestrial plant INS that are: 1) listed as Noxious by the USDA; or 2) listed as noxious (see Table 2.2-1) by the NDDA or Pembina County, North Dakota (NDDA, 2017; NDDA, 2019).

Table 2.2-1
North Dakota Department of Agriculture and Pembina County, North Dakota Noxious Weeds [a]

Species	Common Name
Amaranthus palmeri	Palmer Amaranth
Artemisia absinthium [b]	Absinth Wormwood
Bassia scoparia [b]	Kochia
Carduus nutans [b]	Musk Thistle
Centaurea diffusa	Diffuse Knapweed
Centaurea repens	Russian Knapweed
Centaurea stoebe [b]	Spotted Knapweed
Cirsium arvense [b]	Canada Thistle
Cynoglossum officinale	Houndstongue
Euphorbia esula [b]	Leafy spurge
Linaria dalmatica	Dalmatian Toadflax
Linaria vulgaris [b]	Yellow Toadflax
Lythrum salicaria [b]	Purple Loosestrife
Tamarisk spp.	Saltcedar
Tanacetum vulgare [b]	Common Tansy

Notes:
[a] NDDA, 2017; NDDA, 2019.
[b] Indicates species that have been documented in the Project area based on pre-construction surveys.

2.3 TERRESTRIAL PLANT INVASIVE AND NOXIOUS SPECIES SURVEYS

Enbridge conducted terrestrial INS plant surveys between 2015 to 2019 along a 50-foot-wide buffer on the construction workspace, and 30-foot-wide buffer on access roads and improved haul routes focused on MDNR-administered tracts and lands within the exterior boundaries of the FDL Reservation. Surveys have been completed on 100 percent of MDNR-administered lands and 80 percent of the entire Project construction workspace, access roads, and improved haul routes.

Enbridge survey crews identified 46 terrestrial plant INS and mapped their locations (see Attachment C). No USDA Noxious Weeds were observed. Brown knapweed (*Centaurea jacea*), a species that must be eradicated in Minnesota, was observed at three locations. The most commonly observed INS was Canada thistle (*Cirsium arvense*), a Prohibited Noxious Weed in Minnesota and North Dakota that must be controlled by all landowners. Tables 2.2-1 and 2.2-2 note MDA and NDDA species identified during surveys.

As described in Section 1.1 of the EPP, signs will be posted on the construction workspace or along access roads or improved haul routes to identify INS infestations.

2.4 STANDARD BEST MANAGEMENT PRACTICES

Enbridge has committed to several Best Management Practices ("BMPs") described in the Environmental Protection Plan ("EPP") that will limit the amount of disturbance associated with construction activities and assist with managing terrestrial INS infestations. These BMPs include:

- Reducing the width of the construction workspace in wetlands and near waterbodies as described in Appendix A of the EPP;
- Limiting grading and topsoil segregation to trench-line-only in wetlands and forested vegetation communities as described in Section 1.10.1 of the EPP;
- Installing construction mats for travel lanes in wetlands and other specific locations as described in Appendix A of the EPP, and Section 3.1 of the EPP;
- Utilizing certified weed-free mulch as described in Section 1.9.2 of the EPP;
- Removing accumulated sediment from silt fence when depth reaches one-third of height as described in Section 1.9 of the EPP;
- Stabilizing workspaces, including spoil piles, within 14 days after construction activities have ceased, and within 7 days in areas within 1 mile of special impaired waters as described in Section 1.9.1 of the EPP;
- Utilizing Minnesota Board of Water & Soil Resources native seed mixes and adapted restoration guidelines as described in Section 7.0 and Appendix C of the EPP;
- Decompacting subsoil as described in Sections 1.18 and 7.11 of the EPP; and
- Utilizing seed mixes labelled "Noxious Weeds: None Found" as required by regulations and will utilize yellow tag seed when available (Section 7.2 of the EPP).

Construction activities in agricultural lands will proceed as described in the Agricultural Protection Plan.

Enbridge has also prepared a Post-Construction Wetland and Waterbody Monitoring Plan that includes monitoring and performance standards for INS within these features. Similar monitoring and performance standards for MDNR-administered lands will be included in the Vegetation Management Plan (see Section 2.6).

2.5 ACTIVE MANAGEMENT STRATEGIES FOR TERRESTRIAL PLANT INVASIVE AND NOXIOUS SPECIES

This section outlines the active management strategies and BMPs that may be implemented by Enbridge to minimize the spread of documented occurrences of terrestrial plant INS. Active management practices will vary depending on the property administrator/owner (e.g., MDNR-Administered Lands, FDL Reservation), land use (e.g., organic farm), and will be selected based on the site-specific conditions, timing, and INS ecology.

Enbridge will implement active management strategies and BMPs during one or more of the following phases as appropriate:

- Prior to clearing: Where practicable and feasible, Enbridge will implement BMPs prior to initiating clearing of the construction workspace. However, the ability to implement BMPs is dependent upon the timing of the receipt of required permits and authorizations, landowner or land-managing agency permissions, seasonality, INS ecology (e.g., maturity of plant, aggressiveness), and the proposed treatment method, effectiveness, and frequency of application.

- During clearing or other construction activities: Should the implementation of certain BMPs not be feasible prior to clearing (e.g., herbicide treatment), alternative BMPs (e.g., cleaning stations) may be implemented during clearing or other construction activities to minimize the spread of INS.

- Restoration: Once construction activities are complete, and final grading and permanent seeding is complete as described in Sections 1.16, 3.9, and 7.3 of the EPP, Enbridge will continue to monitor and manage terrestrial INS until the revegetation performance standards have been met (refer to Section 2.6).

- Post-Construction Monitoring: Enbridge will perform post-construction monitoring at wetlands and waterbodies as described in Enbridge's Post-Construction Wetland and Waterbody Monitoring Plan. Enbridge will manage INS as described in this Plan until the performance standards described in the Post-Construction Wetland and Waterbody Monitoring Plan have been met. Enbridge will also establish performance standards for MDNR-administered lands in the Vegetation Management Plan.

As described in Sections 1.4 and 1.5 of the EPP, construction, restoration, and post-construction monitoring activities are restricted to the construction workspace and designated access roads and haul routes. Once restoration and/or post-construction monitoring activities are complete, terrestrial INS will be managed by Enbridge Operations within the 50-foot-wide permanent right-of-way easement.

Prior to construction, Enbridge will prioritize INS sites and select the appropriate management strategy, timing, and frequency of application to be applied at each INS site. For sites located on MDNR-administered lands, Enbridge will coordinate with the appropriate land-managing division and INS staff. Enbridge will work directly with the FDL Resource Management Department for lands within the external boundaries of the FDL Reservation.

2.5.1 Personnel Training

Enbridge will provide terrestrial plant INS awareness training that:

- Ensures that personnel conducting monitoring and terrestrial plant INS treatments are qualified to distinguish between INS and commonly mistaken native species. This may include, for example, documentation of personnel experience with control of the target INS and their INS control work in similar environments with sensitive resources.

- Require personnel that will work within the construction workspace, access roads, and improved haul routes to view the MDNR land-based prevention staff training video "Cleaning to Avoid Spreading Terrestrial Invasive Species."

- Require personnel that will work within the construction workspace, access roads and improved haul routes to review the Minnesota Department of Transportation "Minnesota Noxious Weeds" guide, or excerpts of this guide that highlight known INS in the Project area.

2.5.2 Pre-Treatment

Pre-treatment will be prioritized for INS listed by the MDA as Prohibited Noxious Weeds that must be eradicated or controlled in Minnesota (Table 2.1-1). Where possible, Enbridge will pre-treat known locations of terrestrial plant INS by spot mowing, mechanical removal (e.g., hand-pulling, digging), spot herbicide application, prescribed burning, spot propane weed torching, or an integrated management approach that combines one or more of these techniques prior to clearing. Any of these methods or combination thereof may also be used during construction, restoration, and/or post-construction monitoring as needed. The pre-treatment objective will be to reduce the observable aboveground vegetative growth and seed production by INS at known locations and reduce the likelihood that plants, seeds (observable on aboveground seed heads), and propagules are viable when clearing and ground-disturbing activities begin. Where possible, Enbridge will attempt to minimize the spread of INS by first managing the outlying populations, and then working toward the center of an infestation. The chosen method(s) will be species-specific and will consider the timing of implementation, quality of the surrounding vegetation, proximity to water resources, and other considerations as noted below. Pre-treatment will commence when all necessary permits and authorizations, and the necessary landowner or land-managing agency permissions are in place and will continue until the start of clearing or other construction activities.

Attachments D and E provide potential treatment methods for each of the 46 species identified during INS surveys. A treatment method or combination of methods will be selected based on several considerations, including MDA status (i.e., eradicate or control) and/or land-managing agency specifications, biological characteristics, and season, and will be based on consultation with the appropriate state and local agencies. Specific site factors such as topography, soil types and condition, water table level, open bodies of water, domestic water wells, and precipitation rates must also be taken into consideration when deciding the appropriate treatment option for a site. Additional important ecological and local land use factors that will be considered in designing and implementing treatment methods will include:

- Aquatic or wetland environments;
- Presence of federal or state-listed species or species of concern;
- Desirable existing vegetation community;
- Areas used for wildlife habitat or grazing;
- Recreation areas (e.g., campsite or picnic areas); and
- Residences.

Pre-treatment strategies and methods, while taking into account all of the considerations noted above, are generally prescribed in Attachment D. Treatment implementation plans will include a decision-making process for personnel conducting treatments to prescribe the most effective and efficient methods for adapting to site-specific and species-specific circumstances and responses.

Pesticide Use and Application

Enbridge will only utilize those pesticides (including herbicides) and methods of application approved by the MDA, MDNR, and the U.S. Environmental Protection Agency in the state of Minnesota. For proposed use of herbicides on MDNR-administered lands, Enbridge will prepare a Pre-Treatment Plan for review and approval by the appropriate MDNR land-managing division and INS staff prior to implementation. Selective foliage or basal application will be used when practicable. All pesticides will be applied in a safe and cautious manner so as not to damage adjacent properties including crops, orchards, tree farms, apiaries, or gardens, and sensitive environmental resources. Enbridge will obtain necessary permits and/or certifications for the use of the applicable herbicides, will be responsible to limit off-right-of-way overspray, and will comply with state laws regarding the use of those herbicides.

Enbridge will contact the landowner or designee to obtain approval for the use of pesticide (including herbicides) at least 14 days prior to any application on their property. The landowner may request that there be no application of pesticides on any part of the site within the landowner's property. Enbridge will provide notice of pesticide application to affected landowners and known beekeepers operating apiaries within 3 miles of the site at least 14 days prior to such application. If the landowner or land-managing agency does not approve the use of pesticides, an alternative treatment method will be selected. Enbridge will keep proper documentation of the locations where pesticides have been used.

The following best management practices will be considered for herbicide use:

- Integrate biological controls instead of, or to complement, herbicide use, if available;
- Select spot treatments over broadcast applications when practicable to minimize potential impacts on pollinators and associated nectar or host plants;
- Products should be selected to be the most target-specific and applied on the smallest area practical to meet management objectives;
- The type of herbicide and treatment method will be selected to minimize impacts to wildlife (e.g., spot treatment, herbicides appropriate for application near aquatic resources); and
- Follow herbicide label instructions and industry standard practices to minimize non-target damage.

Cut stump or basal treatments may be used within the 75-foot vegetative buffer zone of aquatic resources. If herbicide treatment is necessary near rare species or rare natural communities or in or near aquatic resources, the herbicide must be designed for such use as designated by manufacturer’s specifications and federal and state regulations. Additional restrictions will be followed for INS control as required by federal, Tribal, and state permits or other environmental plans.

If herbicide treatment is limited due to landowner restrictions, or proximity to sensitive resources, an alternative treatment method may be selected.

2.5.3 Alternative Best Management Practices

In areas where pre-treatment cannot be implemented prior to clearing, a combination of the following BMPs may be implemented, where appropriate and as determined prior to construction.

Full Construction Workspace Topsoil Segregation

Enbridge may implement full construction workspace topsoil segregation to minimize the spread of INS and to allow equipment to work through the area after topsoil has been stripped, as long as equipment stays on the subsoil (clearing, grading, and restoration equipment will still be cleaned as described in the "Cleaning Stations" section).

Stored topsoil in heavily infested areas will be covered or sprayed with tackifier or mulch to reduce the viability of INS seeds and rootstock prior to the restoration phase and prevent transport by wind. Weed-infested stockpiles will be marked with clearly visible signage until the restoration phase. During restoration, Enbridge will return topsoil and vegetative material from infestation sites to the areas from which they were stripped and will not move soil and/or vegetative matter outside of the identified and marked noxious weed infestation areas.

Installation of Construction Mats

In areas of the construction workspace where pre-treatment of the INS population or full construction workspace topsoil segregation is not feasible, Enbridge will install and work off of construction mats or equivalent to cover the INS source. Construction mats will then be cleaned before use at another non-infested site as described in the "Cleaning Stations" section. Enbridge will also consider the use of construction mats in pre-treated areas with heavy infestations of INS.

Access Roads and Improved Haul Routes

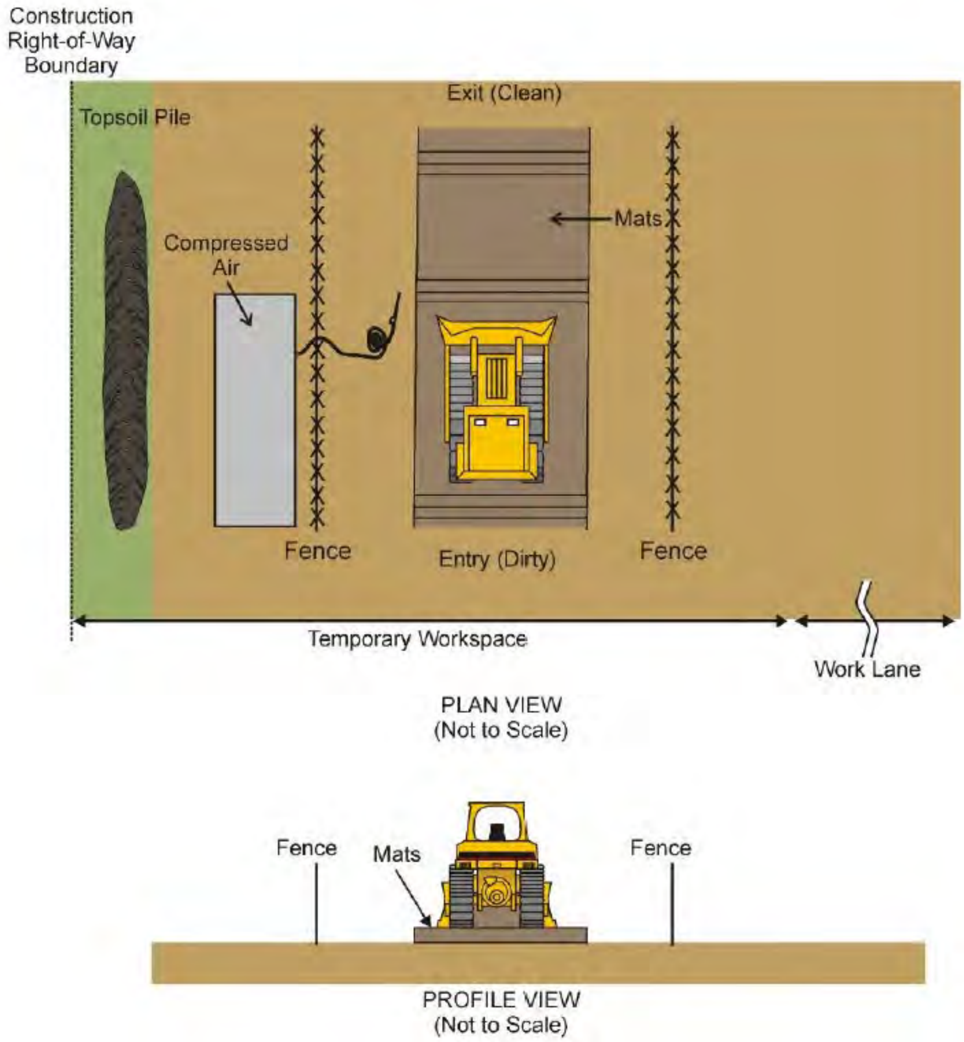
Enbridge does not propose to implement additional BMPs for INS that have been identified adjacent to existing access roads or improved haul routes. Enbridge will either add fill or construction mats to widen existing access roads or haul routes, which will prevent spread of existing infestations in those areas. Where construction mats are used, Enbridge will clean the construction mats before use at another non-infested site as described in the "Cleaning Stations" section.

Cleaning Stations

In areas where pre-treatment of terrestrial plant INS has not been implemented prior to clearing, Enbridge may establish cleaning stations to remove visible dirt and plant material from equipment and mats when exiting a known terrestrial INS infestation area along the construction workspace. Cleaning stations may also be implemented at select sites during construction, restoration, or post-construction monitoring, as needed. Construction mats utilized in an INS site will either be cleaned at designated cleaning stations or will be transported to constructions yards for storage and/or cleaning prior to re-use. Construction mats will be stored on top of plastic tarps or geotextile fabric to prevent the spread of seeds. Removal of dirt and plant material will be documented in a cleaning log (see Attachment F). See Figure 2.5-1 for a typical drawing of a cleaning station.

Mechanical means (initial scrape down followed by blow down) will be the primary method used to remove dirt and plant materials from vehicles, equipment, and construction mats at the cleaning stations or construction yards. Enbridge does not propose the use of high-pressure wash stations due the need for additional water and space, and the challenges with containing and disposing of the cleaning water.

Figure 2.5-1 Typical Compressed Air Cleaning Station



Representation Only

2.6 PERFORMANCE STANDARDS

Enbridge proposes the following performance standards for terrestrial INS in uplands as determined during restoration:

- Absolute percent cover of INS within the construction workspace is similar to absolute percent cover in adjacent undisturbed areas outside of the construction workspace within the same community type.

The INS performance standards in wetlands and riparian areas are described in the Post-Construction Wetland and Waterbody Monitoring Plan. Additional INS performance criteria for MDNR-administered lands will be described in the Vegetation Management Plan.

3.0 INVASIVE AQUATIC SPECIES

The MDNR regulates non-native and invasive aquatic plants and wild animals and designates infested waters. Non-native invasive aquatic species present in the Project area, include the zebra mussel (*Dreissena polymorpha*), faucet snail (*Bithynia tentaculata*), and Eurasian watermilfoil (*Myriophyllum spicatum*). A guide to aquatic invasive species identification is provided in Attachment G.

Aquatic invasive species are typically spread via movement of equipment used in infested waters, such boats, docks, and other equipment. Faucet snail can close their shell with their operculum and survive out of water for multiple days (MDNR, 2019b). Adult zebra mussels can survive out of the water up to 21 days in wet conditions. The larvae of the zebra mussel are microscopic and may spread in any water-containing device (MDNR, 2019c). Eurasian watermilfoil spreads primarily through vegetative fragmentation whereby a fragment from the plant breaks off, grows roots, and establishes a new plant; it looks similar to and may hybridize with native beneficial watermilfoils, including the northern watermilfoil (MDNR, 2019d).

The L3R crosses over 200 waterbodies in the state of Minnesota and will appropriate from water sources to support horizontal directional drills ("HDDs"), hydrostatic testing, and fugitive dust control. Most equipment and construction activities will be in the water (either for crossing or water appropriation) for 24 hours or less. Equipment exposed to water for longer periods of time[4] incudes HDD equipment (refer to the Summary of Construction Methods and Procedures in Appendix A of the EPP for a complete description), and in-stream bridge supports. HDD installation can take several weeks to complete, and in-stream bridge supports may remain in the water through restoration (see Section 2.6.3 of the EPP).

Enbridge has reviewed MDNR's list of designated infested waters (MDNR, 2019a) and has removed designated infested waters as water sources where practical in an effort to reduce the potential risk of spread of these species. Based on the MDNR's list of infested waters (MDNR, 2019a), only one of the water sources currently proposed as a primary source for use has aquatic INS (see Table 3.0-1); the other three sources are contingency sources that would only be used if there is inadequate water flow at the primary source. In all cases, Enbridge will discharge back to the source water or infiltrate the discharge to control potential spread of INS (see Section 3.1.1).

[4] Higher risk equipment is defined as equipment that is in the water for longer periods; the longer period of exposure the higher the risk (Zook and Phillips, 2012).

Further, none of the currently designated infested waters will be crossed using trenching methods that require in-water work.

Table 3.0-1
Line 3 Replacement Proposed Infested Water Sources

Milepost	County	Water Name	Crossing Method	Infestation Species	Appropriation Purpose	Proposed Discharge Method
801.8	Kittson	Red River	HDD	Zebra mussel	HDD and Mainline Hydrostatic Test Appropriation	Back to source or infiltration
991.2	Wadena	Shell River	HDD	Faucet snail	HDD (winter contingency only)	Back to source
993.3	Wadena	Crow Wing River	HDD	Faucet snail	HDD (winter contingency only)	Back to source
1120.3	Carlton	Chub Lake	N/A	Eurasian water-milfoil	Mainline Hydrostatic Test Appropriation (contingency only)	Back to source

3.1 MANAGEMENT STRATEGIES FOR INVASIVE AQUATIC SPECIES

To minimize the spread of invasive aquatic species in Minnesota and North Dakota, Enbridge will implement the following procedures when working in waterbodies in compliance with Minnesota Statute 84D.10 Subd. 4, and consistent with the *Recommended Uniform Minimum Protocols and Standards for Water Craft Interception Programs for Dreissenid Mussels in the Western United States* (Zook and Phillips, 2012 as cited by Minnesota Statutes 84D.01), and MDNR and North Dakota Game and Fish recommendations (MDNR, 2019e; North Dakota Game and Fish, 2016). As described in Section 1.1 of the EPP, Enbridge will post signs at designated infested waters.

3.1.1 Procedures at Any State Watercourse

- Equipment intended for use at the Project site will be free of invasive species prior to being transported to the worksite. Equipment (e.g., hoe stick and bucket, pumps, hoses) used in any state watercourses, regardless of designated infestation status, will be inspected for invasive aquatic species prior to and following in-water work.

- Pumps, hoses, and other equipment with water intakes will be drained of water after use. Enbridge will remove plants, mud, debris, and organisms from the exterior of the equipment (e.g., hoe stick and bucket).

- If aquatic invasive species are identified during inspection of the equipment, Enbridge will implement one or more of the following decontamination procedures[5] before use in another waterbody:

    - clean with heated (to at least 140 degrees Fahrenheit) high-pressure washer;

    - rinse with water above 140 degrees Fahrenheit for at least 10 seconds (e.g., pumps); or

    - dry for 5 days prior to using at another waterbody.

---

5 https://www.dnr.state.mn.us/invasives/preventspread_watercraft.html and https://files.dnr.state.mn.us/natural_resources/invasives/protect-waters.pdf.

- Decontamination water will be allowed to infiltrate in an upland area at least 300 feet from any watercourse, or within 300 feet of the aquatic invasive species source in accordance with applicable permits.

- Felt-soled waders will not be allowed for use in any state watercourse because felt can easily trap, and thus potentially transport, invasive species.

3.1.2 Designated Infested Waters

- If equipment has been used in a designated infested water, Enbridge will implement one or more of the following decontamination procedures[5] before use in another waterbody:

    - clean with heated (to at least 140 degrees Fahrenheit) high-pressure washer; or

    - rinse with water above 140 degrees Fahrenheit for at least 10 seconds (e.g., pumps); or

    - dry for 5 days prior to using at another waterbody.

- Decontamination water will be allowed to infiltrate in an upland area at least 300 feet from any watercourse, or within 300 feet of the aquatic invasive species source in accordance with applicable permits.

- If personnel enter infested waterbodies, personnel will scrub clothes, waders, boots, and other personal gear with a stiff brush to remove debris.

3.1.3 Public Watercourses,[6] Sensitive Non-Public Watercourses, and Surface Water Appropriation Sites[7]

- Enbridge will implement the procedures described in Section 3.1.2 at public watercourses, the non-public watercourses identified in Table 3.1-1, and surface water appropriation sites for in-water construction activities and for the equipment used at HDD installations.

---

[6] Public water or public waters means those waters of the state identified under Minnesota Statutes, section 103G.005, subdivision 15 or 15a, or 103G.201, as shown on the public water inventory maps.

[7] Surface water appropriation sites submitted to the MDNR as part of the Water Appropriation Permit Application for HDD and Hydrostatic Testing Activities (MPARS Reference No. 2018-3690).

Table 3.1-1
Line 3 Replacement Non-Public Sensitive Watercourses

Approximate Milepost	County	Waterbody Survey ID	Waterbody Name
867.4	Red Lake	s-152n43w4-a	Unnamed Ditch
893.9	Polk	s-150n39w19-d	Unnamed Ditch
894.2	Polk	s-150n39w30-a	County Ditch No. 89
894.8	Polk	s-150n39w29-a	Unnamed Ditch
894.8	Polk	s-150n39w29-b	Unnamed Ditch
894.9	Polk	s-150n39w29-c	Unnamed Ditch
999.6	Cass	CAC5006aWB	Unnamed Ditch
1081.5	Aitkin	s-51n22w22-a	Unnamed Stream
1084.4	Aitkin	s-51n22w24-a	Unnamed Stream
1108.3	Carlton	s-49n18w18-b	Unnamed Tributary to Stoney Brook

- Enbridge will discharge appropriated water for HDD and hydrostatic testing activities[8] either back to source or infiltrate in an upland area at least 300 feet from any watercourse and in accordance with applicable permits.

4.0 INVASIVE TREE PESTS

Invasive tree pests occur in the Project area as well, including the native eastern larch beetle (*Dendroctonus simplex*) and non-native emerald ash borer (*Agrilus planipennis*). Eastern larch beetle infests tamarack trees (eastern larch or *Larix laricina*). Adults of the eastern larch beetle emerge in the spring from infected wood; removal of infected tamaracks prior to spring can reduce the spread of the disease (Seybold et al., 2002). Emerald ash borer larvae feed on all species of ash trees. Most of the species' life cycle occurs underneath the bark; early indications of infestation are bark removal or flecking from woodpeckers that eat the larvae (MDNR, 2019f).

As described in Sections 1.8 and 3.2 of the EPP, Enbridge would clear vegetation in upland and wetland areas and would generally dispose of non-merchantable timber and slash by mowing, chipping, grinding and/or hauling off site to an approved disposal facility. Merchantable timber would be disposed of in accordance with Enbridge contract specifications and applicable permits and licenses. The Project does not cross any existing quarantine areas for tree pests[8]; therefore, no special management strategies have been proposed. Enbridge Environmental will monitor quarantine notifications during construction; should any portion of the Project come under quarantine during construction, Enbridge would consult with applicable agencies to identify the appropriate management procedures.

4.1 OAK WILT

In the event that a healthy oak tree adjacent to the construction workspace is damaged or wounded during construction activities in counties where the oak wilt fungus is present, Enbridge will treat the cut surface with water-based paint, a pruning/wound sealer, or shellac to prevent further spread of the disease. Treated trees will be inspected by the Environmental Inspector.

[8] https://www.mda.state.mn.us/plants-insects/pest-regulations.

5.0 REFERENCES

Minnesota Department of Agriculture. 2019 Noxious Weed List. Available at: https://www.mda.state.mn.us/plants-insects/minnesota-noxious-weed-list. Accessed January 14, 2019.

Natural Resources Conservation Service. Undated. Introduced, Invasive, and Noxious Plants. Available at http://plants.usda.gov/java/noxious. Accessed January 14, 2019.

Minnesota Department of Natural Resources ("MDNR"). 2017. Invasive Species Prevention and Management. Available at: https://files.dnr.state.mn.us/assistance/grants/habitat/heritage/oporder_113.pdf. Accessed January 14, 2019.

MDNR. 2019a. Infested Waters List. Available at: https://www.dnr.state.mn.us/invasives/ais/infested.html. Last updated December 31, 2019. Accessed January 17, 2020.

MDNR. 2019b. Faucet Snail (*Bithynia tentaculata*). Available at: https://www.dnr.state.mn.us/invasives/aquaticanimals/faucet_snail/index.html. Accessed April 23, 2019.

MDNR. 2019c. Zebra mussel (*Dreissena polymorpha*). Available at: https://www.dnr.state.mn.us/invasives/aquaticanimals/zebramussel/index.html. Accessed April 23, 2019.

MDNR, 2019d. Eurasian watermilfoil (*Myriophyllum spicatum*). Available at: https://www.dnr.state.mn.us/invasives/aquaticplants/milfoil/index.html. Accessed April 24, 2019.

MDNR. 2019e. Aquatic Nuisance Species: What you Should Do. Available at: https://www.dnr.state.mn.us/invasives/preventspread_watercraft.html. Accessed October 26, 2019.

MDNR. 2019f. Emerald Ash Borer (EAB). Available at: https://www.dnr.state.mn.us/invasives/terrestrialanimals/eab/index.html. Accessed April 23, 2019.

Minnesota Invasive Species Advisory Council. 2009. A Minnesota State Management Plan for Invasive Species. Available at: https://static1.squarespace.com/static/57539006044262fce01261c5/t/5a567acf0d92976e0856bd5d/1515616983437/state_invasive_species_plan.pdf. Accessed January 14, 2019.

Minnesota Department of Transportation. February 2018. Minnesota Noxious Weeds. Available at: http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf. Accessed March 1, 2019.

North Dakota Department of Agriculture ("NDDA"). 2017. Noxious Weeds. Available at: https://www.nd.gov/ndda/plant-industries/noxious-weeds. Accessed April 23, 2019.

NDDA. 2019. North Dakota County and City Listed Noxious Weeds. Available at: https://www.nd.gov/ndda/sites/default/files/resource/2019%20April%20-%20City%20County%20Noxious%20Weeds%20List%204.19.pdf. Accessed April 23, 2019.

North Dakota Game and Fish Department. 2016. Aquatic Nuisance Species. Available at https://gf.nd.gov/ans. Accessed April 23, 2019.

Seybold, S.J., M.A. Albers, and S.A. Katovich. 2002. Eastern Larch Beetle. United States Department of Agriculture: Forest Insect & Disease Leaflet 175. Available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev2_043217.pdf. Accessed April 23, 2019.

Zook, B., and S. Phillips. 2012. Uniform Minimum Protocols and Standards for Watercraft Interception Programs for Dreissenid Mussels in the Western United States (UMPS II): An updated version of the original 2009 document. Pacific States Marine Fisheries Commission. Version: January 2012. Available online at: https://www.anstaskforce.gov/QZAP/Uniform_watercraft_interception_protocols_and_standards.pdf. Accessed October 23, 2019.

Attachment A

Noxious and Invasive Species Regulations

Attachment A NOXIOUS AND INVASIVE SPECIES REGULATIONS			
Region	**Regulatory Category**	**Agency [a]**	**Reference**
Federal	Federal Noxious Weeds (aquatic and terrestrial plants)	USDA-APHIS	https://plants.usda.gov/java/noxious?rptType=Federal
	Federal Seed Act	USDA-AMS	https://www.ams.usda.gov/rules-regulations/fsa
	All-States Noxious Weed Seed List	USDA-AMS	https://www.ams.usda.gov/sites/default/files/media/StateNoxiousWeedsSeedList.pdf
	Federal Plant Pest Protection Act	USDA-APHIS	https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases
	Interstate Regulations: Pest movement restriction	USDA-APHIS	https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs
North Dakota	State Aquatic Nuisance Species	NDGFD	https://gf.nd.gov/ans/species
	State Noxious Weeds	NDDA	https://www.nd.gov/ndda/plant-industries/noxious-weeds
	County/City Noxious Weeds	Defining County/City	https://www.nd.gov/ndda/sites/default/files/resource/2018%20Feb%20-%20City%20County%20Noxious%20Weeds%20List.pdf
Minnesota	State Prohibited, Regulated, Unregulated Nonnative, and Unlisted Nonnative Invasive Species (wild animals and aquatic plants)	MDNR	https://www.dnr.state.mn.us/invasives/laws.html
	State Prohibited, Restricted, and Specially Regulated Noxious Weeds (terrestrial plants)	MDA	https://www.mda.state.mn.us/plants-insects/minnesota-noxious-weed-list
	County Noxious Weeds	MDA	https://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/countynoxiousweeds
	Seed Regulations	MDA	https://www.mda.state.mn.us/plants-insects/buying-and-selling-seed-minnesota
	State Plant Pest Act (insects and terrestrial plants)	MDA	http://www.mda.state.mn.us/plants/pestmanagement/invasivesunit/pestindex.aspx
	State ballast water regulations (aquatic organisms)	MPCA	https://www.pca.state.mn.us/water/vessel-discharge

[a] APHIS: Animal Plant Health Inspection Service MDA: Minnesota Department of Agriculture
MDNR: Minnesota Department of Natural Resources MPCA: Minnesota Pollution Control Agency
NDDA: North Dakota Department of Agriculture NDGFD: North Dakota Game and Fish Department USDA: United States Department of Agriculture

Attachment B

Terrestrial Invasive and Noxious Plant Species List

Attachment B - Terrestrial Invasive and Noxious Plant List			
Species	**Common Name**	**List Source[1]**	**MISAC Status**
Acer ginnala	Maple, Amur	*MISAC; MDA (S); Op Order 113*	Moderate/Established
Acer platanoides	Maple, Norway	*MISAC; MITPPC (71.85); Op Order 113*	Severe/Established
Aegopodium podagraria	Goutweed	*MISAC*	Minimal/Established
Ailanthus altissima	Tree of Heaven	*MISAC; MDA (R); Op Order 113*	Not likely to establish
Albizia julibrissin	Mimosa	*MISAC*	Not likely to establish
Allaria petiolaria	Garlic Mustard	*MISAC; MITPPC (76.38); MDA (R); Op Order 113*	Severe/Established
Alnus glutinosa	Black Alder	*MISAC*	Considered/not ranked
Amaranthus palmeri	Palmer Amaranth	*MITPPC (73.72); MDA (E); Op Order 113; NDDA*	NA
Ampelopsis brevipedunculata	Porcelain Berry	*MISAC; MDA (R); Op Order 113*	Watch/Unknown
Anchusa arvensis	Common Bugloss	*MISAC*	Minimal/Established
Arctium minus	Burdock, Common	*MISAC*	Minimal/Established
Arctium nemorosum	Burdock, Woodland	*MISAC*	Watch/Unknown
Artemisia absinthium	Absinth Wormwood	*NDDA*	NA
Berberis thunbergii	Japanese Barberry	*MISAC; MITPPC (74.87); MDA (C); Op Order 113*	Moderate/Established
Berberis vulgaris	European or Common Barberry	*MISAC; MITPPC (72.84); MDA (R); Op Order 113*	Severe/Established
Berteroa incana	Alyssum, hoary	*MISAC; MITPPC (69.09)*	Severe/Established
Campanula rapunculoides	Creeping Bellflower	*MISAC*	Minimal/Established
Cannabis sativa	Hemp	*MISAC*	Minimal/Established
Caragana arborescens	Siberean Peashrub	*MITPPC (57.16); Op Order 113*	NA
Cardamine impatiens	Narrowleaf Bittercress	*MITPPC (57.73); MDA (C); Op Order 113*	NA
Carduus acanthoides	Thistle, plumeless	*MISAC; MITPPC (77.39); MDA (C); Op Order 113*	Severe/Established
Carduus nutans	Thistle, musk	*MISAC; NDDA*	Severe/Established
Celastrus orbiculatus	Oriental Bittersweet	*MISAC; MITPPC (74.87); MDA (E); Op Order 113*	Severe/Not in state
Centaurea debeauxii	Meadow Knapweed	*MITPPC (71.69)*	NA
Centaurea diffusa	Diffuse Knapweed	*MDA (E); Op Order 113; NDDA*	NA
Centaurea jacea	Brown Knapweed	*MDA (E); Op Order 113*	NA
Centaurea repens	Russian Knapweed	*NDDA*	NA
Centaurea solstitialis	Yellow Star Thistle	*MITPPC (71.46); MDA (E); Op Order 113*	NA
Centaurea stoebe (Syn. Centaurea maculosa)	Spotted Knapweed	*MISAC; MITPPC (93.35); MDA (E); Op Order 113; NDDA*	Severe/Established
Centaurea x moncktonii	Meadow Knapweed	*MDA (C); Op Order 113*	NA
Chelidonium majus	Celandine	*MISAC*	Watch/Unknown
Chicorium intybus	Chicory	*MISAC*	Watch/Unknown
Cirsium arvense	Thistle, Canada	*MISAC; MITPPC (82.76); MDA (C); Op Order 113; NDDA*	Severe/Established
Cirsium palustre	Thistle, marsh	*MISAC*	Severe/Not in state
Cirsium vulgare	Thistle, bull	*MISAC*	Minimal/Established
Conium maculatum	Poison Hemlock	*MITPPC (54.15); MDA (E)*	NA
Convallaria majalis	Lily-of-the-Valley	*MISAC*	Moderate/Established
Convoluvus arvensis	Field bindweed	*MISAC*	Moderate/Established
Cuscuta spp.	Dodder	*USDA*	NA
Cynanchum louiseae (Syn. Vincetoxicum nigrum)	Black Swallow-wort	*MISAC; MITPPC (74.16); MDA (E); Op Order 113*	Severe/Not in state
Cynoglossum officinale	Houndstongue	*MITPPC (69.68); NDDA*	NA
Daucus carota	Carrot, wild	*MISAC; MITPPC (52.84); MDA (R); Op Order 113*	Moderate/Established
Digitalis lanata	Foxglove, Grecian	*MISAC; MITPPC (56.00); MDA (E); Op Order 113*	Severe/Established
Digitalis purpurea	Foxglove, Garden	*MISAC*	Watch/Unknown
Dioscorea oppositifolia	Chinese Yam	*MISAC*	Not likely to establish
Dipsacus fullonum (Syn. Dipsacus sylvestris)	Teasel, common	*MISAC; MITPPC (55.59); MDA (E); Op Order 113*	Moderate/Not in state
Dipsacus laciniatus	Teasel, cut leaf	*MISAC; MDA (E); Op Order 113*	Moderate/Established
Echinochloa crusgalli	Barnyard grass	*MISAC*	Minimal/Established
Echinops sphaerocephalus	Globe Thistle	*MISAC*	Moderate/Not in state
Elaeagnus angustifolia	Russian Olive	*MISAC*	Minimal/Established
Elaeagnus umbellata	Autumn Olive	*MISAC; Op Order 113*	Severe/Established
Elytrigia repens	Quackgrass	*MISAC*	Moderate/Established
Epipactis helleborine	Helleborine	*MISAC*	Minimal/Established
Euonymus alatus	Burning Bush, Winged Euonymus	*MISAC; MITPPC (56.39)*	Watch/Unknown
Euphorbia cyparissias	Spurge, Cypress	*MISAC*	Moderate/Established
Euphorbia esula	Spurge, Leafy	*MISAC; MITPPC (79.05); MDA (C); Op Order 113; NDDA*	Severe/Established

Attachment B - Terrestrial Invasive and Noxious Plant List			
Species	**Common Name**	**List Source[1]**	**MISAC Status**
Filipendula ulmaria	Queen of the meadow	*MISAC*	Watch/Unknown
Frangula alnus	Buckthorn, glossy (all cultivar)	*MISAC; MITPPC (86.73); MDA (R); Op Order 113*	Severe/Established
Galium odoratum	Sweet Woodruff	*MISAC*	Considered/not ranked
Glechoma hederacea	Creeping Charlie	*MISAC*	Moderate/Established
Gypsophila paniculata	Baby's-breath	*MISAC*	Watch/Unknown
Hedera Helix	English Ivy	*MISAC*	Watch/Unknown
Hemerocallis fulva	Orange Day Lily	*MISAC*	Moderate/Established
Heracleum mantegazzianum	Giant Hogweed	*MISAC; MITPPC (64.95); MDA (E); Op Order 113*	Severe/Not in state
Hesperis matronalis	Dame's Rocket	*MISAC*	Moderate/Established
Hieracium auranticum	Orange Hawkweed	*MITPPC (60.52)*	NA
Hieracium caespitosum	Meadow Hawkweed	*MITPPC (60.46)*	NA
Humulus japonicus	Japanese Hops	*MISAC; MITPPC (70.09); MDA (E); Op Order 113*	Watch/Unknown
Hypericum perforatum	St. Johns'swort	*MISAC*	Moderate/Established
Inula britannica	Elecampane	*MISAC*	Moderate/Established
Kochia scoparia	Mexican Fireweed	*MITPPC (71.30); NDDA*	NA
Lathyrus latifolius	Everlasting Pea	*MISAC*	Watch/Unknown
Leonurus cardiaca	Motherwort	*MISAC*	Minimal/Established
Lespedeza cuneata	Lespedeza, Chinese	*MISAC*	Severe/Not in state
Leucanthemum lacustre	Daisy, Portuguese	*MISAC*	Watch/Unknown
Leucanthemum vulgare	Daisy, oxeye	*MISAC*	Moderate/Established
Linaria dalmatica	Dalmation Toadflax	*MISAC; MITPPC (71.58); MDA (E); Op Order 113; NDDA*	Moderate/Established
Linaria vulgaris	Butter-and-eggs	*MISAC; NDDA*	Minimal/Established
Lonicera japonica	Japanese Honeysuckle	*MISAC*	Watch/Unknown
Lonicera maackii	Honeysuckle, Amur	*MISAC; MDA (R); Op Order 113*	Severe/Not in state
Lonicera morrowii	Honeysuckle, Morrow's	*MISAC; MITPPC (89.55); MDA (R); Op Order 114*	Severe/Established
Lonicera tatarica	Tartarian Honeysuckle	*MISAC; MITPPC (85.14); MDA (R); Op Order 115*	Severe/Established
Lonicera x bella	Honeysuckle, Bela	*MISAC; MDA (R); Op Order 116*	Severe/Established
Lotus corniculatus	Bird's-foot trefoil	*MISAC; MITPPC (68.72); Op Order 113*	Severe/Established
Lupinus polyphyllus	Big-leaf Lupine	*MISAC*	Minimal/Established
Lythrum salicaria	Purple Loosestrife	*MISAC; MDA (C); Op Order 113; NDDA*	Severe/Established
Maclura pomifera	Osage Orange	*MISAC*	Considered/not ranked
Medicago lupulina	Black medic	*MISAC*	Minimal/Established
Melilotus alba	White Sweetclover	*MITPPC (70.33)*	NA
Melilotus officinalis	Yellow Sweetclover	*MITPPC (71.49)*	NA
Microstegium vimineum	Japanese Stilt Grass	*MISAC*	Not likely to establish
Morus alba	Mulberry, White	*MISAC*	Moderate/Established
Pastinaca sativa	Wild Parsnip	*MITPPC (78.86); MDA (C); Op Order 113*	NA
Paulownia tomentosa	Princess Tree	*MISAC*	Watch/Unknown
Phalaris arundinacea	Reed canary grass	*MISAC; MITPPC (78.18); Op Order 113*	Severe/Established
Phellodendron amurense	Japanese Cork Tree	*MISAC*	Watch/Unknown
Phleum pratense	Timothy	*MISAC*	Watch/Unknown
Phragmites australis	Common Reed - Non-native subspecies	*MITPPC (86.32); MDA (R); Op Order 113*	NA
Polygonum cuspidatum (Syn. Polygonum japonica)	Japanese Knotweed	*MISAC; MITPPC (78.28); MDA (S); Op Order 113*	Severe/Established
Polygonum sachalinense	Giant Knotweed	*MISAC; MITPPC (74.47); MDA (S); Op Order 113*	Severe/Established
Populus alba	Poplar, White	*MISAC*	Minimal/Established
Populus nigra	Lombardy Poplar	*MISAC*	Considered/not ranked
Potentilla argentea	Cinquefoil, Silver	*MISAC*	Considered/not ranked
Potentilla recta	Cinquefoil, Sulphur	*MISAC*	Considered/not ranked
Pueraria montana	Kudzu	*MISAC*	Not likely to establish
Quercus acutissima	Sawtooth Oak	*MISAC*	Watch/Unknown
Ranunculus acris	Buttercup, tall	*MISAC*	Moderate/Established
Rhamnus cathartica	Buckthorn, common or European	*MISAC; MITPPC (84.38); MDA (R); Op Order 113*	Severe/Established
Robinia hispida	Locust Bristly	*MISAC*	Watch/Unknown
Robinia pseudocacia	Locust, black	*MISAC; MDA (R); Op Order 113*	Severe/Established
Robinia viscosa	Locust, clammy	*MISAC*	Watch/Unknown
Rosa multiflora	Multiflora Rose	*MISAC; MITPPC (69.26); MDA (R); Op Order 113*	Severe/Established
Rosa rugosa	Rugosa Rose	*MISAC*	Watch/Unknown

Attachment B - Terrestrial Invasive and Noxious Plant List

Species	Common Name	List Source[1]	MISAC Status
Salix alba	Willow, White	*MISAC*	Minimal/Established
Salix fragilis	Willow, Crack	*MISAC*	Minimal/Established
Salix x rubens	Willow, Hybrid	*MISAC*	Moderate/Established
Saponaria offinalis	Bouncing Bet	*MISAC*	Minimal/Established
Securigera varia (Syn. Coronilla varia)	Crown Vetch	*MISAC; MITPPC (77.32); MDA (R); Op Order 113*	Severe/Established
Silene latifolia	Campion, White	*MISAC*	Minimal/Established
Silene vulgaris	Campion, Bladder	*MISAC*	Minimal/Established
Silybum marianum	thistle, milk	*MISAC*	Severe/Not in state
Solanum dulcamara	Bittersweet Nightshade	*MISAC*	Minimal/Established
Sonchus arvensis	Sowthistle, perennial	*MISAC*	Moderate/Established
Sorbus aucuparia	European Mountain-ash	*MISAC*	Minimal/Established
Tamarisk spp.	Saltcedar	*NDDA*	NA
Tanacetum vulgare	Tansy	*MISAC; MITPPC (91.39); MDA (C); Op Order 113; Pembina*	Severe/Established
Torilis japonica	Japanese Hedge-parsley	*MITPPC (48.01)*	NA
Toxicodendron radicans	Poison Ivy	*MDA (S)*	NA
Trifolium hybridum	Clover, Alsike	*MISAC*	Considered/not ranked
Trifolium pratense	Clover, Red	*MISAC*	Minimal/Established
Trifolium repens	Clover, White	*MISAC*	Moderate/Established
Ulmus pumila	Siberian Elm	*Op Order 113*	NA
Verbascum thaspus	Mullein	*MISAC*	Minimal/Established
Viburnum opulus	Europ. Highbush Cranberry	*MISAC*	Moderate/Established

[1] MDA-Minnesota Department of Agriculture (E-Eradicate, C-Control, S- Special); Op Order 113-Minnesota Department of Natural Resources Operational Order 113; MISAC-Minnesota Invasive Species Advisory Council; MITPPC-Minnesota Invasive Terrestrial Plants and Pests Center; NDDA-North Dakota Department of Agriculture; Pembina-Pembina County, North Dakota

Attachment C

Terrestrial Plant Invasive and Noxious Species Survey Results

Attachment C INS Documented from 2015-2019 within the L3R Construction Right-of-Way [a]							
County	**Scientific Name**	**Common Name**	**Listing [b]**	**Land Owner / Administrator**			**Total**
				FDL [c]	**MDNR [c]**	**Other [d]**	
Aitkin	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	3	-	**3**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	3	-	**3**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	24	10	**34**
	Lotus corniculatus	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	17	1	**18**
	Phalaris arundinacea	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	28	3	**31**
	Phragmites australis	Common Reed	MITPPC (86.32); MDA (R); Op Order 113	-	6	-	**6**
	Securigera varia	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	-	18	2	**20**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	37	6	**43**
	Toxicodendron radicans	Poison Ivy	MDA (S)	-	12	2	**14**
Carlton	*Arctium minus*	Common Burdock	MISAC	3	-	-	**3**
	Berteroa incana	Hoary Alyssum	MISAC; MITPPC (69.09)	21	-	-	**21**
	Campanula rapunculoides	Creeping Bellflower	MISAC	5	-	-	**5**
	Caragana arborescens	Siberian Peashrub	MITPPC (57.16); Op Order 113	1	-	-	**1**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	26	-	6	**32**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	79	12	15	**106**
	Cirsium vulgare	Bull Thistle	MISAC	36	-	-	**36**
	Convolvulus arvensis	Field bindweed	MISAC	3	-	-	**3**
	Daucus carota	Wild Carrot	MISAC; MITPPC (52.84); MDA (R); Op Order 113	16	-	-	**16**
	Echinochloa crusgalli	Barnyard Grass	MISAC	11	-	-	**11**
	Elytrigia repens	Quackgrass	MISAC	26	-	-	**26**
	Euphorbia esula	Leafy Spurge	MISAC; MITPPC (79.05); MDA (C); Op Order 113	3	-	-	**3**
	Glechoma hederacea	Creeping Charlie	MISAC	1	-	-	**1**
	Hemerocallis fulva	Orange Day Lily	MISAC	1	-	-	**1**
	Hieracium spp.	Hawkweed	MITPPC (60.52/60.46)	63	-	-	**63**
	Hypericum perforatum	St. John's Wort	MISAC	3	-	-	**3**
	Leucanthemum vulgare	Oxeye Daisy	MISAC	45	-	-	**45**
	Linaria vulgaris	Butter-and-Eggs	MISAC	7	-	-	**7**
	Lonicera x bella	Bell's Honeysuckle	MISAC; MDA (R); Op Order 113	6	-	-	**6**
	Lotus corniculatus	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	55	-	-	**55**
	Lupinus polyphyllus	Big-leaf Lupine	MISAC	3	-	-	**3**
	Lythrum salicaria	Purple Loosestrife	MISAC; MDA (C); Op Order 113	2	-	-	**2**
	Medicago lupulina	Black Medic	MISAC	14	-	-	**14**

Attachment C INS Documented from 2015-2019 within the L3R Construction Right-of-Way [a]							
County	**Scientific Name**	**Common Name**	**Listing [b]**	**Land Owner / Administrator**			**Total**
				FDL [c]	**MDNR [c]**	**Other [d]**	
	Melilotus spp.	Sweetclover	MITPPC (70.33/71.49)	20	-	-	**20**
	Pastinaca sativa	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	15	-	-	**15**
	Phalaris arundinacea	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	79	1	-	**80**
	Phleum pratense	Timothy	MISAC	62	-	-	**62**
	Potentilla argentea	Silver Cinquefoil	MISAC	14	-	-	**14**
	Potentilla recta	Sulphur Cinquefoil	MISAC	15	-	-	**15**
	Ranunculus acris	Tall Buttercup	MISAC	16	-	-	**16**
	Securigera varia	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	1	-	-	**1**
	Silene latifolia	White Campion	MISAC	27	-	-	**27**
	Solanum dulcamara	Bittersweet Nightshade	MISAC	1	-	-	**1**
	Sonchus arvensis	Perennial Sowthistle	MISAC	11	-	-	**11**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	144	18	43	**205**
	Trifolium spp.	Clover	MISAC	57	-	-	**57**
	Verbascum thaspus	Common Mullein	MISAC	3	-	-	**3**
	Viburnum opulus	Highbush Cranberry	MISAC	1	-	-	**1**
Cass	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	2	**2**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	2	8	**10**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	1	38	**39**
	Lotus corniculatus	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	2	-	**2**
	Phalaris arundinacea	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	3	-	**3**
	Securigera varia	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	-	3	-	**3**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	5	9	**14**
	Toxicodendron radicans	Poison Ivy	MDA (S)	-	2	-	**2**
Clearwater	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	2	85	**87**
	Carduus nutans	Musk Thistle	MISAC	-	-	2	**2**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	7	112	**119**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	5	129	**134**
	Lotus corniculatus	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	2	-	**2**
	Lythrum salicaria	Purple Loosestrife	MISAC; MDA (C); Op Order 113	-	-	2	**2**
	Phalaris arundinacea	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	2	-	**2**
	Rhamnus cathartica	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	11	**11**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	6	39	**45**

Attachment C
INS Documented from 2015-2019 within the L3R Construction Right-of-Way [a]

County	Scientific Name	Common Name	Listing [b]	Land Owner / Administrator			Total
				FDL [c]	MDNR [c]	Other [d]	
	Toxicodendron radicans	Poison Ivy	MDA (S)	-	3	-	**3**
Hubbard	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	2	87	**89**
	Centaurea jacea	Brown Knapweed	MDA (E); Op Order 113	-	-	1	**1**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	2	120	**122**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	1	87	**88**
	Lotus corniculatus	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	-	2	**2**
	Phalaris arundinacea	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	2	1	**3**
	Rhamnus cathartica	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	1	**1**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	2	64	**66**
	Toxicodendron radicans	Poison Ivy	MDA (S)	-	2	1	**3**
Kittson	*Cirsium arvense*	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	-	20	**20**
Marshall	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	1	**1**
	Centaurea jacea	Brown Knapweed	MDA (E); Op Order 113	-	-	2	**2**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	-	74	**74**
	Pastinaca sativa	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	-	-	3	**3**
	Rhamnus cathartica	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	9	**9**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	-	3	**3**
Pembina	*Bassia scoparia*	Kochia	NDDA	-	-	2	**2**
	Cirsium arvense	Canada Thistle	NDDA	-	-	29	**29**
	Euphorbia esula	Leafy Spurge	NDDA	-	-	2	**2**
	Tanacetum vulgare	Common Tansy	NDDA	-	-	2	**2**
Pennington	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	1	**1**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	-	1	**1**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	7	47	**54**
	Pastinaca sativa	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	-	-	1	**1**
	Rhamnus cathartica	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	4	7	**11**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	2	2	**4**
	Toxicodendron radicans	Poison Ivy	MDA (S)	-	-	1	**1**
Polk	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	22	**22**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	-	21	**21**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	-	23	**23**
	Phragmites australis	Common Reed	MITPPC (86.32); MDA (R); Op Order 113	-	-	1	**1**

Attachment C INS Documented from 2015-2019 within the L3R Construction Right-of-Way [a]							
County	**Scientific Name**	**Common Name**	**Listing [b]**	**Land Owner / Administrator**			**Total**
				FDL [c]	**MDNR [c]**	**Other [d]**	
	Rhamnus cathartica	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	2	**2**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	-	5	**5**
Red Lake	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	6	**6**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	-	3	**3**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	-	32	**32**
	Rhamnus cathartica	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	4	**4**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	-	1	**1**
St. Louis	*Berteroa incana*	Hoary Alyssum	MISAC; MITPPC (69.09)	1	-	-	**1**
	Campanula rapunculoides	Creeping Bellflower	MISAC	2	-	-	**2**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	16	-	-	**16**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	6	-	-	**6**
	Cirsium vulgare	Bull Thistle	MISAC	7	-	-	**7**
	Daucus carota	Wild Carrot	MISAC; MITPPC (52.84); MDA (R); Op Order 113	2	-	-	**2**
	Echinochloa crusgalli	Barnyard Grass	MISAC	7	-	-	**7**
	Elytrigia repens	Quackgrass	MISAC	3	-	-	**3**
	Hieracium spp.	Hawkweed	MITPPC (60.52/60.46)	8	-	-	**8**
	Hypericum perforatum	St. John's Wort	MISAC	4	-	-	**4**
	Leucanthemum vulgare	Oxeye Daisy	MISAC	14	-	-	**14**
	Lonicera x bella	Bell's Honeysuckle	MISAC; MDA (R); Op Order 113	2	-	-	**2**
	Lotus corniculatus	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	68	2	-	**70**
	Lythrum salicaria	Purple Loosestrife	MISAC; MDA (C); Op Order 113	2	-	-	**2**
	Medicago lupulina	Black Medic	MISAC	6	-	-	**6**
	Melilotus spp.	Sweetclover	MITPPC (70.33/71.49)	16	-	-	**16**
	Pastinaca sativa	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	9	-	-	**9**
	Phalaris arundinacea	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	9	1	-	**10**
	Phleum pratense	Timothy	MISAC	67	-	-	**67**
	Potentilla argentea	Silver Cinquefoil	MISAC	1	-	-	**1**
	Potentilla recta	Sulphur Cinquefoil	MISAC	1	-	-	**1**
	Ranunculus acris	Tall Buttercup	MISAC	7	-	-	**7**
	Securigera varia	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	-	2	-	**2**
	Sonchus arvensis	Perennial Sowthistle	MISAC	4	-	-	**4**
	Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	142	3	-	**145**

Attachment C INS Documented from 2015-2019 within the L3R Construction Right-of-Way [a]							
County	**Scientific Name**	**Common Name**	**Listing [b]**	**Land Owner / Administrator**			**Total**
				FDL [c]	**MDNR [c]**	**Other [d]**	
	Trifolium spp.	Clover	MISAC	66	-	-	**66**
Wadena	*Carduus acanthoides*	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	6	1	**7**
	Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	1	2	**3**
	Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	7	6	**13**
	Lotus corniculatus	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	1	-	**1**
	Phalaris arundinacea	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	3	-	**3**
	Securigera varia	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	-	5	2	**7**
	Toxicodendron radicans	Poison Ivy	MDA (S)	-	3	1	**4**
Total				**1,366**	**282**	**1,228**	**2,876**

[a] Includes Permanent Right-of-Way, Temporary Workspace, Additional Temporary Workspace, and Access Roads.

[b] MISAC - Minnesota Invasive Species Advisory Council; MITPPC - Minnesota Invasive Terrestrial Plants and Pests Center; MDA - Minnesota Department of Agriculture (E-Eradicate, C-Control, S-Special); Op Order 113 - Minnesota Department of Natural Resources Operational Order 113; NDDA – North Dakota Department of Agriculture.

[c] Three MDNR-administered properties overlap with the FDL reservation; therefore, observed occurrences within the overlapping boundaries are counted under both the FDL and MDNR categories.

[d] "Other" includes private land and public land that is not administered by the MDNR.

Attachment D

Treatment Methods for the Terrestrial Plant Invasive and Noxious Species

Attachment D Treatment Methods for the INS Plant Species Identified within the L3R Construction Right-of-Way and Access Roads				
Species	**Common Name**	**List Source [a]**	**Characteristics [b]**	**Growing Season Management [b]**
Arctium minus	Common Burdock	MISAC	• Biennial, herbaceous • Dry - mesic soils, disturbed sites - roadsides, ditch banks, old field, pasture • Seed propagation •First year rosette of large, heart-shaped, hairy leaves; Second year upright stem, 3' - 10' tall with broad, wooly leaves and purple flowers, burs	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application to first year rosette Oct. - Nov.
Artemisia absinthium	Absinth Wormwood	NDDA	• Perennial, herbaceous • Dry - mesic soils, disturbed sites - pasture, old field, roadsides • Seed propagation • woody upright stem, 3' - 5' tall with deeply lobed leaves and many yellow flower heads	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application June - Sept.
Bassia scoparia	Kochia	NDDA	• Annual, herbaceous • Dry soils, disturbed sites - cropland, pastures, fields, roadsides • Seed propagation • Multiple upright stems, 1' - 6' tall with 2" lance-shaped leaves	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - Sept.
Berteroa incana	Hoary Alyssum	MISAC; MITPPC (69.09)	• Annual, herbaceous • Dry soils, disturbed sites - roadsides, trail sides, gravelly stream banks, pastures, fields • Seed propagation • Multiple upright stems, 7" - 30" tall with small white flowers and seed pods	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - June
Campanula rapunculoides	Creeping Bellflower	MISAC	• Perennial, herbaceous • Dry soils - fields, stream banks, woodlands, prairies, roadsides, oak savannas, urban areas • Propagation through seeds and rhizomes • Upright stem, 1' - 3' tall with purple bell-shaped flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - Sept.
Caragana arborescens	Siberian Peashrub	MITPPC (57.16); Op Order 113	• Perennial, shrub • Dry -mesic soils - coniferous forest, hardwood forest, forest edge, rights-of-way, trail sides • Seed propagation • Multi-stemmed, up to 18' tall with tubular yellow flowers and 1" - 2" log seed pods	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide cut stem / basal bark application year-round
Carduus acanthoides	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	• Biennial, herbaceous • Dy - mesic soils - pastures, woodlands, waste areas, roadsides, ditches, stream banks • Seed propagation - development of large seed bank in short period of time • Upright stem, 1' - 4' tall with pink - purple terminal flowers and winged, spiny leaves	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - June and Oct. - Nov. • **See Attachment E for details**
Carduus nutans	Musk Thistle	MISAC	• Biennial, herbaceous • Dry to mesic soils - woodland, waste areas, roadsides, ditches, stream banks • Propagation through seed and tap root regeneration • First year basal rosette. Second year singular, upright stem, 1' - 7' tall with pink - purple terminal flowers and spiny wings from leaf bases	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - June and Oct. - Nov. • **See Attachment E for details**
Centaurea jacea	Brown Knapweed	MDA (E); Op Order 113	• Perennial, herbaceous • Cool, mesic soils - wet meadow, ditches, woodlands • Seed propagation • Multi-branched, 8" - 32" tall with pink - purple terminal disk flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - Nov. • **See Attachment E for details**
Centaurea stoebe	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	• Perennial, herbaceous • Dry - mesic soils, disturbed sites - old field, rail / road rights-of-way, gravel pits • Seed propagation • Multi-branched, 8" - 32" tall with pinkish - cream terminal disk flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - Nov. • **See Attachment E for details**
Cirsium arvense	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113; NDDA	• Perennial, herbaceous • Dry - mesic soils, disturbed sites - old field, roadsides, open woodland, prairie, wet meadow • Propagation through seed, root cuttings, rhizomes • Hairy, upright stem, 2' - 6' tall with purple terminal flowers and spiny edged leaves	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May and Sept. - Oct. • Herbicide cut stem application May - June • **See Attachment E for details**
Cirsium vulgare	Bull Thistle	MISAC	• Biennial, herbaceous • Dry - mesic soils, disturbed sites - pasture, roadsides, ditch banks • Seed propagation • Singular upright stem, 3' - 6' tall with purple disk shaped terminal flowers and spine tipped leaf lobes	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application to first year rosette Oct. - Nov.
Daucus carota	Wild Carrot	MISAC; MITPPC (52.84); MDA (R); Op Order 113	• Biennial, herbaceous • Dry to mesic soils, disturbed sites • Propagation through seed and tap root regeneration • First year basal rosette. Second year singular, upright stem, 3' - 4' tall with flat-top compound umbel of small white flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application to first year rosette June - Sept. • **See Attachment E for details**
Echinochloa crusgalli	Barnyard Grass	MISAC	• Annual, herbaceous grass • Mesic soils, disturbed sites - cropland, roadsides, river banks, lawns, old fields • Seed propagation • Sprawling stems, up to 5' tall with dense clusters of knot-like flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May
Elytrigia repens	Quackgrass	MISAC	• Perennial, herbaceous grass • Dry - mesic soils, disturbed sites - cropland, roadsides, river banks, lawns, old fields • Propagation through seed and rhizomes • Upright stems, 1' - 4' tall with .25" wide leaf blades	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May
Euphorbia esula	Leafy Spurge	MISAC; MITPPC (79.05); MDA (C); Op Order 113; NDDA	• Perennial, herbaceous • Dry - mesic soils • Seed propagation • Upright stem, 1' - 3' tall with small yellowish-green flowers and a milky sap	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May and Sept. - Oct. • **See Attachment E for details**

Attachment D
Treatment Methods for the INS Plant Species Identified within the L3R Construction Right-of-Way and Access Roads

Species	Common Name	List Source [a]	Characteristics [b]	Growing Season Management [b]
Glechoma hederacea	Creeping Charlie	MISAC	• Perennial, herbaceous • Mesic soils, degraded/disturbed sites - semi-shaded to shaded • Propagation through seeds and stolons • Creeping square stems, 2' long with blue - purple flowers and palmate leaves	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application Oct. - Nov. **• See Attachment E for details**
Hemerocallis fulva	Orange Day Lily	MISAC	• Perennial, herbaceous • Dry - mesic soils - roadsides, fields, stream banks • Propagation through seed and root segments • Upright stem, 2' - 5' tall with large orange flowers and sword=like leaves	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application early spring
Hieracium spp.	Hawkweed	MITPPC (60.46)	• Perennial, herbaceous • Dry soils, disturbed sites - old field, pasture, roadsides • Propagation through seeds and rhizomes • Upright stem, 10" - 20" tall with dense clusters of orange - yellow flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - June
Hypericum perforatum	St. John's Wort	MISAC	• Perennial, herbaceous • Dry soils, disturbed sites - fields, pastures, waste areas, forest edges • Propagation through seeds and rhizomes • Branched, upright stem, 1' - 5' tall with yellow terminal flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - June
Leucanthemum vulgare	Oxeye Daisy	MISAC	• Perennial, herbaceous • Dry - mesic soils, disturbed sites - old field, pasture • Propagation through seeds and rhizomes • Upright stem, 1' - 2' tall with terminal flowers of white petals with a central yellow disc	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - June
Linaria vulgaris	Butter-and-Eggs	MISAC	• Perennial, herbaceous • Dry - mesic soils, disturbed sites - old field, pasture, railroad yards, roadsides, waste places • Propagation through seeds and segmented roots • Upright stem, up to 4' tall with bright yellow flowers with a long spur arranged in clusters along the stem	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May and Sept. - Oct. **• See Attachment E for details (*Linaria dalmatica*)**
Lonicera spp.	Honeysuckle	MISAC; MITPPC (89.55); MDA (R); Op Order 113	• Perennial, shrub • Forest edges, disturbed sites, open upland, roadsides, old field/pasture • Propagation through seed and vegetative sprouting • Multi-stemmed, 6' - 15' tall with fragrant white, pink, red or yellow flowers or red/purple to orange berries	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application June - Oct. • Herbicide cut stem / basal bark application year-round **• See Attachment E for details**
Lotus corniculatus	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	• Perennial, herbaceous • Dry soils, disturbed sites - roadsides, old fields, prairies • Propagation through seeds and rhizomes • Sprawling stems, 12" - 24" tall with bright yellow, pea-like flowers pinnately compound leaves	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - June
Lupinus polyphyllus	Big-leaf Lupine	MISAC	• Perennial, Herbaceous • Dry - mesic soils, disturbed sites - fields, roadsides • Propagation through seeds, rhizomes • Upright stem, 2' - 4' tall with pea-shaped purple flowers on spike-like racemes	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - June
Lythrum salicaria	Purple Loosestrife	MISAC; MDA (C); Op Order 113	• Perennial, herbaceous • Mesic - wet soil, aquatic habitats/wetlands - ditches, wet meadow, stream banks, marshes • Propagation through seed and rhizomes • Upright, wood-like stem, 4' - 7' tall with spikes of pinkish - purple flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - Oct. • Herbicide cut stem application June - July **• See Attachment E for details**
Medicago lupulina	Black Medic	MISAC	• Annual, herbaceous • Dry - mesic soils, disturbed sites - roadsides, fields, lawns, waste areas • Seed propagation • Sprawling stem, 2" - 30" tall with small pea-like yellow flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - Oct.
Melilotus spp.	Sweetclover	MITPPC (71.49)	• Biennial, herbaceous • Dry soil - prairies, savannas, dunes, roadsides, old fields • Seed propagation • First year tri-lobed leaflets; Second year branched, upright stems, 3' - 5' tall with dense racemes of small white flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application early spring
Pastinaca sativa	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	• Monocarpic biennial, herbaceous • Dry - mesic soils, disturbed sites - old field, roadsides, abandoned lots • Seed propagation • First year basal rosette; Second year upright stem, 4' - 6' tall with flat umbels of small yellow flowers	• Herbicide foliar application to first year rosette May - June and Sept. - Oct. **• See Attachment E for details**
Phalaris arundinacea	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	• Perennial, herbaceous • Mesic - wet soil, aquatic habitats/wetlands - ditches, wet meadow, stream banks, marshes • Propagation through seed and rhizomes • Upright grass, 2' - 6' tall with 0.5" wide leaf blade and up to 0.5" long ligule	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May
Phleum pratense	Timothy	MISAC	• Perennial, herbaceous grass • Dry soils, deturbed sites - fields, woodland edges, roadsides, embankments, vacant los • Seed propagation • Upright stem, 12" - 40" with .33" wide leaf blades and a terminal 2" - 4" terminal spike	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May
Phragmites australis	Common Reed	MITPPC (86.32); MDA (R); Op Order 113	• Perennial, herbaceous grass • Shorelines of rivers/lakes, pond edges, marshes, roadside ditches • Propagation through seed, root fragments, rhizomes • Grass stems, up to 15' tall form dense clusters	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar / cut stem application Aug. - Oct. (after flower) **• See Attachment E for details**

Attachment D Treatment Methods for the INS Plant Species Identified within the L3R Construction Right-of-Way and Access Roads				
Species	Common Name	List Source [a]	Characteristics [b]	Growing Season Management [b]
Potentilla argentea	Silver Cinquefoil	MISAC	• Perennial, herbaceous • Dry soil - fields, prairies, roadsides • Propagation through seed and root segment • Sprawling stem, 1" - 20" tall with palmately compound leaves and yellow flowers at top of stem	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May
Potentilla recta	Sulphur Cinquefoil	MISAC	• Perennial, herbaceous • Dry soil - fields, prairies, roadsides • Propagation through seed and root segment • Upright stem, 12" - 30" tall with palmately compound leaves and pale yellow flowers at top of stem	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May
Ranunculus acris	Tall Buttercup	MISAC	• Perennial herbaceous • Mesic soils, disturbed areas - old field, field edges, woodland edges, roadsides • Seed propagation • Upright stem, 1' - 3' tall with yellow terminal flowers on long stalks	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May
Rhamnus cathartica	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	• Perennial, woody shrub • Forest edges, woodland understory • Propagation through seed and vegetative sprouting • Singular stem, 20' - 26' tall with small green flowers or purplish-black berries	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application June - Oct. • Herbicide cut stem / basal bark application year-round **• See Attachment E for details**
Securigera varia	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	• Perennial, herbaceous • Old field/pastures, roadsides • Propagation through seed and rhizomes • Reclining, dense masses of 2' - 6' stems with umbels of small pinkish flowers and pinnate leaves	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - Oct. **• See Attachment E for details**
Silene latifolia	White Campion	MISAC	• Annual, herbaceous • Dry soils, disturbed sites - cropland, field edges, roadsides, shorelines, waste areas • Propagation through seeds and root segments • Upright stem, 1' - 4' tall with downy foliage and showy white flower	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide resistant • Regular mowing and cultivation prior to going to seed
Solanum dulcamara	Bittersweet Nightshade	MISAC	• Perennial, herbaceous • Mesic soils - thickets, woodland, waste areas • Propagation through seeds and rhizomes • Vine, 2' - 8' long with flowers of purple petals and yellow stamens; Red berries	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May and Sept. - Oct.
Sonchus arvensis	Perennial Sowthistle	MISAC	• Perennial, herbaceous • Dry - mesic soils, disturbed sites - cultivated fields, pastures, woodlands, roadsides, gardens • Propagation through seed and root segments • Upright stem, 2' - 5' tall with bright yellow terminal flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May and Sept. - Oct.
Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113; NDDA	• Perennial, herbaceous • Dry -mesic, well drained soil, disturbed areas - trails edges, roadsides, pastures, old field, stream banks • Propagation through seed, root cuttings, rhizomes • Upright, woody-like stem, 2' - 5' tall with flat clusters of yellow, button-like flowers	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - Nov. **• See Attachment E for details**
Toxicodendron radicans	Poison Ivy	MDA (S)	• Perennial, shrub • Prairie, woodland, disturbed sites - roadsides, trail sides, fencerows, parks • Propagation through seed and rhizomes • Dense shrub, 1' - 2' tall with three shiny leaves, small green flowers, tannish berries	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application May - July • Herbicide cut stem application Aug. - Nov. **• See Attachment E for details**
Trifolium spp.	Clover	MISAC	Perennial, herbaceous Mesic soils - open woodland, roadsides, lawns, fields Propagation through seeds and stoloniferous stems Upright stem, 3" - 6" tall with round flower head	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May
Verbascum thaspus	Common Mullein	MISAC	• Biennial, herbaceous • Dry soils, disturbed areas - pasture, old field, wastelands • Seed propagation • First year thick-, fuzzy-leaved rosette; Second year upright stem, 2' - 6' tall with long wooly leaves and small yellow flowers on terminal spikes	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application April - May and Sept. - Oct.
Viburnum opulus	Highbush Cranberry	MISAC	• Perennial, shrub • Mesic soil - Forest edges, disturbed sites, open upland, roadsides, old field/pasture • Propagation through seed and vegetative sprouting • Multi-stemmed, 10' tall with white flowers or red berries	• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging) • Herbicide foliar application June - Oct. • Herbicide cut stem / basal bark application year-round

Attachment D Treatment Methods for the INS Plant Species Identified within the L3R Construction Right-of-Way and Access Roads				
Species	Common Name	List Source [a]	Characteristics [b]	Growing Season Management [b]

[a] MISAC - Minnesota Invasive Species Advisory Council; MITPPC - Minnesota Invasive Terrestrial Plants and Pests Center; MDA - Minnesota Department of Agriculture (E-Eradicate, C-Control, S-Special, R-Restricted); Op Order 113 - Minnesota Department of Natural Resources Operational Order 113; NDDA - North Dakota Department of Agriculture.

[b] Plant characteristics and management methods provided are generalized. Additional technical instruction is necessary from herbicide manufacturers or agencies prior to implementation. Provided characteristics and methodologies are derived from:

Minnesota Department of Transportation. Minnesota Noxious Weeds. 2018. http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf
Ohio State University. Pocket Gardner. https://hvp.osu.edu/pocketgardener/source/index.html
Wisconsin Department of Natural Resources. Terrestrial Invasive Species. 2015. https://dnr.wi.gov/topic/Invasives/species.asp?filterBy=Terrestrial&filterVal=Y
University of California. Statewide Integrated Pest Management Program. http://ipm.ucanr.edu/
Ohio State University. Ohio Perennial and Biennial Weed Guide. http://www.oardc.ohio-state.edu/weedguide/index.php
Minnesota Department of Natural Resources. Invasive Terrestrial Plants. https://www.dnr.state.mn.us/invasives/terrestrialplants/index.html
North Dakota State University. Identification and Control of Invasive and Troublesome Weeds in North Dakota. 2018. https://www.ag.ndsu.edu/publications/crops/identification-and-control-of-invasive-and-troublesome-weeds-in-north-Dakota
University of California. Weed Research and Information Center. Weed Control in Natural Areas in the Western United States. 2013. https://wric.ucdavis.edu/information/natural%20areas/natural_areas_common_A-B.htm
Washington State, King County. Weed Identification photos - Index for identification and control of noxious weeds. 2019. https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification.aspx
U.S. Forest Service. Invasive Species Program - Species Profiles. 2016. https://www.fs.fed.us/invasivespecies/speciesprofiles/index.shtml
Minnesota Wildflowers. A Field Guide to the Flora of Minnesota. https://www.minnesotawildflowers.info/
PennState Extension. Weed Identification and Control. https://extension.psu.edu/pests-and-diseases/pest-disease-and-weed-identification/weed-identification-and-control
Texas A&M Agrilife Extension. AquaPlant. https://aquaplant.tamu.edu/plant-identification/category-emergent-plants/
Pacific Northwest Extension. Pest Management Handbooks. Weed Management Handbook. https://pnwhandbooks.org/weed

Attachment E

Minnesota Department of Transportation
Minnesota Noxious Weeds Guide

Minnesota Noxious Weeds

Includes Native and Nonnative Look-alike Species for Comparison

DEPARTMENT OF TRANSPORTATION

Attachment 1 to MNRD Non-Local Beings Report

Minnesota State Listed Noxious Weeds

Category	Page	Common Name	Scientific Name	Family
Prohibited: Eradicate	4	Black swallow-wort	*Cynanchum louiseae* Kartesz & Gandhi	Asclepiadaceae
	5-6	Common / cutleaf teasel	*Dipsacus fullonum* L. and *D. laciniatus* L.	Dipsacaceae
	7	Dalmatian toadflax	*Linaria dalmatica* (L.) Mill.	Scrophulariaceae
	8	Giant hogweed	*Heracleum mantegazzianum* Sommier & Levier	Apiaceae
	9	Grecian foxglove	*Digitalis lanata* Ehrh.	Scrophulariaceae
	10	Japanese hops	*Humulus japonicus* Siebold & Zucc.	Cannabaceae
	11	Oriental bittersweet	*Celastrus orbiculatus* Thunb.	Celastraceae
	12	Palmer amaranth	*Amaranthus palmeri* S. Watson	Amaranthaceae
	13	Poison hemlock	*Conium maculatum* L.	Apiaceae
	14	Yellow starthistle	*Centaurea solstitialis* L.	Asteraceae
	15-16	Brown knapweed	*Centaurea jacea* L.	Asteraceae
		Meadow knapweed	*Centaurea* x *moncktonii* C.E. Britton [*jacea* × *nigra*]	Asteraceae
		Diffuse knapweed	*Centaurea diffusa* Lam.	Asteraceae
Prohibited: Control	17	Spotted knapweed	*Centaurea stoebe* L. subsp. *micranthos* (Gugler) Hayek	Asteraceae
	18	Barberry, common	*Berberis vulgaris* L.	Berberidaceae
	19	Canada thistle	*Cirsium arvense* (L.) Scop.	Asteraceae
	20	Plumeless thistle	*Carduus acanthoides* L.	Asteraceae
	21	Leafy spurge	*Euphorbia esula* L.	Euphorbiaceae
	22	Narrowleaf bittercress	*Cardamine impatiens* L.	Brassicaceae
	23	Purple loosestrife	*Lythrum salicaria* L. and *Lythrum virgatum* L.	Lythraceae
	24	Common tansy	*Tanacetum vulgare* L.	Asteraceae
	25	Wild parsnip	*Pastinaca sativa* L.	Apiaceae
Restricted Noxious Weeds	26	Asian bush honeysuckles	*Lonicera* spp.	Caprifoliaceae
	27	Black locust	*Robinia pseudoacacia* L.	Fabaceae
	28	Crown Vetch	*Securigera varia* (L.) Lassen	Fabaceae
	29	Common buckthorn	*Rhamnus cathartica* L.	Rhamnaceae
	30	Glossy buckthorn	*Frangula alnus* Mill.	Rhamnaceae
	31	Garlic mustard	*Alliaria petiolata* (M. Bieb.) Cavara & Grande	Brassicaceae
	32-33	Japanese barberries	*Berberis thunbergii* DC. and listed hybrids and cultivars.	Berberidaceae
	34	Multiflora rose	*Rosa multiflora* Thunb.	Rosaceae
	35	Nonnative phragmites	*Phragmites australis* (Cav.) Trin. Ex Steud. subsp. *Australis*	Poaceae
	36	Porcelain berry	*Ampelopsis brevipedunculata* (Maxim) Trautv.	Vitaceae
	37	Tree-of-heaven	*Ailanthus altissima* (Mill.) Swingle	Simaroubaceae
	38	Wild carrot	*Daucus carota* L.	Apiaceae
Specially Regulated	39	Amur maple	*Acer ginnala* Maxim.	Aceraceae
	40-41	Knotweed, Japanese	*Polygonum cuspidatum* Siebold & Zucc.	Polygonaceae
		Knotweed, giant	*Polygonum sachalinense* F. Schmidt ex Maxim.	Polygonaceae
	42	Poison ivy - western	*Toxicodendron rydbergii* (Small) Green	Anacardiaceae
		Poison ivy - common	*T. radicans* (L.) Kuntze subsp. *negundo* (Greene) Gillis	Anacardiaceae

Each Specially Regulated species is subject to unique restrictions. See notes on page 74

Scientific names (genus and species) were sourced from : USDA Plants Database

Dalmatian toadflax

Japanese hops

Garlic mustard

Plant descriptions provided for comparison: nonnative and native Minnesota plants.

Following are plants, commonly misidentified as a species on the noxious weed list. It is important to identify and protect the native plants, while at the same time managing the State listed noxious weeds.

As for the nonnatives listed here, while these plants may be aggressive on some sites, management is usually not a high priority.

Nonnative Plants
Provided for comparison

Page	Common Name	Scientific Name	Family
43	Alfalfa	*Medicago sativa* L.	Fabaceae
	Hairy vetch	*Vicia villosa* Roth	Fabaceae
44	Balkan catchfly	*Silene csereii* Baumgarten	Caryophyllaceae
45	Carrot look-alikes	Various genus and species of the carrot family	Apiaceae
46	Chervil, wild	*Anthriscus sylvestris* (L.) Hoffm.	Apiaceae
47	Musk or nodding thistle	*Carduus nutans* L.	Asteraceae
48	Yellow rocket	*Barbarea vulgaris* W.T. Aiton	Brassicaceae

Minnesota Native Plants
Provided for comparison

Page	Common Name	Scientific Name	Family
49	American bittersweet	*Celastrus scandens* L.	Celastraceae
50	American vetch	*Vicia americana* Muhl. Ex Willd.	Fabaceae
	Canadian milkvetch	*Astragalus canadensis* L.	Fabaceae
51	Cherries / wild plum	*Prunus* spp.	Rosaceae
52	Common hops	*Humulus lupulus* L.	Cannabaceae
53	Cow-parsnip	*Heracleum maximum* W. Bartram	Apiaceae
54	Cucumber, wild and bur	*Echinocystis lobata* Michx. and *Sicyos angulatus* L.	Cucurbitaceae
55	Fireweed	*Chamerion angustifolium* (L.) Holub subsp. *angustifolium*	Onagraceae
56	Golden alexanders	*Zizia* spp.	Apiaceae
57	Goldenrods	*Solidago* spp.	Asteraceae
58	Grape, riverbank	*Vitis riparia* Michx.	Vitaceae
59	Honeysuckles, native	*Diervilla lonicera* and *Lonicera* spp.	Caprifoliaceae
60	Native phragmites	*Phragmites australis* subsp. *americanus* Saltonstall	Poaceae
61	Sumacs	*Rhus typhina* L. and *R. glabra* L.	Anacardiaceae
62	Swamp thistle	*Cirsium muticum* Michx.	Asteraceae
63	Virginia creeper / Woodbine	*Parthenocissus quinquefolia* (L.) Planch. *P. vitacea* (Knerr) Hitch.	Vitaceae
64	Water hemlock	*Cicuta maculata* L.	Apiaceae
65	Yarrow, Common	*Achillea millefolium* L.	Asteraceae

66-71 Citations to images and web links to reference materials.
72 Control Calendar: Suggested timing of control options
74 Definitions of noxious weed categories.


Field thistle (native)


Cow parsnip (native)


Stiff goldenrod (native)

Prohibited: Eradicate | Black swallow-wort : *Cynanchum louiseae* Kartesz & Gandhi

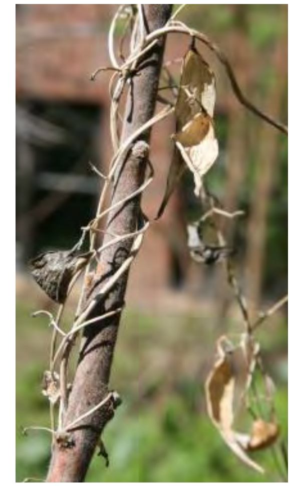
Identification: Synonyms: *C. nigrum* (L.) Pers., non Cav.; *Vincetoxicum nigrum* (L.) Moench

Plant: A perennial, herbaceous vine with a twining habit reaching heights of 3-8 feet. Only milkweed family member in Minnesota that vines. Also, plants have clear sap, not milky.

Leaves: Opposite, shiny and dark green foliage has a smooth (toothless) edge terminated by a pointed tip. Leaves are somewhat oval at 3-4 inches long by 2-3 inches wide.

Flower: Clustered, small (1/4 inch) dark purple flowers with five downy, thickened petals.

Bloom time is June to July.



Fruit and seed: Slender pods, taper to a point at about 1½-3 inches. Pods are described as milkweed-like and at maturity split open to release flattened seeds carried on the wind by downy, filamentous fibers.

Life History: Herbaceous vine that dies back to the ground every winter. Below ground rhizomes sprout to create a group of stems. With more stems, plants in full sun will produce more flowers and set more seed (up to 2,000/meter square). Long distance wind dispersal of seeds can begin in late July. Seeds contain one to four embryos which helps to ensure germination. Seed viability is potentially 5 years.

Habitat: Prefers full sun in upland soils. Disturbances, natural or human caused, provide an opening in which black swallow-wort can gain a foothold. Old fields, grasslands, road or rail corridors, quarries and other disturbed areas provide excellent habitat.

Management: Goals should be to control seed production and stimulate competitive plant cover. **Manual** removal and destruction of plants and root crowns will meet these goals.

Repeated mowing or **cutting** can impact plants, but will not eradicate a population. After early season mowing or cutting, plans must be in place to monitor and repeat the process as necessary. Black swallow-wort if cut early in the season can still produce seed that year and the goal of cutting is to eliminate seed production. If seeds are present, clean equipment before moving offsite.

Prescribed fire can be used in conjunction with other management efforts to encourage stands of native grasses that will compete with black swallow-wort for resources. Monitoring will be necessary to control resprouting and seedlings that germinate after burns are completed.

Herbicide applications should target plants at or beyond flowering stage. As plants reach maturity, foliar applications of glyphosate or triclopyr ester cover enough surface area to potentially deliver a lethal dose to the root system. Timing the application prior to pod formation may limit the production of viable seed that season. Applying herbicide to early emerging plants with limited foliar area will likely result in roots remaining viable and plants resprouting.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar				Treat actively growing plants - once flowering has begun. Treat plants having enough foliage to carry a lethal dose to the root system.					
	Cut stem									
	Mow									
	Don't mow				Follow-up mowing to control seed production.					
Flowering Period										

Prohibited: Eradicate | Common teasel : *Dipsacus fullonum* L.

Above: Bracts may be longer than flower head

Image right: common teasel (L), cutleaf teasel (R).

<u>Identification</u>: *Compare to Cutleaf teasel (next page) flower bracts and leaves.*

<u>Plant</u>: Herbaceous, monocarpic perennial (plant dies after bearing fruit), first identifiable as a basal rosette. At maturity 2-7 feet tall with erect, ridged and prickly stems.

<u>Leaves</u>: On upright stems - opposite, stalkless (sessile), cup-forming, up to 12 inches long by 3 inches wide, hairless, yellowish to reddish-green, *lance-shaped with a wavy edged margin*. Central leaf vein forms a whitish line on top with stout prickles below.

<u>Flower</u>: Many irregular, 4-parted and white to lavender flowers. Dense, cylindrically clustered heads up to 4 inches tall and 1½ inches wide.
Stiff and spiny flower bracts are very narrow (linear) and may be taller than flower clusters.

<u>Bloom time is June to October</u>.

<u>Fruit and seed</u>: Each floret or small flower produces one capsule containing a grayish-brown, slightly hairy seed.

<u>Life History</u>: During the rosette stage, which may extend beyond one season, the plant creates a substantial tap root, up to 24 inches long by 1 inch wide at the crown.

Each flower head can produce upwards of 2000 seeds with germination success of 30-80%. Seed on immature heads may still ripen. Seed is viable for approximately two years with typical dispersal up to 50 feet. Seed may be transported longer distances via water.

<u>Habitat</u>: Disturbed, open sunny site with moist to dry soils. Common on roadsides and disturbed areas.

<u>Management</u>:

Cutting of roots below ground and removal of as much as possible will limit sprouting. Accomplish cutting and removal of either life stage with tools such as dandelion pullers or a sharp shovel.

Mowing of the rosette stage does not kill the plant, however mowing of the flowering stalks can disrupt seed production. After mowing or cutting of flowering plants monitor for new flower heads. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal.

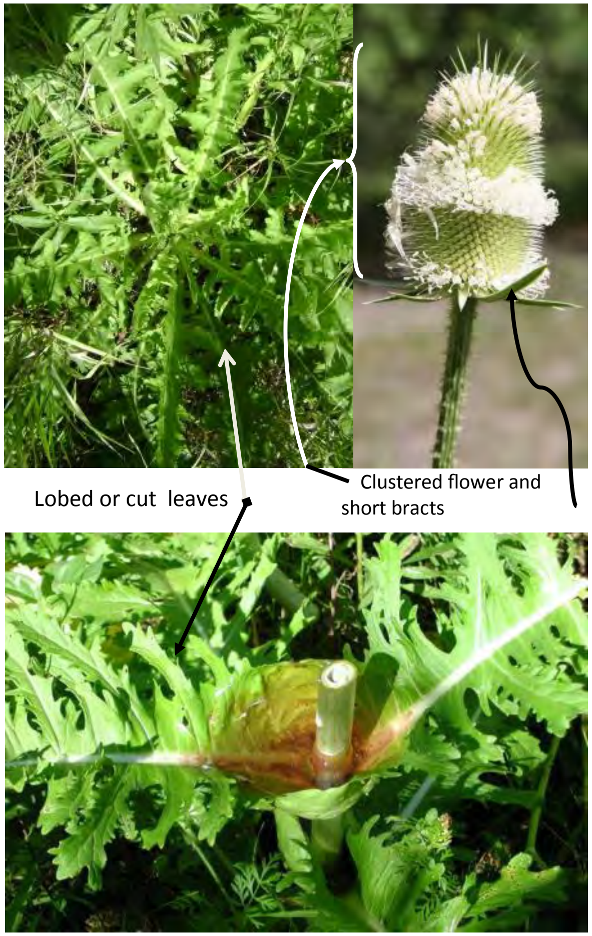
Prescribed fire can be used to increase competition from native warm season grasses, if they are present. Fire can also be used in combination with follow-up herbicide treatments. Keep in mind, high density infestations (large numbers of plants) will not burn well.

Herbicides such as metsulfuron methyl, clopyralid, triclopyr or 2,4-D amine are broadleaf specific herbicides that work on teasel at the rosette stage. Glyphosate is applicable but care must be exercised since it is not broadleaf specific.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem	Not applicable.								
	Mow		Mowing is not recommended: mowing does not kill the plant and flowering may still occur. Seed dispersal can occur if mature plants are mowed. Mower scalping creates a good seed bed.							
	Don't mow									
Flowering Period										

Prohibited: Eradicate

Cutleaf teasel : *Dipsacus laciniatus* L.



Identification: *Compare to common teasel (previous page) flower bracts and leaf shape.*

Plant: Herbaceous, monocarpic perennial (plant dies after bearing fruit), first identifiable as a basal rosette. Matures to 2-7 feet tall with erect, ridged and prickly stems.

Leaves: On upright stems - opposite, stalkless (sessile), cup-forming, up to 12 inches long by 3 inches wide, hairless, *lance-shaped, lobed with sinuses cut almost to the midrib*. Prominent leaf vein with stout prickles below.

Flower: Many irregular, 4-parted and white to lavender flowers. Dense, cylindrically clustered heads up to 4 inches tall and 1½ inches wide.
Spiny, stiff flower bracts are not taller than flower cluster and are wider than cut-leaf teasel.

Bloom time is July to September.

Fruit and seed: Each floret or small flower produces one capsule containing a grayish-brown, slightly hairy seed.

Life History: During the rosette stage, which may extend beyond one season, the plant creates a substantial tap root, up to 24 inches long by 1 inch wide at the crown.

Each flower head can produce upwards of 2000 seeds with germination success of 30-80%. Seed on immature heads may reach viability. Seed is viable for approximately 2 years with typical dispersal up to 50 feet. Seed may be transported longer distances via water.

Habitat: Disturbed, open sunny site with moist to dry soils. Common on roadsides and disturbed areas.

Management:

Cutting of roots below ground and removal of as much as possible will limit sprouting. Accomplish cutting and removal of either life stage with tools such as dandelion pullers or a sharp shovel.

Mowing of the rosette stage does not kill the plant, however mowing of the flowering stalks can disrupt seed production. After mowing or cutting of flowering plants monitor for new flower heads. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal.

Prescribed fire can be used to increase competition from native warm season grasses, if they are present. Fire can also be used in combination with follow-up herbicide treatments. Keep in mind, high density infestations (large numbers of plants) will not burn well.

Herbicides such as metsulfuron methyl, clopyralid, triclopyr or 2,4-D amine are broadleaf specific herbicides that work on teasel at the rosette stage. Glyphosate is applicable but care must be exercised since it is a non-selective herbicide.

Left: teasel flowering on short stems after being mowed.

Right: Prickles underside of leaf.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem	Not applicable.								
	Mow		Mowing is not recommended: mowing does not kill the plant and flowering may still occur. Seed dispersal can occur if mature plants are mowed. Mower scalping creates a good seed bed.							
	Don't mow									
Flowering Period										

Prohibited: Eradicate | Dalmatian toadflax : *Linaria dalmatica* (L.) Mill.

Identification: *Compare to introduced Balkan catchfly (Silene csereii). See page 44.*

Plant: A short-lived herbaceous perennial up to 4 feet tall. Base may be woody and plant is often branched. Waxy stems and leaves have a bluish-gray color.

Leaves: Alternate leaves 1-3 inch in length clasp stems, are wider and more heart-shaped than similarly flowered butter-and-eggs (*Linaria vulgaris*).

Flower: Erect, spike-like racemes of yellow flowers with orangey center markings. Flowers are 1-1½ inches long with slender spurs extending downward from the back.

Bloom time is May to September.

Fruit and Seed: On average 140-250 seeds are contained in ½ inch long pods. Seeds are dark in color, flattened, angular and 3-edged with a slight, narrow wing on each edge. Mature plants produce up to 500,000 seeds with soil viability up to 10 years.

Life History: Reproduction is primarily by seed that is viable in the seedbank up to 10 years, but the plant also forms colonies via vegetative reproduction from roots.

Habitat: Rapidly colonizes disturbed sites such as roadsides, rail right-of-way, and other locations including cultivated ground. Prefers a drier site in coarse, well-drained soils.

Management: Recommendation - identify and treat early.

Eradication is the goal in Minnesota; therefore, biological control is not a compatible option at this time.

Prescribed fire can set plants back and drain some energy while **mowing** can prevent or delay seed production. However, both stimulate vegetative reproduction, thus potentially increasing stem counts. Monitor the infestation and consider follow-up treatments of periodic mowing and / or herbicide treatments.

Manual methods including, **cutting**, **hand pulling** or **tillage** if done repeatedly and in conjunction with other treatments may control infestations. **Grazers** eat the flowers, but may also carry the seeds.

Herbicide formulations of chlorsulfuron, dicamba, imazapic or picloram have had reported success. Also, combinations of picloram and chlorsulfuron or imazapic and chlorsulfuron or diflufenzopyr and picloram and chlorsulfuron are being used in some areas. Re-treatment is likely necessary.

Below center: early season regrowth.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn	Fire does not kill rhizomes. Result is likely an increased stem count.								
Herbicide	Foliar	■	■				■	■		
	Cut stem									
	Mow	Mowing can prevent seed production, but forces vegetative reproduction.								
	Don't mow	Therefore, after mowing, monitoring and repeating the process is likely necessary.								
Flowering Period			■	■	■	■	■			

Prohibited: Eradicate	Giant hogweed : *Heracleum mantegazzianum* Sommier & Levier

Identification: *Compare to native cow-parsnip (Heracleum lanatum). See page 53.*

Plant: Herbaceous, biennial giant at 10-15 feet tall (potentially 20 feet). When flowering the second year, 2-4 inch diameter hollow stalks are mottled reddish-purple with sturdy bristles.

Leaves: Alternate, up to 5 feet across, compound leaves with 3 deeply incised (cut) leaflets which may be further divided. The spotted leaf stalks, underside of leaves and stems are covered with coarse white hairs.

Flower: Large, flat umbels of small white florets create massive displays up to 2½ feet in diameter. Bloom time is June to July.

Fruit and Seed: Seed is large, flattened, with visible brown resin canals.

Life History: A single flower head can produce upwards of 1500 seeds. First season basal rosette foliage can be 1-5 feet across with flower stalks typically appearing in the second season. When plants die a large bare patch of soil results which creates a good seed bed and potential erosion problems.

Habitat: Moist soils of woodlands and riparian zones with partial shade as found on woodland edges.

Management: Caution! Use protective clothing, goggles or face mask. Caution!

Phytophotodermatitis,
contact with bristles (stiff hairs) or sap of plants (i.e., phyto)
when combined with exposure to sunlight (i.e., photo)
can cause severe blistering and swelling (i.e., dermatitis).

Manual methods including cutting and removal by hand are effective on small infestations. The focus of this method is to prevent seed production. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal.

Root systems can be weakened by repeated cutting but consider removal for best results. After cutting, monitor sites for follow-up treatment needs.

Herbicide applications of triclopyr or glyphosate are effective when applied early season to basal rosettes. If manual methods such as cutting are used early in the season, plan on returning to chemically treat re-sprouts.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar	Before the plant flowers.						Treat rosettes		
	Cut stem									
	Mow					Cut and remove roots and				
	Don't mow					or seeds by hand for disposal.				
Flowering Period										

Prohibited: Eradicate | Grecian foxglove : *Digitalis lanata* Ehrh.

Identification:

Plant: Herbaceous, perennial beginning its first year as a basal rosette with a single flowering stalk from 2-5 feet tall in subsequent years.

Leaves: Alternate, smooth, stalk-less upper leaves with toothless edges are narrow (lance-shaped). Basal leaves are more oval with rounded tips and are densely woolly.

Flower: Many tubular flowers attached to a central stalk (raceme) with bloom progression from the bottom to the top of the stalk. Flowers have a brown or purple veined upper hood and a creamy-white, elongated lower lip.

Bloom time is June to July.

Fruit and seed: Seed capsules are 2-parted and split to release tiny reddish-brown seed with 3-4 year viability. The hook (stiff, persistent style of the flower) on the seed pods are easily caught on clothing or fur and transported to new locations.

Life History: A perennial plant that blooms following its first year as a basal rosette. Each flower produces numerous seeds that are viable for up to 4 years. Small wingless seeds are easily transported by birds, animals, human activity as well as wind and water.

Habitat: Minnesota sites are in full sun to partial shade along roads, woodland edges and in open fields.

Management: Caution! Grecian foxglove contains toxins (cardiac glycosides) that potentially can be absorbed through the skin. These compounds are harmful to livestock and humans. Do not pull or handle this plant without protective clothing, in particular, rubber gloves and long sleeves are required.

Repeated mowing or **cutting** to prevent flowering throughout the year and over several years can drain plants of energy and help control an infestation. Since flowering can occur on mowed, short stems follow-up treatments with herbicide may be necessary.

Prescribed fire, there is no research information available at this time.

Herbicide applications in May and again in July are beneficial to knock down plants before flowering can occur. A fall application is also recommended to kill basal rosettes that were missed earlier or that developed during the season. Metsulfuron-methyl formulations are recommended for good control.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Eradicate | Japanese hops : *Humulus japonicus* Siebold & Zucc.

Below left: Male flower structure.
Below right: Female flower structure.

Identification: *Compare to native common hops (Humulus lupulus). See page 52.*
Compare to native cucumbers, wild and bur (Echinocystis lobata and *Sicyos angulatus). See page 54.*
Compare to native Virginia creeper/woodbine (Parthenocissus spp.). See page 63.

Plant: Herbaceous, annual vine trailing on the ground or climbing vegetation and infrastructure. Stems are covered with downward pointing prickles.

Leaves: Opposite, 2-5 inches long and almost as wide, with 5-7 (maybe 9) palmate lobes. *Compare to common hops: typically 3-lobed occasionally 5.* Japanese hops leaves are rough and edges are toothed. Two bracts (stipules) are at leaf stalk bases and the leaf stalks (petioles) are as long or longer than the leaves.

Flower: Male flowers and female flowers are on separate plants (dioecious). Flowers are small and greenish to reddish, not showy. Male flowers are branched clusters (panicles) while the female flowers are drooping structures that are rather plump and composed of overlapping reddish bracts or scales (hops).

Bloom time is July into August.

Fruit and Seed: Single flattened seeds from each female flower. Each inflorescence produces several seeds that mature in September.

Life History: An annual plant germinating early spring and growing quickly as summer progresses. Vines quickly cover small trees and shrubs weighing them down to the point of breakage and limiting their sunlight. Japanese hops flower in July-August, seeds mature in September. Soon after a killing frost, fragile vines fall apart dispersing their seed.

Habitat: Tolerant of disturbed roadside conditions if there is moist soil. Species prefers conditions found in riparian areas including full sunlight and exposed soils that are moist and rich.

Management: Caution! Stem prickles are known to irritate the skin, long clothing and gloves are recommended.

Manual methods including **cutting** and **pulling**, while labor intensive, can be successful on small infestations. Efforts should be focused on early season work when plants are small and limited entanglement with surrounding vegetation or structures has occurred.

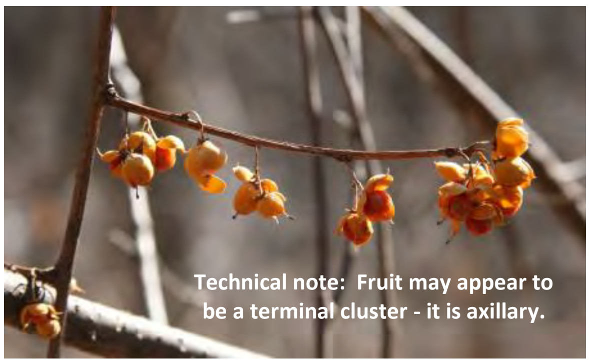
If the area is accessible to **mowers** and vines have limited structure for climbing, such as trees and fences, then **mowing** is an effective method to control maturity and seed production.

Herbicides include pre-emergent and post-emergent applications. Both are useful since this is an annual plant with prolific seed production capabilities. Pre-emergent should be applied prior to the growing season beginning in late March or early April. Once germination has occurred a switch to foliar applications should be made in an effort to keep plants from maturing and producing seed.

Below: Stem prickles

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Post-emerge									
	Pre-emerge									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Eradicate | Oriental bittersweet : *Celastrus orbiculatus* Thunb.



Above: location of fruit is in leaf axils (where leaves attach to stem).

Identification: *Compare to native [American bittersweet](#) (Celastrus scandens). See page 49.*

Plant: Woody, twining, perennial vines up to 60 feet long, reaches tree tops and covers fences. Stem diameters of 4 inches documented in Minnesota.

Leaves: Alternate, fine rounded teeth on the leaf edge, dark green and shiny turning yellow in autumn. Typically, elliptical with a blunt leaf tip and nearly as wide as long at 2-5 inches.

Flower: Female flowers are small, inconspicuous, greenish clumped (3-7) in leaf axils along stems. Dioecious species, male and female flowers on separate plants. Male flowers are also axial but may be terminal. Compare white pollen on male flowers to *yellowish pollen on American bittersweet flowers. Also, American bittersweet flowers are similar in size and color but are found **only terminal** on vine branches (on the ends).*

Bloom time is May to June.

Fruit and Seed: Along the vine in leaf axils are potentially 3-7 yellowish, 3-parted capsules enclosing reddish-colored, 3-parted, berry-like arils. Each part contains 1-2 seeds; therefore, potential total of 3-6 seeds per fruit. Dioecious, separate fruiting (female) and non-fruiting (male) plants. *American bittersweet's 3-parted fruit is more red, the 3-parted capsules more orange and fruits are terminal on the vine branches (on the ends).*

Life History: Vegetative reproduction occurs from below-ground rhizomes, above-ground stolons and suckering of roots. Birds will eat the fruits (arils) during the winter and disperse the seeds. Seeds germinate late spring.

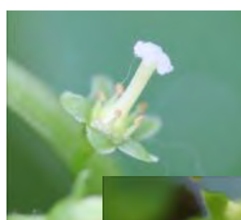
Habitat: Readily invades disturbed, open, sunny sites, yet Oriental bittersweet is moderately tolerant of shade allowing it to grow in open woodlands.

Management:

Prescribed fire research has shown that basal sprouting is stimulated and stand density increases dramatically.

Cutting of stems can be used to kill above ground portions of plants especially if the infestation is covering large areas or is climbing high into forest canopy. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#). Combine with herbicide applications for best results.

Herbicides that act systemically such as formulations of triclopyr or glyphosate can be applied as foliar, basal bark or cut stem applications. Foliar applications are reserved for easy to reach foliage, re-sprouting or along fence lines. Once foliage is out of reach, application to cut stems or basal bark will yield the best results.



Left above: greenish, female flower.
Left below: greenish male flower, note white pollen grains on anthers of the upper flower.

Right: Light brown seeds. Each structure is 3 parted and each part contains 1-2 seeds. Image shows 5 seeds from a single fruit.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn		Burning is not recommended							
Herbicide	Basal Bark									
	Foliar									
	Cut stem									
	Mow		Mowing is not recommended.							
	Don't mow									
Flowering Period										

Prohibited: Eradicate	Palmer amaranth : *Amaranthus palmeri* S. Watson

Above: male plants have soft flower spikes, female flower spikes have sharp bracts (below - upper right).

Below: poinsettia-like foliage, white V-shaped markings (inset), and thick stems.

Identification: Palmer amaranth is one of several native pigweeds and is native to southwestern deserts of the United States. Link: Pigweed Identification, a pictorial guide.

Plant: Herbaceous, annual plant, a potential growth rate of 2-3 inches per day. Plants attain heights of 6-8 feet, potentially 10 feet. Stems are stout, up to 2 inches thick and without hairs (smooth). Top-view of plants as foliage develops resembles a poinsettia.

Leaves: Alternate, green color, some plants with white V-shaped markings on leaves. Elliptical to diamond-shaped leaf blades terminated by a small spine. Petioles up to 2-3 times longer than leaves, image at right.

White petiole bent back over a green leaf blade.

Flower: Plants are dioecious with male and female flowers on separate plants. Flowers are not showy, but flower spikes are significant and useful in positive identification.

Bloom time is June to Sept. Flowers can occur 8 weeks post-emergence to end of season.

Fruit and seed: Seeds are dark colored and extremely small. Research shows pigweeds including palmer amaranth can produce upwards of 250,000 or more seeds per plant.

Life History: Seedling emergence can occur throughout the growing season; thus, flowering and seed set can persist late into the season. **Monitoring** is a necessary activity for control efforts. Seeds germinate in spring if within an inch of soil surface. Research on pigweeds suggests if seed is buried deeper than 3 inches viability is decreased annually with a potential longevity of approximately 3 years. Research on redroot pigweed (*A. retroflexus*) and waterhemp (*A. rudis*) suggests longevity can be as short as 3-4 years in Mississippi/Illinois or as long as 12 years in Nebraska.

Habitat: Native habitat is desert climate, species performs well during heat of summer. Pigweeds are shade intolerant.

Management: Preventing establishment is key. Proper identification and frequent scouting to limit seed production. **Repeated mowing** or **cutting** are not effective at controlling Palmer amaranth infestations. Continue monitoring and consider alternative methods such as cultivation, manual methods like hand-pulling or herbicide applications.

Prescribed fire has the potential to kill seedlings and drain energy from maturing plants, but fire should be considered as a tool to strengthen the health and competitive advantage of the desirable plant community.

Biotypes have shown resistance to **herbicides** in groups 2, 3, 5, 9 and 27 (Group number - check herbicide labels). Yet, **herbicide** applications both pre- and post- emergent are possible. Roger Becker (Univ. of MN, Agronomist) provided the following comment: “There are many products that will control the pigweed group across the different labeled sites, but the challenge will be knowing what the resistance of the particular biotype is that gets here (Minnesota), if at all. Many of the standard ROW (right-of-way) broadleaf materials will control non-resistant palmer.”

Useful herbicides in group 4 include 2,4-D, aminocyclopyrachlor, aminopyralid, clopyralid, and dicamba. Group 2 herbicides include imazapyr, imazapic, metsulfuron and sulfometuron. Nonselective glyphosate, group 9 and glufosinate, group 10 can be used depending on crop tolerance traits or desired vegetation outcomes for non-cropland sites.

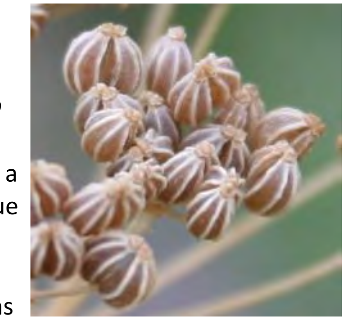
For best results, treat plants when they are small, under 1 foot tall.

As plants mature, use approved higher rates of herbicides.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn	Use fire to improve environment for competing native plant community.								
Herbicide	Post-emerge									
	Pre-emerge									
	Mow		If seed present, do not mow.							
	Don't mow				Follow-up mowing to control seed production.					
Flowering Period										

Prohibited: Eradicate | Poison Hemlock : *Conium maculatum* L.


Caution All plant parts are ***poisonous to humans*** and livestock. Caution
It is reported that toxin can be absorbed through bare skin! Wear appropriate PPE.



Identification: *Compare to wild carrot and native water hemlock on pages 38 and 64. Also compare to carrot look-alikes, wild chervil and common yarrow on pages 45, 46 and 65.*

Plant: Herbaceous, biennial, first year as a basal rosette and second year poison hemlock is a branched, 3-7 feet tall, robust plant. Stems are smooth (no hairs), hollow, appear ridged due to veins and are light green, mottled (spotted) with purplish spots.

Leaves: Alternate, generally triangular in form. Doubly or triply pinnately compound up to 18 inches long by 12 inches wide. Leaflets are fern-like, deeply divided and typically twice as long (2 inches) as wide (1 inch). Basal leaves tend to be larger and have longer petioles than upper stem leaves. Petiole to stem attachments are covered by a sheath.

Flower: Flat or slightly dome-shaped open compound umbels of 3-16 umbellets with 12-25 five-petaled, white florets. There are small ovate-lanceolate bracts with elongated tips under main umbels. Bracts are also present under umbellets.

Bloom time is variable - June to August.

Fruit and Seed: Paired seeds are ⅛ inch tall schizocarps, these split at maturity becoming two carpels . Each carpel is a seed, flattened on 1 side and lined vertically by broken ridges described as wavy ribs. There are no hairs.

Habitat: Partial shade is tolerated but preference is full sun with moist fertile soils. Often found near water or in riparian zones. Can tolerate drier conditions.

Management:

If performed frequently **cutting** or **mowing** are effective control methods to prevent seed production. Same is true for hand pulling, however roots and root fragments remaining in soil may resprout. Monitor and plan additional treatments.

Prescribed fire as a tool should be used to improve the health of surrounding native vegetation. Fire will kill seedlings and top kill other plants; however, after the fire healthy root systems will likely resprout.

Foliar herbicide applications to plants at rosette stage or during active growth (before flowering). Herbicide formulations with 2,4-D or 2,4-D including dicamba or triclopyr have produced good results. Nonselective herbicides such as glyphosate (concentration of 41% or greater) formulations can also produce results.

Other potential choices are formulations including aminopyralid, chlorsulfuron, clopyralid, dicamba, imazapic, imazapyr, metsulfuron-methyl or 2,4-D plus picloram.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn		Stimulate surrounding vegetation							
Herbicide	Foliar			Target pre-flower.						
						Target rosette				
	Mow		Mowing must be repeated to prevent flowering							
	Don't mow						When seed is present			
Flowering Period				■	■	■				

Prohibited: Eradicate | Yellow starthistle : *Centaurea solstitialis* L.

A member of the knapweeds, genus *Centaurea*.

Identification:

Plant: Herbaceous, annual with heights of 6 to 36 inches. Plants start as a biennial or winter annual with a basal rosette the first season. Mature plants are described as bushy with a grayish or bluish cast to otherwise green color.

Leaves: Basal leaves are lobed, dandelion-like at about 8 inches. Basal leaves may not persist as plants bolt to flower. Stem leaves are alternate, narrow to oblong and an extended leaf attachment provides a winged appearance to stems.

Flower: Approximately 1 inch long flowers with substantial ¾ inch yellowish spines emanating from bracts beneath flowers. Flowers are terminal and solitary on stems.

Bloom time is June to August.

Fruit and Seed: Each terminal flower produces between 35 to 80 plumeless or plumed seeds.

Life History: Yellow starthistle is a strong invader. Due to a lack of tufting on some seeds, reliance is on animals and humans for movement any distance from parent plants.

Habitat: Periods of summer drought favor infestations on disturbed sites such as roadsides. Also an invader of prairies, fields, woodlands and pastures where spines can cause injury to grazing animals.

Management: Caution! Gloves and long sleeves are recommended. Knapweeds have chemical and in some species physical defenses. These are known skin irritants.

Limit movement of seed on grazing animals, mowing equipment and vehicles.

Eradication is the goal in Minnesota; therefore, biological control is not a compatible option at this time.

Mowing, monitor infestations and time mowing at early flowering stages, soon after spine development.

Herbicide formulations of aminopyralid, clopyralid or picloram applied as foliar applications early in the growing season appear to be most effective.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Eradicate | Knapweed complex : *Centaurea* spp.

Top: Brown Knapweed, images Bugwood.org
Middle: Meadow knapweed, images T. Jacobson
Below: *Spotted* (left), Diffuse (center), *Russian* (right)
Image: Bugwood.org.

Prohibited: Eradicate Brown knapweed: *Centaurea jacea* L.
Prohibited: Eradicate Diffuse knapweed: *Centaurea diffusa* Lam.
Prohibited: Eradicate Meadow knapweed: *Centaurea* x *moncktonii* C. E. Britton [*jacea* × *nigra*]
Not listed Russian knapweed: *Acroptilon repens* (L.) DC. - synonym: *Centaurea repens* L.
Prohibited: Control *Spotted knapweed*: *Centaurea* *stoebe* L. ssp. *micranthos* (Gugler)

Advice, spotted knapweed is established in Minnesota. Learn to identify it and recognize when something is different. Please report infestations that are not easily identified as spotted knapweed to Early Detection and Distribution Mapping System EDDMaps or Minnesota Department of Agricultures Arrest the Pest.

Compare knapweeds on pages 15, 16 and 17. Compare to thistles (pages 19, 20, 47 and 62) and alfalfa / vetches (pages 43 and 50).

Identification:

Species / Characteristic	**Brown**	**Diffuse**	**Meadow**	***Russian*** *(Not Listed in Minnesota)*	***Spotted*** *(Prohibited: Control)*
Root Types	Short-lived perennial,	Short-lived perennial, tap root	Short-lived perennial,	*Long-lived perennial, creeping perennial, root spread horizontal.*	*Short-lived perennial, tap root.*
Bracts	Brown , with a tan papery tip (edge)	Rigid, spine-like tips	Long fringed (insect-like) Coppery, shiny (mature).	*Rounded bracts, smooth papery transparent tips*	*Darkened tip, short fringe.*
Flowers	Rose to Purplish, 1-1¼ inch wide.	Variable - white to rose Occasionally purplish	Rose to purplish ¾ inch wide.	*Pink to lavender ⅜ to ½ inch*	*Pinkish, cream is rare Approximately 1 inch*
Leaves	Not as deeply lobed as spotted knapweed	Basal leaves deeply and finely, divided with wide lobes.	Basal leaves mostly unlobed, smooth.	*Basal leaves are seldom divided, roughly fuzzy.*	*Gray-green, Deeply lobed leaves, roughly fuzzy*
Habitats	Prefers moist cooler soils.	Dry soils, disturbed sites	Moist soils, wet prairies	*Dry to moist soils, saline soils, disturbed sites*	*Dry to moist soils, disturbed sites*

Table adapted from sources: http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/knapweed.pdf
http://bugwoodcloud.org/mura/mipn/assets/File/KnapweedBrochure072814WEB.pdf

Plants: Herbaceous, typically short-lived perennials or biennial. Knapweeds ascend from woody root crowns and reach heights of 8 to 32 inches. Typically, multi branched with solitary, terminal disk flowers.
Leaves: Simple, alternate, green foliage. *Spotted* knapweed has foliage with fine hairs and a blue-gray color, while *meadow* knapweeds foliage is smooth and a green color. Some species are deeply lobed (*spotted*) while others like *brown knapweed* may not be lobed. In all species, basal leaves tend to be larger than the lance-shaped leaves above.
Flower: Flower colors varying from white to purplish make color a less reliable species identifier. Typically flowers are solitary, terminal to branches, purplish disk flowers that are surrounded by 5-petaled florets. Bracts that cover the bulb-like bases of flowers are 2-parted and the bract characteristics are diagnostic to species, especially the bract tips. Refer to the table above for comparison.

Prohibited: Eradicate | Knapweed complex : *Centaurea* spp.

Top: Brown knapweed
Images: Bugwood.org

Middle: Meadow knapweed
Images: Tom Jacobson, MnDOT.

Bottom left: Diffuse knapweed
Image: Bugwood.org

Bloom time is June to September.

Fruit and seed: Small (less than ⅛ inch) (2-3 mm), some have short, bristly hairs (pappus) at the top. A typical achene (seed) of the Aster family but pappus is limited and wind will not carry seeds.
Life History: Reproduction is by seed which can be moved by water, animals, and birds. Human activities are significant transporters of seed in products like mulch, soil or hay and straw. Seed is also potentially moved on construction or farm equipment, recreational vehicles, as well as on personal automobiles, clothes and recreational gear. Depending on species, seed viability can be up to eight years.

Currently unlisted and not known to be in Minnesota, Russian knapweed is a long-lived perennial with deep roots, potentially to 20 feet. Its roots are dark colored and scaley. Russian knapweeds foliage is blue-gray and has fine hairs, similar to spotted knapweed. It is reported that seed production of Russian knapweed is 'limited' but infestations spread aggressively by roots.

Habitat: *Brown and Meadow knapweeds* prefer moist soil types found along water, wet grasslands or meadows, irrigation ditches, roadsides and openings in woodlands. In contrast, other knapweeds tolerate drier sites such as old fields, road and rail right-of ways, gravel pits or similar disturbed areas.
All prefer full sun locations with the exception of *brown knapweed being tolerant of partial shade*.

Threat to Minnesota: potential development of hybrids that can take advantage of intermediate niches.

Management: Caution! When handling knapweed plants gloves and long sleeves are recommended since knapweeds have defenses that are known skin irritants.

Hand pulling or **digging** while time consuming can be an effective step when coupled with chemical treatments. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal.
Repeated mowing or **cutting** can reduce seed production, but sites must be monitored and applications likely repeated or followed up with herbicide treatments.
Prescribed fire can be used to encourage stands of native grasses that will compete with knapweeds. However, monitoring is needed to check for knapweed germination in bare soil soon after burns are completed.
Herbicide foliar applications with formulations including aminopyralid, clopyralid, or picloram have proven effective in controlling knapweeds.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar		Foliar treatments target rosettes.							
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Spotted knapweed : *Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek

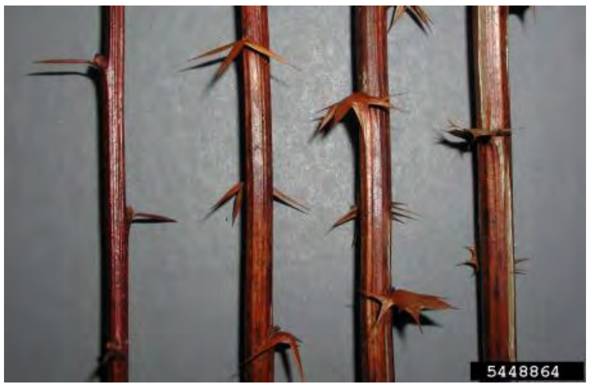
Identification: *Compare to knapweed complex members. See pages 15 and 16.*
Compare to nonnatives alfalfa and hairy vetch. See page 43.
Advice, spotted knapweed is established in Minnesota. Learn to identify it and recognize when something is different.

Compare flower similarities to Canada thistle, page 19.

Plant: Herbaceous, short-lived perennial living 1-4 years. Initial stage is a rosette before the plant produces 1-6 stems ranging from 1-4 feet tall.
Leaves: Simple, alternate, grayish-green basal rosette leaves up to 6 inches long have deep sinuses. Alternate leaves on mature stems vary from smaller, 1-3 inch, versions of the basal leaves to very small linear leaves near the top.
Key difference: *meadow / brown knapweed - green leaves, lacking lobes.*
Flower: Strongly resemble the flowers of thistles in their pink to purple color (rarely white) and multi-parted texture. Below the petals, flowers are held together by bracts that are stiff and tipped with darkened hairs (see image above).
Compare *bract tips; brown - brown, tan papery edge; diffuse - rigid, sharp spines - terminal spine can be ⅓ inch long; meadow - long fringed; Russian - rounded, opaque with transparent tips; and spotted - dark tip, short fringe.*
Bloom time is July to September.
Fruits and Seed: Small (⅛ inch long), brownish, tufted, seeds.
Life History: Allelopathic properties (chemicals exuded by the plant) can suppress the germination of seeds of other plants nearby. Plant removal can lead to bare patches of soil subject to erosion.
Seeds are the primary means of reproduction and a mature plant produces thousands of seeds that may remain viable for up to 5 years. Wind disperses seeds short distances while animal and human activity disperse it far and wide.
Habitat: In contrast to meadow knapweed's preference to moist sites, spotted knapweed prefers disturbed sites with gravely or sandy dry soils. Roadsides, abandoned lots, old fields and gravel pits are habitat that support infestations.
Management: Caution! Knapweeds are known skin irritants, therefore; if handling knapweed plants gloves and long sleeves are recommended.
Biological controls approved for use in Minnesota are seedhead weevils (*Larinus minutus* and *L.* obtusus) and a root-boring weevil (*Cyphocleonus achates).* Weevils are collected July through September and released on infestation sites larger than 1/3 acre. When a combination of seedhead and root boring weevils work together, infestations can be reduced over a number of years.
While **cutting, mowing** and **prescribed fire** can encourage competition from native grasses and help reduce the extent of an infestation they will likely not eradicate it. Early spring prescribed fire is compatible with biological control.
Herbicide formulations including aminopyralid, clopyralid, glyphosate, imazapyr, aminocyclopyrachlor or picloram have demonstrated control with foliar applications.

Above: basal rosette,
Middle right:
basal foliage,
Middle Left: linear foliage near top of plant,
Bottom right: flowers.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar		Foliar treatments target rosettes.							
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Control | Common Barberry : *Berberis vulgaris* L.

Above: common barberry spine variations.

Above: common barberry leaf variations.

Identification: *Compare to Japanese barberry on pages 32-33 and Korean barberry on page 33.*

Plant: Deciduous shrub reaching 8-10 feet in height and up to 6 feet in width. Slender branches are straight between nodes, strongly grooved and common barberry may have single or multi-branched spines, usually 3-branched possibly 5. Bark on second year stems is gray as opposed to reddish second year branches of Korean barberry.

Key difference - *Japanese barberry spines, usually single maybe 3-branched. Korean has 1-5 (7), often 3, flat spines.*

Leaves: Alternate, but clustered not appearing alternate, simple leaves are ovate, narrow near the base, toothed on the edges, described as finely serrate, as few as 8, often 16 to 30 spiny teeth. In particular, young shoots have spiny leaves.

Key difference - *Japanese barberry leaves have smooth edges (no teeth). Korean barberry has toothed leaf edges.*

Flower: Drooping, 1-2 inch long clusters (racemes) of 10-20 yellow, ½ inch long flowers. Flowers are somewhat showy, however; fragrance is not described as pleasant.

Key difference - *Japanese barberry has 1-4 flowers hanging in loose clusters. Korean barberry has 10-25 flowers.*

Bloom time is May to June.

Fruit and Seed: Fruit is an oblong berry, up to ½ inch long, bright red and fleshy. Berries persist into and through winter. Each fruit contains 1-3 seeds. Based on studies in Minnesota and North Dakota the US Forest Service fire effects database indicates seed viability of 7-9 years in soil.

Key difference - *Japanese barberry berries are ¼ to ⅜ inch long with dry flesh. Korean barberry has ¼ inch fleshy berries and fruits are more rounded - not as oblong.*

Life History: Most propagation is by seed dispersal. Birds are a primary disperser. Vegetative reproduction is important to persistence. Mainly through sprouting from rhizomes and lower branches may root at points of ground contact.

Habitat: Typically, found in open or lightly shaded woods. Also found in pastures, fencerows and roadsides in full sun.

Management:

Cutting or **mowing** can be effective once mature shrubs are removed. Follow-up with frequent mowing to control regeneration or utilize other treatments as needed.

Repeated **prescribed fire** can damage above ground parts and drain energy from shrubs; however, resprouting will likely occur. Monitor after fire and follow up as necessary with additional treatments.

As with most woody species, there are several methods to apply **herbicide. Foliar** applications should be made when plants are fully leafed out and for best effect while plants are fruiting. Active ingredients include dicamba + 2,4-D, glyphosate, metsulfuron-methyl and triclopyr. **Cut stump** treatments using glyphosate or triclopyr will likely be successful and **basal bark** treatments with triclopyr or imazapyr formulations are also effective.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar			When fully leafed out and when in fruit.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings.							
	Don't mow									
Flowering Period										

Prohibited: Control	Canada thistle : *Cirsium arvense* (L.) Scop.

Identification: *Compare to native swamp thistle (Cirsium muticum). See page 62.*
Compare to nonnative musk thistle (Carduus nutans). See page 47.
Compare to nonnatives alfalfa and hairy vetch. See page 43.
Compare flower similarities to spotted knapweed, page 17.

Plant: Herbaceous, perennial with grooved, non-spiny, hairy and typically upright stems to a height of 2-6+ feet tall.
Leaves: Alternate, simple, pinnately lobed leaves that are generally lance-shaped. The leaves are irregularly lobed, with toothed, spiny edges. The leaves are stalkless (sessile) and at maturity are downy or hairy on the underside.
Flower: Male and female (dioecious) ¾ inch flowers occur singly on the end of branches. The disk or composite inflorescence is comprised of numerous purple to pinkish small florets. Bracts below the inflorescence do not have spines on the tips.

Bloom time is June to October.

Fruit and Seed: Tufted light brown seeds are easily dispersed by wind. Do not mow after seed has developed as this strongly aids seed dispersal.
Life History: Reproduction can occur from seed, root cuttings and from rhizomes. Clonal stands are common and spread significant from roots that can grow horizontally 10-12 feet per year.
Habitat: A successful inhabitant of disturbed areas such as roadsides and old fields but will also move into open wood-lands and prairies. This species is also found where water levels fluctuate such as in wet meadows, along stream banks and ditches.

Management:
A **biological control** is under investigation, stem-mining weevil (*Ceutorhynchus litura*). This insect is available from com-mercial vendors and is acceptable for distribution in Minnesota.
Cutting or **mowing** should target plants that are approximately 3 inches tall and the process must be repeated throughout the season to maintain the plants at 3 inches or less in height. Continuing this approach for several years can drain the plants of reserves.
Repeated **prescribed fire** can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.
Herbicide foliar sprays with formulations of clopyralid, aminopyralid, or metsulfuron-methyl. These foliar applications are made as the plants bolt, prior to flower set, or in late summer/early autumn to rosettes.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Control | Plumeless thistle : *Carduus acanthoides* L.

Identification: *Compare to native* [*swamp thistle*] *(Cirsium muticum). See page 62.*
Compare to nonnative [*musk thistle*] *(Carduus nutans). See page 47.*
Compare to nonnatives [*alfalfa*] *and* [*hairy vetch*]*. See page 43.*

Plant: Herbaceous, biennial reaching heights of 1-4 feet. Unlike native thistles, the stems of plumeless thistle are winged and spiny.
Leaves: Edges of rosette leaves are wavy with yellowish spines. Stem leaves are alternate, attached directly to stems and typically have hairs on bottoms along mid-veins.
Flower: Numerous stem branches support terminal, single, composite flowers that are ½ to 1½ inches wide. Linear or narrow bracts with short spines are found immediately below pink to purple flowers.
Bloom time is July to October.
Fruit and Seed: Small seeds approximately 1/16 inch long described as straw colored and tufted with fibers on the terminal end. The fibers aid in wind dispersal.
Life History: Reproduction is by seed and seeding is prolific building a large seed bank in a short period of time. Thus, control measures should focus on eliminating seed production and exhaustion of seed banks. Movement is greatly increased by animal and/or human activities such as mowing or haying.
It is reported that musk thistle (*Carduus nutans*) and plumeless thistle hybridize.
Habitat: Found on dry to moist soils in pastures, woodlands, waste areas, along roadsides, ditches and stream banks.
Management:

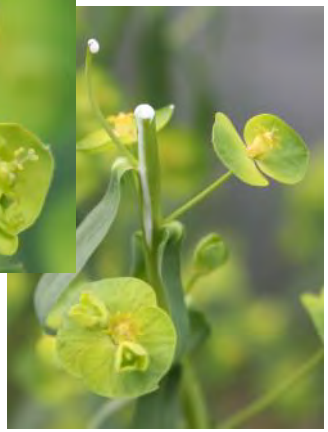
Cutting taproots 1-2 inches below ground is effective but time consuming for large numbers of plants. **Mowing** should be timed at flower bud stage to prevent seed production and should be repeated 2-3 times per season to be effective. Avoid spreading seed with hay or straw and with mowing and vehicle movement through infestations.

Prescribed fire can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.

Herbicide applications timed at the early bolting phase are foliar applications of 2,4-D ester or dicamba formulations. For foliar applications at the budding to flower stage or fall applications to basal rosettes turn to formulations of aminopyralid, clopyralid, metsulfuron-methyl or triclopyr.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn	■	■	■			■	■	■	
Herbicide	Foliar	■	■	■				■	■	
	Cut stem									
	Mow		■	■						
	Don't mow				■	■	■	■	■	
Flowering Period					■	■	■	■		

Prohibited: Control | Leafy spurge : *Euphorbia esula* L.



Above: Flower and bracts.
Right: Cut stem exuding white latex.

Squares = ¼ inch.

Identification: *Similar to invasive cypress spurge (E. cyparissias). Due to bloom period overlap confused with introduced yellow rocket (Barbarea vulgaris). Compare to yellow rocket, page 48.*

Plant: Herbaceous, perennial to 3 feet tall. *Cypress spurge is 8-14 inches tall*. Broken stems of many *Euphorbia* spp. produce a milky sap (latex) that is a good identification characteristic.

Leaves: Alternate, linear to lance-like, bluish-green and 1-4 inches in length. *Cypress spurge leaves are approximately 1 inch in length, alternate or whorled and narrower than leafy spurge leaves.*

Flower: There are no petals or sepals on the small yellowish-green flowers. Upper stem leaves or bracts develop just below flowers and are yellow-green in color providing the appearance of yellowish petaled flowers. The bracts develop before the true flowers.

Bloom time is May to August.

Left: Leafy spurge
Right: Cypress spurge.

Fruit and Seed: Three-celled capsules that expel seeds up to 20 feet. Each cell contains a seed.

Life History: Leafy and cypress spurge reproduction can be vegetative from buds on roots, rhizomes and root cuttings. The ability to reproduce vegetatively makes these plants difficult to control. Deep roots to 21 feet and extensive horizontal roots allow plants to store vast reserves providing the ability to recover after removal attempts. Seed production is significant with plants producing on average 140 seeds per stem. Seeds can remain viable in the soil up to 8 years.

Habitat: Leafy and cypress spurge readily invade dry sites in full sun, but tolerance of a range of conditions allows them to invade moist, rich soils as well.

Management: Caution! Some people are sensitive to the sap of spurges and develop skin rashes after pulling or handling plants, so gloves and long clothing are recommended. The milky sap is toxic to cattle and horses.

Biological controls are available for controlling leafy spurge. Flea beetles (*Aphthona lacertosa*) are widely used in Minnesota. Flea beetles are collected late May to early June and released on infested sites larger than 1/3 acre. Additionally in Minnesota, stem and root boring beetles (*Oberea erythrocephala*) provide some control. Early spring prescribed fire is compatible with biological control on this plant species.

Cutting or **mowing** if timed before flower development can reduce or limit seed production. Grazing goats and sheep can effectively limit the spread of infestations.

Prescribed fire is another tool that helps drain plants of reserve energy. Control of spurges typically requires a multi-tactic approach - eliminate or reduce seeding, exhaust seed banks, and drain reserves of existing plants while attempting to encourage native plants for competitive cover. So, consider spring mowing or fire with a fall application of imazapic.

Herbicide controls are applied as foliar applications and usually involve formulations of aminocyclopyrachlor, picloram, 2,4-D, glyphosate, dicamba, or imazapic. Repeated applications are likely necessary.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Control | Narrowleaf bittercress : *Cardamine impatiens* L.

Identification:

Plant: Herbaceous, annual or biennial starting its first season as a basal rosette and in the second season sending up a smooth flower stem to approximately two feet in height.

Leaves: Basal rosette leaves are pinnately compound with 3-11 round lobed leaflets. Alternate leaves on flowering stems, while still pinnately compound, likely will not have rounded lobes but 6-20 lance or arrowhead shaped leaflets. Edges of flowering stem leaves may be smooth or sharply toothed.

An important differentiation from other plants can be found at the point where leaves attach to stems, look for narrow pointed ears or auricles that grasp and may extend beyond stems.

Flower: Small (0.1 inch), white 4-parted flowers. White petals may not be present.

Bloom time is May to August.

Fruit and Seed: Similar to other mustard family members, seed pods are long (0.6 - 0.8 inch) and slender. Seed ripens from May to September and is dispersed short distances from plants.

Life History: Reproduction is by seed. Seed pods average 10-24 seeds and individual plants can produce thousands of seeds. Movement of seeds is aided by water, animals and human activities.

Habitat: Moist woodlands, forested areas and on margins of thickets. River bottom sites, streambanks and other moist areas are very good habitat and provide avenues for dispersal. This species can tolerate a variety of conditions and has been reported in areas such as roadsides, vacant lots, as well as yards and gardens.

Management: Recommendations at this time focus on hand pulling infestations.

Good advice from the Minnesota Department of Agriculture in reference to controlling narrowleaf bittercress;

"Following guidelines for controlling other biennial mustards such as garlic mustard, *Alliaria petiolata*, may be helpful."

Hand pulling timed to prevent flower and/or seed production is recommended. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal. Subsequent re-treatments will be re-quired due to germination and recruitment from the seedbank. If infestations are large or dense, consider the need for ground cover to prevent erosion and to provide competing vegetation.

Prescribed fire in spring to top-kill basal rosettes and seedlings. Follow-up treatment with **herbicide** is imperative after seedling germination to further slow growth of infestations.

Herbicide applications to foliage with formulations of triclopyr, metsulfuron-methyl, or imazapic.
Use glyphosate or 2,4-D after native plants have entered dormancy and narrowleaf bittercress is still active.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Control	Purple loosestrife : *Lythrum salicaria* L.

Listing includes European wand loosestrife (*Lythrum virgatum* L.).

Identification: *Compare to native fireweed (Chamerion angustifolium). See page 55.*

Plant: Herbaceous, wetland perennial, 4-7 feet tall with a 4 to 6 sided wood-like stem.

Leaves: Opposite, sometimes whorled, lance-shaped, and downy with a slightly wavy yet smooth edge. Leaf pairs are positioned at right angles to the leaf pairs above and below.

Flower: Each plant can have from one to many spikes of pinkish-purple flowers. Center of the flower is yellowish and surrounded by 5-7 petals that have a wrinkled appearance.

Bloom time is July to September.

Fruit and seed: Tiny seeds are released from 2-parted capsules.

Life History: Reproduction by seeds and rhizomes produce large monoculture infestations.

Habitat: Purple loosestrife can be found on upland sites but is best known as an invader of wetlands or aquatic habitats such as ditches, wet meadows, ponds, marshes, river and stream banks as well as lake shores. Purple loosestrife disrupts aquatic habitats as it displaces wetland emergent species.

Management:

Biological controls in the form of two leaf feeding beetles of the same genus (*Galerucella calmariensis* and *G. pusilla*) have been very effective in Minnesota.

Mowing is seldom an option due to wet environments. **Cutting** of flower spikes can be an effective control of seed production. **Hand pulling** or **digging** of plants can also be effective but care should be taken to remove entire root systems if possible. Resprouting can occur from roots and root segments left in the ground or on the site. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal.

Herbicide formulations labeled for use on rights-of-way and near water; 2,4-D, glyphosate, imazamox, metsulfuron-methyl+aminopyralid, triclopyr, imazapyr and aminocyclopyrachlor.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Control

Common tansy : *Tanacetum vulgare* L.

Identification: *Compare to native goldenrods (Solidago spp.). See page 57.*

Plant: Herbaceous, perennial reaching 2-5 feet in height. Stems appear woody, are slightly hairy to smooth and at the base are purplish-red.

Leaves: Alternate, pinnately divided, toothed on edges and 2-12 inches long, typically smaller near the top of plants. Leaves are strongly aromatic when crushed.

Flower: Single stems support multi-branched, flat clusters of bright yellow button-like flowers. Each ¼-½ inch wide button is comprised of many small florets and the flower heads, like the leaves, are strongly aromatic.

Key difference - *Note the lack of ray petals surrounding the flower heads.*
Compare to goldenrods which have ray petals.

Bloom time is July to October.

Fruit and seed: Small, yellowish-brown, dry, 5-toothed crowned seeds.

Life History: Reproduction is both vegetative from rhizomes and root fragments or by seed. Seeds are dispersed by wind, water and human activities such as vehicle traffic and mowing.

Habitat: Found most often in open, disturbed areas typical of stream and river banks, trail edges, roadsides, gravel pits and old farmsteads or pastures. Can be found in riparian areas, but most often in dry, well drained soils in full sun.

Management: Caution! The alkaloids contained in common tansy are toxic to livestock and humans if consumed in quantity. Toxins can potentially be absorbed through skin, gloves are recommended when handling or pulling this plant.

Mechanical methods like **tilling** can spread common tansy by spreading small root segments. **Pulling** also may leave root segments in the ground which may resprout.

Cutting or **mowing** to prevent seed production can be effective and should be timed just prior to flowering.

Prescribed fire can eliminate competition and create favorable conditions for common tansy by opening the canopy and preparing bare soil. Thus, fire can make an infestation worse; however, fire can be used to remove dead material to improve follow-up herbicide application providing better contact and potentially better control.

Herbicide formulations of metsulfuron-methyl, imazapyr, glyphosate or 2,4-D provide good control when applied as foliar applications in spring.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar		Foliar treatments target rosettes.							
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Prohibited: Control | Wild parsnip : *Pastinaca sativa* L.

Identification: *Compare to golden alexanders (Zizia aurea) and heart-leaved golden alexanders (Z. aptera), both native.* *See page 56.*

Plant: Herbaceous, classed as a monocarpic perennial (plant dies after bearing fruit). Early life form is a basal rosette with mature stems developing a hollow, grooved flowering stalk potentially reaching 5 feet.

Leaves: Basal rosette leaves can be 6 inches in height and are pinnately compound with 5-15 leaflets. Flowering stalk leaves are alternate, 2-5 leaflets that become smaller near the top of the stem. Leaflets are coarsely toothed, sinuses cut to varying depths creating lobes of various sizes. The base of the leaf stalks wrap or clasp the grooved stem.

Flower: 12-35, 5-petaled, small yellow flowers on wide, flat umbels of 15-25 umbellets approximately 2 to 6 inches across.

Bloom time is June to July.

Fruit and Seed: Flattened, yet ridged, oval seeds.

Life History: Typical life span is two years, first year a basal rosette. At this stage, it is one of the first plants to green up in the spring and one of the last to brown down in autumn providing good opportunities for scouting and treating. Mid to late summer, mature second-year plants will bolt, flower and set dozens of seed per plant. Seeds are moved off infested sites by animal and human activity or wind and water movement. Seed is reported to be viable in soil for up to 4 years.

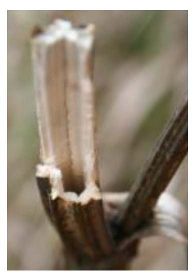
Habitat: Disturbed sites such as roadsides and abandoned fields or lots. Can occur in wet meadows but dry to mesic soils are more typical. Full to partial sun is a must for this species.

Management: Caution! Use protective clothing, goggles or face mask. Contact with the sap of the plant (i.e., phyto) when combined with exposure to sunlight (i.e., photo) can cause severe blistering and swelling (i.e., dermatitis) - phytophotodermatitis.

If **cutting** or **mowing** after seed set, clean equipment to leave seeds on the infested site. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal. If a site is mowed early in the season it must be monitored as plants will likely re-sprout, bolt and flower.

Prescribed fire can be used to encourage stands of native grasses for competition. However, follow-up treatments (herbicide or cutting) are still required to prevent seed production.

Herbicide controls include foliar applications of 2,4-D or metsulfuron-methyl to the rosette stage during May and June and again in September or October. If glyphosate is to be applied to rosettes, it is recommended to hold off until late fall to prevent damage to desirable plants that should then be dormant.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar		■	■			■	■		
	Cut stem									
	Mow		■	■						
	Don't mow				■	■	■	■	■	
Flowering Period				■	■					

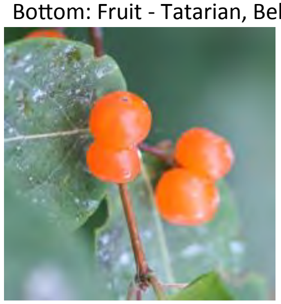
Restricted | Asian bush honeysuckles : *Lonicera* spp.

Tatarian honeysuckle (*L. tatarica* L.),
Morrow's honeysuckle (*L. morrowii* Gray),
Bell's or 'Bella' honeysuckle (*L.* × *bella* Zabel [*morrowii* × *tatarica*]),
Amur honeysuckle (*L. maackii* [Rupr.] Herder) - not known to be in Minnesota.

Identification: *Compare to native honeysuckles.* *See page 59.*
Plant: Perennial woody shrubs, multi-stemmed and ranging in heights of 6-15 feet tall (Bell's to 20 feet, Amur to 30 feet). All nonnative bush honeysuckles have hollow stems with a brownish pith (image upper right).
Leaves: Opposite, egg-shaped to lanceolate (*Amur has lance-shaped with drawn out tips*). Other species have rounded to acute leaf tips with tapered, straight or heart-shaped leaf bases. Surfaces range from smooth and hairless on Tatarian to pubescent (hairy) on Amur and Morrow's. Leaf lengths are 1 to 2½ inches.
Flower: Fragrant pairs of tubular flowers approximately ¾ to 1 inch across. Color ranges from cream to white (Amur and Morrow's) or pink (Bell's) fading to yellow. Tatarian produces white, pink or red to crimson not fading to yellow. Bloom time is mid May to early June.
Fruit and Seed: Most species bright red, Tatarian red to orange. The ¼ inch berries are in clusters of 2-4, mature in late summer and are readily eaten by birds that then disperse the oval, flattened seeds. *Amur honeysuckle fruit can be dark red to purplish, persists into winter and is held on stalks (peduncles) shorter than the leaf stalks (petioles).*
Life History: Vegetative sprouting aids renewal of shrubs. As mentioned above, seed dispersal is mainly by birds.
Habitat: Shade-intolerant plants often found along the forest edges (image upper left). Also found in disturbed, open upland sites such as roadsides, and abandoned pastures or fields.

Management: **Prescribed fire** can be useful to kill seedlings, and drain energy from mature plants . **Mowing (cutting)** can prevent or delay seed production but typically is not considered an eradication method. Monitor the infestation and utilize follow-up treatments of additional mowing and/or herbicide.
For small numbers of plants, **manual methods** including **cutting, digging, or hand pulling** if done repeatedly **and in conjunction** with other treatments can control infestations. Monitor and consider supplemental herbicide treatments. When pulling and digging suspend roots above ground to ensure they dry out. Plants should be disposed of onsite or contained (e.g., bagged) and removed to an approved facility.
Foliar herbicide treatments with formulations of metsulfuron, dicamba, picloram + 2,4-D, triclopyr + 2,4-D , imazapyr or glyphosate at full leaf out during the active growing season.
Cut stem or basal bark applications at any time with 2,4-D, imazapyr, or triclopyr formulations. Additionally, for **cut stem** options include picloram or glyphosate and for **basal bark** treatments options also include aminopyralid.

Top: Honeysuckle in sunlight, on the forest edge.
Center: Honeysuckle leaf and flower color variations.
Bottom: Fruit - Tatarian, Bella or Morrow's and Amur.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn				Follow-up with other treatments as necessary.					
Herbicide	Foliar			When fully leafed out and when in fruit.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings. Monitor for follow-up.							
	Don't mow									
Flowering Period										

Restricted | Black Locust : *Robinia pseudoacacia* L.

Identification:

A native of eastern US, an aggressive, introduced invader in Minnesota.

Plant: Woody perennial, large trees attaining heights ranging from 40-60 feet tall (potentially 80 feet). Bark is dark gray-brown with deep furrows between flat-topped ridges. Vigorous sprouts and young shoots are greenish-colored and have paired spines up to 1 inch long at the base of leaves.

Leaves: Alternate, pinnately compound with 11-19 leaflets creating leaves 3-8 inches long. Oblong leaflets about ¾ to 2¼ inches long by ¼ to 1¼ inches wide. Leaf surfaces are dull dark green to blue-green and paler beneath.

Flower: Before leaves reach full expansion, showy racemes of ¾ inch long white to creamy white, pea-like flowers appear. Fragrant flowers attract early season pollinators.

Bloom time is June.

Fruit and Seed: Flat pods about 2-4 inches long by ½ inch wide turning brown at maturity. Pods contain 4-8 seeds.

Life History: A nitrogen fixing legume that produces a shallow root system. Most reproduction is vegetative, the species sprouts vigorously from roots and stumps. Many stands of trees are clonal stands. It is reported that while black locust produces seed they seldom germinate.

Habitat: Performs well in full sun on well drained soils where there is little competition. Does well in disturbed areas such as roadsides, abandoned fields and woodland sites that are degraded. Has been used in the past for mine soil (spoils) reclamation due to its tough nature and nitrogen fixing capability.

Management:

Mechanical methods such as **cutting** or **mowing** are seldom worth the time or effort since the plants are strong sprouters from root and stump. All of these mechanical methods can have limited effects, but eradication or even good control is unlikely. The same is true of **prescribed fire**.

Basal bark or cut stump herbicide applications with either aminopyralid or clopyralid formulations including bark oil are effective. Other formulations for **cut stump** might include dicamba, glyphosate, imazapyr, triclopyr or combinations of picloram + 2,4-D, triclopyr + 2,4-D, or aminopyralid + triclopyr. Growing season **foliar** applications can be made with the same active ingredients; aminopyralid and clopyralid. Additionally, metsulfuron, picloram + 2,4-D, glyphosate and imazapyr are labeled for use.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn						Monitor and follow-up.			
Herbicide	Foliar			When fully leafed out and actively growing.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings.							
	Don't mow									
Flowering Period										

Restricted	Crown Vetch : *Securigera varia* (L.) Lassen

Synonym: *Coronilla varia* L., also known as purple crown vetch.

Identification: *Compare to nonnatives alfalfa, hairy vetch. See page 43.*
Compare to native American vetch. See page 50.
Compare to native Canadian milkvetch. See page 50.

Roadside infestation being held in check by mowing and herbicide applications.

Plant: Erect, perennial plant at 1-2 feet tall that forms dense tangled masses of reclining 2-6 feet long stems.
Leaves: Alternate, compound leaves, odd-pinnate with 11-25 oval, smooth-edged leaflets often with a minutely pointed tip. Leaves are stalkless.
Flower: Up to 6 inch long, erect flower stalks support dense umbels or crown-like clusters of 10-25, 5-parted, ⅓-½ inch long pinkish flowers.

Bloom time is May to September.

Fruit and Seed: Erect, narrow, multi-segmented, pointy-tipped, angular pods containing up to 12 seeds are clustered at ends of upright stalks. See seed pod images lower left.

Life History: Colonies develop rapidly as plants produce lots of seed and also spread aggressively via vegetative rhizomes. Seed is reported to remain viable for as long as fifteen years. Unattractive, large brown patches in winter and early spring help identify crown vetch infestations.
Habitat: Old fields, pastures and roadsides. Crown vetch has been planted extensively for forage products and along roadsides and steep embankments for erosion control.

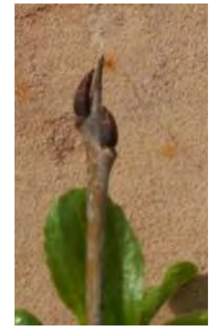
Management:
Cutting or **mowing** will reduce vigor but not eliminate an infestation. Plan to mow several times a season and monitor to time operations with a goal to prevent seed set.

Prescribed fire can be used with other management tactics to encourage stands of native grasses that will compete for resources. However, monitoring is necessary as crown vetch will resprout after burns.

There is a long list of active ingredients applied as a **foliar herbicide** applications. Active ingredients include, but may not be limited to, 2,4-D, aminopyralid, clopyralid, dicamba, glyphosate, metsulfuron-methyl, sulfometuron, picloram and triclopyr. Recommendation is to apply aminopyralid before flower while others are recommended for application during active growing periods.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn		Late Spring							
Herbicide	Foliar		During active growth periods.							
	Mow		Mowing must be repeated							
	Don't mow					Prevent flower and seed.				
Flowering Period										

Restricted | Common buckthorn : *Rhamnus cathartica* L.



<u>Identification</u>: *Compare to the native* *[cherries and wild plum](#)* (*Prunus* spp.*). See page 51.*

<u>Plant</u>: Tall shrub at 20-26 feet with potential to become a small tree reaching 36 feet. Often one to a few stems with diameters up to 5-6 inches and occasionally larger. Light-colored lenticels on shiny gray to brown bark leads to confusion with young native cherries and plums (*Prunus* spp.). Many twigs are terminated by a small ***thorn-like spine between dark colored, scale covered buds.***.

<u>Leaves</u>: **Sub-opposite**, at times appearing opposite and on fast growing sprouts alternate. Shiny green, 1-2½ inches, oval with tiny teeth on leaf edges. Veins curving to the tip of the leaf (arcuate venation) provide a strong identification characteristic and green leaves persisting into autumn.

<u>Flower</u>: **Dioecious**, male and female flowers on separate plants, small, 4-parted and green.

<u>Bloom time is May to June</u>.

<u>Fruit and Seed</u>: Fruit on female plants only. At maturity a purplish-black, small (¼ inch), berry-like fruit held close to the stem in clusters. Strong identification characteristic are these blackish fruits held close to twigs late into winter. Typically, 3-4 seeds per fruit.

<u>Life History</u>: Reproduction is by seed and dispersal is often aided by birds. Heavy seed production combined with stems and stumps that sprout vigorously when damaged make control difficult.

<u>Habitat</u>: A strong competitor on upland sites in a variety of soil types and moisture regimes. Common buckthorn thrives in the understory, on the forest edge or in full sun often to complete exclusion of other species.

<u>Management</u>:

Keep in mind, if funds and/or time are limited female plants are the fruit producers and should be targeted first. Caution should be exercised to avoid creating large bare patches and/or extensive soil disturbance. Both scenarios lead to soil erosion and create good seed beds for common buckthorn regeneration.

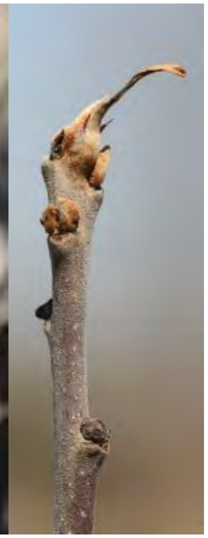
Hand pulling or the mechanical advantage provided by a **weed-wrench** can help control small infestations. **Cutting** of stems must be accompanied by herbicide treatments or resprouting will occur. **Mowing** is typically not an option in sensitive wetland areas, but on upland sites may be a useful tool in seedling and small diameter stem control.

Prescribed fire is used to control seedlings and small diameter stems and if used consistently can drain larger plants of reserves and provide control. However, sprouting will occur and a follow-up herbicide application should be considered.

Herbicide formulations of triclopyr, imazapyr, metsulfuron-methyl, 2,4-D, glyphosate or picloram are used as foliar applications. Herbicides include triclopyr or glyphosate for late autumn into winter applications to basal bark, cut stumps or frill cuts.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar			When fully leafed out. During active growth.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings.							
	Don't mow									
Flowering Period										

Restricted | Glossy buckthorn : *Frangula alnus* Mill.



Identification: *Compare to the native cherries and wild plum (Prunus spp.). See page 51.*

Plant: Shrub or small tree at 20 feet in height, often multi-stemmed with prominent light-colored lenticels on dull grayish to dark brown bark. Heartwood may be orange to pinkish and sapwood may be yellowish, both can facilitate identification. ***No thorns or spines!*** There are no bud scales protecting overwintering buds - referred to as naked buds.

Leaves: **Alternate**, glossy, 2-3 inch length with prominent parallel veins terminating near a smooth edge. Undersides are slightly hairy and dull. Leaves will likely persist longer in autumn than native deciduous shrubs, but they will turn yellow and drop.

Flower: **Monoecious,** male and female parts present in flowers. Therefore, all shrubs can fruit. Not showy, small, 5-petaled, yellowish and borne in clusters in the leaf axils.

Bloom time is May to July.

Fruit and Seed: Clustered in leaf axils along the stem, initially reddish maturing to purplish-black in late summer into autumn. Each fruit contains 2-3 seeds, dispersed by birds.

Life History: Reproduction is by seed and while birds disperse the seed, dense thickets suggest many seeds drop close. Shades out native shrubs and forbs creating monocultures in sites that typically support very diverse flora.

Habitat: An invader of wetlands, including sedge meadows, sensitive acidic bogs and calcareous fens. Tolerant of shade, yet will perform well in full sun on upland sites.

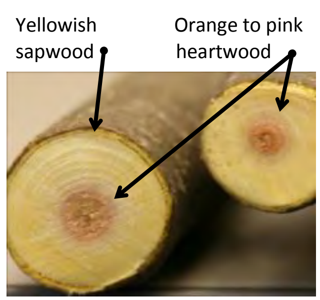
Management:

Caution should be exercised to avoid creating large bare patches and/or extensive soil disturbance. Both scenarios lead to soil erosion and create good habitat for glossy buckthorn regeneration.

Hand pulling or the mechanical advantage provided by a weed-wrench can help control small infestations. **Cutting** of stems must be accompanied by herbicide treatments or resprouting will occur. **Mowing** is typically not an option in sensitive wetland areas, but on upland sites may be a useful tool in seedling and small diameter stem control.

On upland sites **prescribed fire** can be used to control seedlings and small diameter stems and if used consistently can drain larger plants of reserves and provide control. However, sprouting will occur and a follow-up herbicide application should be considered.

Herbicide formulations of triclopyr, imazapyr, metsulfuron-methyl, 2,4-D, glyphosate or picloram are used as foliar applications. Herbicides include triclopyr or glyphosate for late autumn into winter applications to basal bark, cut stumps or frill cuts.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar			When fully leafed out. During active growth.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings.							
	Don't mow									
Flowering Period										

Restricted | Garlic mustard : *Alliaria petiolata* (M. Bieb.) Cavara & Grande

Identification:

Plant: Herbaceous, biennial with first year plants being basal rosettes. Second year flowering plants can attain heights of 4 feet and can produce more than one flowering stem.

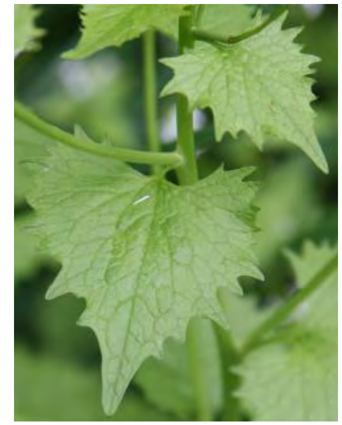
Leaves: Basal rosettes with coarsely toothed, kidney-shaped foliage remains green through winter. Foliage on flowering stems is alternate, triangular, coarsely toothed and stalked. Foliage has the odor of garlic when crushed.

Flower: Clustered, 4-parted, white flowers are approximately ⅓ inch across.

Bloom time is April to June.

Fruit and Seed: The 1-2½ inch long slender seed pods are very recognizable and contain numerous black, shiny seeds.

Life History: Reproduction is by seed that matures June into July and can be dispersed about 6 inches when pods burst at maturity. Seed remains viable in soil for up to 5 years.



Habitat: An invader of shady, moist forests or woodland settings but also invades oak savannas and disturbed areas in full sun. It is reported that garlic mustard will inhibit the growth of beneficial fungi associated with native plants thus causing a decline in herbaceous cover.

Management: **Biological controls** are under investigation, but none are approved for release at this time. One insect being studied is *Ceutorhynchus scrobicollis*, a crown and stem-mining weevil.

Manual methods include pulling plants in early spring prior to flowering (seed set is almost coincidental with flowering) and cutting plants back to the ground as they bolt for flowering, prior to flower opening. Monitor the site as cutting may need to be repeated. If mature flowers (or seed pods) are present, plants should be disposed of onsite or contained (e.g., bagged) and removed to an approved facility.

Prescribed fire in spring to top-kill basal rosettes and seedlings. Follow-up treatment with **herbicide** is imperative after seedling germination to further slow growth of infestations.

Herbicide applications to foliage with formulations of triclopyr, metsulfuron-methyl, or imazapic. Use glyphosate or 2,4-D after native plants have entered dormancy and garlic mustard is still active.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Restricted — Japanese barberry : *Berberis thunbergii* DC.

Above: *B. thunbergii* in flower late May.
Below left: *B. thunbergii* 'Erecta'
Below right: *B. thunbergii* 'Rose Glow' (top) and
B. thunbergii 'Sparkle' (bottom)

Identification: *Compare to common barberry (B. vulgaris) on page 18.*
More images and regulated cultivars next page.

Plant: Perennial woody shrubs, multi-stemmed, typically 3-6 feet tall (potentially to 8 feet tall). Stems are grooved or angular and ranging in color from gray to reddish-brown. Single (possibly 3 branched) ½ inch long spines occur at nodes where leaves attach. Lateral spine branches if present may be very small.

Leaves: Alternate, typically clustered so not appearing alternate. Leaves are simple, narrow near the twig and described as obovate (wider towards the end). The leaf edge or margin is smooth (*B. koreana* and *B. vulgaris* have teeth) and occasionally there is a minute spine tip or point at the ends of leaves.

Flower: Small (¼ to ⅓ inch) yellowish flowers suspended under the foliage. Therefore not considered showy. Japanese barberry flowers are typically individual but flowers may be in clusters of 2-4 while Korean barberry (*B. koreana*) may have up to 20 flowers per raceme (cluster). See fruit of Korean barberry in upper right-hand image on next page.

Bloom time is May to early June.

Fruit and Seed: Bright red, dry flesh, a true berry that persists into and through winter (image next page, bottom right: fruit at leaf out in April). The ⅓ inch long ellipsoidal berries, like the flowers, will be solitary or in clusters of 2-4.

Life History: Seed production is strong and this special regulation targets species and cultivars producing on average more than 600 seeds. Seed bank viability (longevity) is not well understood; although, a report on *B. thunbergii* 'Beth' states that the seed remain viable up to 10 years. Reproduction can also be vegetative via root sprouts and shrub branches may root if in contact with the ground.

Habitat: Prefers well drained soils in full sun to partial or deep shade. Forest edges, open forests and other woodlands yet also found in old fields, areas of disturbance and can survive in wetland soils.

Management: **Prescribed fire** (or direct flame from a propane torch) can be useful to kill seedlings, and drain energy from mature plants. **Mowing (cutting)** can prevent or delay seed production but typically is not considered an eradication method. Monitor the infestation and utilize follow-up treatments of mowing and/or herbicide.

For small numbers of plants **manual methods** including **cutting, digging, and hand pulling** if done repeatedly **and in conjunction** with other treatments can control infestations. Monitor and consider supplemental herbicide treatments. When pulling and digging suspend roots above ground to ensure they dry out. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal.

Foliar herbicide treatments with metsulfuron products at full leaf out during the active growing season. Additionally, dicamba + 2,4-D, triclopyr or glyphosate at full leaf out while the plants are fruiting during the growing season.

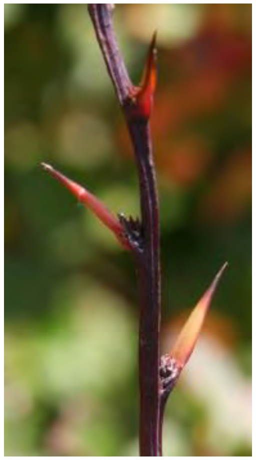
Cut stem applications at any time with glyphosate or triclopyr formulations can also be useful.

Basal bark treatments at any time with imazapyr or triclopyr products have proven effective.

Wild type, single and paired flowers.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar			When fully leafed out. During active growth.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings.							
	Don't mow									
Flowering Period										

Restricted | Japanese barberry : *Berberis thunbergii* DC.



Above: 'Tara' (Emerald Carousel®; *B. koreana* × *B. thunbergii* hybrid)

Above left: Grooved, reddish-brown stem, single spines at nodes. Above center: Foliage and racemes of fruits. Above right: Form

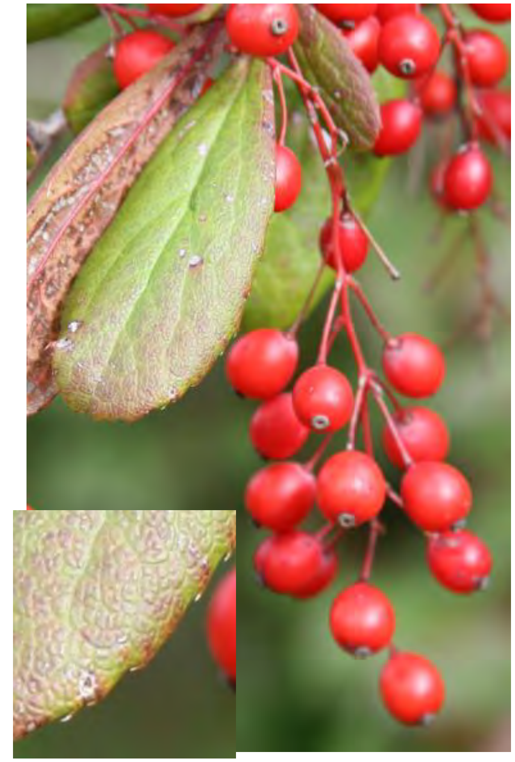
Left: *B. thunbergii*
'Bailone'
Ruby Carousel®

Right: *B. thunbergii*
'Bailtwo'
Burgundy Carousel®

Japanese barberry cultivars to be phased out and then prohibited from sale.

These plants average greater than 600 seeds per plant.and
began a three-year phase-out period in Minnesota beginning January 1, 2015.

'Angel Wings' 'Antares' 'Anderson' (Lustre Green™) var. atropurpurea
'Crimson Velvet' 'Erecta' 'Gold Ring' 'Inermis' 'Kelleris' 'Kobold'
'Marshall Upright' 'Painter's Palette' 'Pow Wow' 'Red Rocket' 'Rose Glow'
'Silver Mile' 'Sparkle'
'JN Redleaf' (Ruby Jewel™) 'JN Variegated' (Stardust™) 'Monomb' (Cherry Bomb™)
'Bailgreen' (Jade Carousel®) 'Bailone' (Ruby Carousel®) 'Bailtwo' (Burgundy Carousel®)
'Bailsel' (Golden Carousel®; *B. koreana* × *B. thunbergii* hybrid)
'Tara' (Emerald Carousel®; *B. koreana* × *B. thunbergii* hybrid) Wild Type (parent species - green barberry)



Above: *B. koreana* **images for comparison**.
Toothy foliage (serrulate margin) and
more than 10 *rounded* fruits per raceme
Inset: Close-up of Korean barberry leaf edge.
Below: Unknown *Berberis* species / cultivar
holding fruit at leaf out in April.

Restricted	Multiflora rose : *Rosa multiflora* Thunb.

Identification:

Plant: Shrub with 6-13 feet long, wide arching canes reaching 6-15 feet tall. Canes armed with stiff, downward curved prickles (thorns) form an impenetrable thicket.

Leaves: Alternate, pinnately compound, 5-11 sharply-toothed leaflets. The oval leaflets are nearly smooth on the topside and are covered with short hairs below. A unique feature are fringed stipules where leaves attach to stems.

Flower: Numerous, showy flowers. Five-parted, fragrant, white to slightly pink, ½-1½ inches across.

Bloom time is May to July.

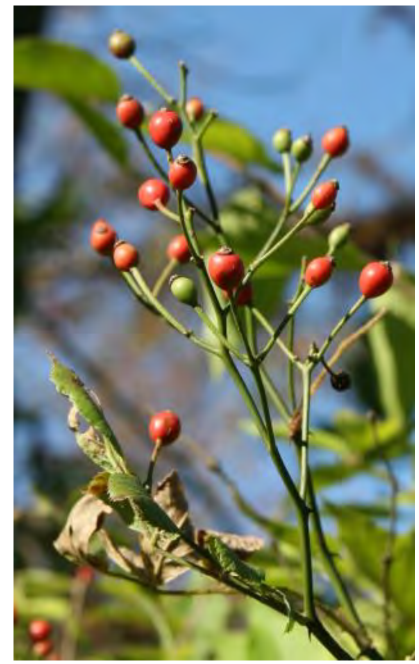
Fruit and Seed: Numerous rose hips, ¼ inch diameter, bright red to orange-red, hairless or smooth. Hips are on a wide branched structure and persist into winter.

Life History: Plants reproduce by seed and by cane tips with ground contact taking root. The plants are prolific seed producers and seeds are viable in seed banks for up to 20 years.

Habitat: Readily invades disturbed areas such as woodlands, prairies, roadsides, along streams and has become a problem in pastures where the thorns discourage grazing.

Management:

Cutting or **mowing** frequently during the growing season (3-6 times) for 2-4 years can achieve good control of infestations. **Prescribed fire** in the spring will provide good control of small stems and seedlings.
Herbicide applications to cut stems and to resprout stems with systemic herbicides such as glyphosate have proven successful. As with most species, late season applications of herbicides are effective as plants are moving photosynthates to storage in root systems.



Images clockwise order: Iowa (IA) and Illinois (IL)
UR: White, five-parted flower (IA, 2009-6-11).
LR: Wide branched, maturing ¼ in. hips (IL, 2015-10-16).
LL: Compound leaves (IA). Thorns, stipules and hips (IL).
UL: Fringed stipules and downward curved thorns (IA).

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Restricted | Nonnative phragmites or common reed (nonnative subspecies)




Phragmites australis* (Cav.) Trin. Ex Steud. subsp. *australis

Compare to [native phragmites](#) (P. australis subsp. *americanus), Page 60.*

Identification:

Plant: A perennial grass reaching heights of 15 feet. Dense stands develop from rhizomatous root systems with live stems and dead stems intermingled. Hollow stems are green in summer and yellow in winter.

Leaves: Dark green, grass-like elongated foliage that is at most 1½ inches wide. Leaf sheaths are typically retained on culms (stems) into winter even if leaves drop from dead culms. *Compare to native phragmites that sheds leaves and leaf sheaths.*

Flower: Bushy panicles of purplish or golden flowers appear in July. Bloom time is July to September.

Fruit and Seed: Large, dense seed heads become gray-brown. Hairy seeds give heads a fuzzy, fluffed appearance.

Life History: Rhizomes, rhizome fragments, root runners and copious amounts of seed provides common reed a strong competitive edge. It forms such dense stands and thick root systems that all native plants can be forced out. Rhizome segments can break free and coupled with seed production plants readily move into and take over new areas.

Habitat: Shorelines of lakes and rivers as well as pond edges and freshwater marshes. Disturbed areas and roadsides can support common reed very well.

Management: Once established, chemical treatments are recommended as a first step in restoration efforts. **Cutting** or **mowing** will not kill plants or eradicate infestations, but can be effective at slowing the spread. **Prescribed fire** after the plant has flowered. Used prior to herbicide treatments, fire (or mowing) removes biomass improving herbicide application to regrowth. Do not burn prior to flowering, as this timing may only encourage growth. **Herbicide** applications, aquatic formulations of imazapyr or glyphosate are effective, even on established stands. Rapid recognition of infestations and treatments soon after increase effectiveness. Late summer/early autumn herbicide applications to foliage or to cut stems are best and repeat treatments in subsequent seasons are likely necessary.

Glumes or seed covers vary in length. Upper and lower glumes are longer on the native subspecies. Best analyzed under a microscope.

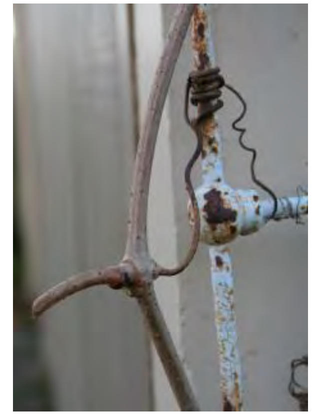
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn					After flower				
Herbicide	Foliar					After Flower				
	Cut stem					After Flower				
	Mow		Mowing must be repeated							
	Don't mow									
Flowering Period										

Restricted | Porcelain Berry : *Ampelopsis brevipedunculata* (Maxim) Trautv.


Image by: Paul Kortebein

Family: Vitaceae, same genus as *Vitis* (grapes).
Synonyms: *A. brevipedunculata* (Maxim.) Trautv. var. *maximowiczii* (Regel) Rehder
A. glandulosa (Wall.) Momiy. var. *brevipedunculata* (Maxim.) Momiy.
A. heterophylla (Thunb.) Siebold & Zucc.
A. heterophylla (Thunb.) Siebold & Zucc. var. *brevipedunculata* (Regel) C.L. Li

Identification: *Compare to native riverbank grape (Vitis riparia). See page 58.*
Plant: Perennial, woody vines that climb trees or structures with assistance of tendrils. Like riverbank grape, tendrils occur opposite leaves. Bark of porcelain berry is gray and retains smoothness with age and the pith is white.
Key differences - *Riverbank grape has dark brown bark that peels in narrow, vertical strips.*
Leaves: Alternate, simple leaves with a cordate (heart-shaped) base and 3-5 palmate coarsely toothed lobes separated by deep sinuses. Some leaves may resemble wild grape leaves.
Key differences - *Riverbank grape has shallow sinuses between 3 distinct palmate, coarsely toothed lobes.*
Flower: Inconspicuous, panicles of greenish flowers occur opposite leaves .
Bloom time is June to August.
Fruit and Seed: Shiny, brightly colored berries in hues of blue to purple mature in September and October. Each berry contains 2-4 seeds and seed viability is reported to be 'several' years.
Life History: Water may play a small part in seed movement but predominant means of dispersal is by birds and small mammals that have fed on the colorful berries. Vegetative reproduction is also possible. Vines have strong root systems and will resprout after cutting.
Habitat: When found, typically in riparian (floodplain) areas that are not permanently wet. Full sun to partial shade on forest edges, stream banks, thickets and other such places.
Management:
Acceptable control can be attained with **mechanical** methods such as **hand pulling** or **cutting** (possibly **mowing**). However, after cutting, plants will resprout so there should be a plan to monitor and follow up cutting treatments with additional cutting or herbicide treatments. Follow-up to monitor for new seedlings will also be required.



For large infestations **herbicide** applications are likely the most cost effective approach. Systemic herbicides for woody brush control such as glyphosate and triclopyr have been used effectively as **foliar** or **basal bark / cut stem** treatments.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Foliar		During active growth or cut and treat resprouts.							
	Cut stem					Basal bark (with oil) or cut stem				
	Mow		Mowing, when possible, must be repeated							
	Don't mow						When seed is present			
Flowering Period				■	■	■				

Restricted	Tree-of-Heaven : *Ailanthus altissima* (Mill.) Swingle

Synonyms: *A. glandulosa* Desf. and *Toxicodendron altissimum* Mill.

Identification: *Compare to native* sumacs (*Rhus typhina* and *R. glabra*). *See page 61.*

Plant: Tree, woody perennial plant that can attain heights of 70 feet. Very thick twigs with dime-sized leaf scars aid winter identification. Cutting twigs reveals a soft white pith.

Leaves: Alternate, 1-4 feet long, odd-pinnate compound with 11-25 (up to 40) leaflets. Leaflets are 3-5 inches long by up to 2 inches wide, smooth edged with 1-5 distinct glands (bumps) near leaflet bases. **Key difference:** *leaflets are smooth edged, unlike toothy sumac leaflets.*

Flower: Clusters of small yellowish-green flowers are showy due to the sheer number of flowers per cluster. Species is predominantly dioecious (male and female flowers on separate trees).

Bloom time is June.

Fruit and Seed: Clusters of 1-1½ inch long twisted samaras develop mid-summer. A pinkish hue develops, then maturing to light tan. Samaras are documented to wind disperse up to 300 feet.

Life History: Trees sprout vigorously from stumps when cut or broken and there is also strong root sprouting potential. Trees in the 12 to 20 year age class produce lots of seed. Seed bank capability is reported to be low, but initial seed viability is high. Allelopathic (chemical) effects prevent germination of other plants near tree-of-heaven.

Habitat: Tolerant of urban stresses including pollution, soil disturbance, nutrient poor soils, drought conditions (once established), compaction, salty roadside soils and prefers full sun.

Management: Prevention is key - early detection and removal is recommended.

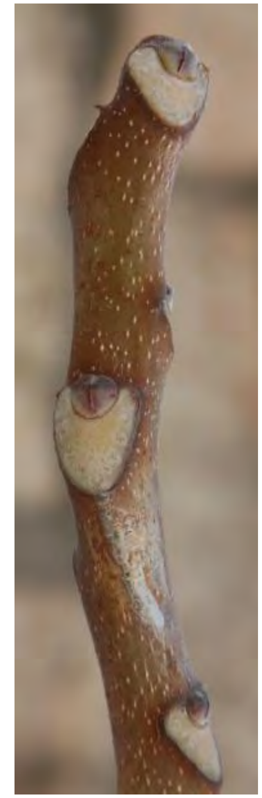
Cultural methods like **Cutting** or **mowing** are beneficial but should be followed up with good monitoring. Goal with these methods is to prevent flower and seed.

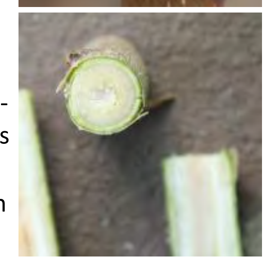
Prescribed fire, where applicable, can top kill seedlings and or saplings. The goal would be to strengthen the native plant community.

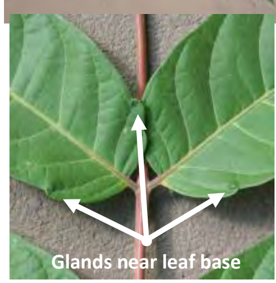
Herbicide applications of glyphosate during July through September are effective when applied to **cut stumps**. Other active ingredients would include triclopyr, dicamba, and imazapyr. Stumps should be cut as low as possible to minimize surface area from which potential resprouts occur.

Hack-and-squirt applications with dicamba, glyphosate, imazapyr, picloram or triclopyr formulations are effective. In addition, **basal bark** treatments with triclopyr or imazapyr active ingredients in oil are also recommended.

At full leaf-out during active growth, **foliar** applications with 2,4-D, glyphosate, imazapyr, picloram or triclopyr are also effective when targeting smaller trees and resprouts.







		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar			When fully leafed out and active growth.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings.							
	Don't mow									
Flowering Period										

Restricted	Queen Anne's Lace (wild carrot) : *Daucus carota* L.

Identification: *Compare to nonnative poison hemlock and carrot look-alikes.*

Compare to native water hemlock. See pages 13, 45 and 64.

Plant: Herbaceous, biennial, first year as a basal rosette. Basal leaves are clustered, up to 5 inches long and arch away from a central location. Second year flowering plants attain heights of 3-4 feet on hollow stems that are hairy to sparsely hairy and striped with light colored lines.

Leaves: Alternate, fern-like, finely divided leaves are widely spaced on upper stems and up to 4 inches across by 2 inches wide. Stem and basal leaves are fern-like, finely divided, narrowly lobed described as bipinnate-pinnatifid. Underside of leaves may be slightly hairy along veins. Leaves are attached to stems with sheaths, also a trait of family members.

Flower: Similar to other family members - many small (1/8 inch), 5-petaled, white flowers (florets) make up a flat-topped compound umbel 2-5 inches across. Compound umbels are dense with 20-90 umbellets of which each has 15-60 flowers. Often, outer flower petals are large in comparison to others and a central flower (or flowers) of the compound umbel is purplish (not always present).

Another distinguishing characteristic in this family are bracts beneath flower umbels. Some family members have few if any bracts, wild carrot has very prominent often branched bracts under main umbels and smaller sometimes linear (unbranched) bracts under umbellets making up the larger floral display.

Bloom time is June to September. For about two months various bloom stages within infestations.

Fruit and Seed: Each floret produces 2 seeds (a schizocarp splits into carpels). Seeds are flat and bristly to catch passing fur or clothing. Entire seed clusters may break off plants in winter to roll across the snow distributing seed.

Life History: Infestations spread mainly by seed. Seeds are reported to be viable for as long as seven years. Deep tap roots are difficult to remove and provide strong energy reserve for resprouting.

Habitat: Preferred habitat is dry to moist, disturbed soils in full sunlight. Tolerant of a variety of soils and partial shade

Management:

If performed frequently **cutting** or **mowing** are effective control methods. Same is true for hand pulling, roots and root fragments remaining in the soil may resprout. Monitor infestations and plan on additional treatments.

Prescribed fire as a tool should be used to improve the health of surrounding native vegetation. Wild carrot will likely not outcompete healthy vegetation and will decline on its own.

Foliar herbicide applications to plants at rosette stage with 2,4-D or 2,4-D formulations including dicamba or triclopyr have produced good results. Nonselective herbicides such as glyphosate formulations can also produce results.

Use herbicides wisely, 2,4-D **resistant** wild carrot populations have been identified in Michigan.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn		Stimulate surrounding vegetation							
Herbicide	Foliar		Target seedlings or rosettes							
	Mow		Mowing must be repeated to prevent flowering							
	Don't mow				When seed is present					
Flowering Period										

Specially Regulated | Amur Maple : *Acer ginnala* Maxim.

<u>Identification</u>:
<u>Plant</u>: Woody perennial, large shrub or small tree up to 20 feet in height. Mature bark is faint gray developing thin vertical stripes.
<u>Leaves</u>: Opposite, 1-3 inch long simple leaves are three lobed with center lobe extending past shorter side lobes and edges (margins) are doubly toothed. Bright green early in the season and producing brilliant fall colors in hues of red, yellow and gold-orange.
<u>Flower</u>: Fragrant, but not showy, loose clusters of pale yellow to creamy white flowers appear in early spring.
<u>Bloom time is mid May to early June</u>.
<u>Fruit and Seed</u>: Approximately ¾ to 1 inch long, paired, winged seed structures called samaras. The samara pair hang at close to a right angle almost parallel to one another. Initially, seed is very red in color, maturing to a light brown.
<u>Life History</u>: Species is a prolific seed producer. Small animals or birds may spread seeds but wind is likely the force behind most seed dispersal. Species stump sprouts but reproduction by vegetative means is not a strong characteristic.
<u>Habitat</u>: Preferences are to full sun or partial shade in well drained moist soils. However, the species is considered tough and specimens will tolerate dry conditions, salt and pH range of 6.1 to 7.5. A frequent invader of savannas, prairies and open forests where native shrubs, trees and forbs can be displaced.

<u>Management</u>: **Prescribed fire** will set back plants and may top kill seedlings but plants will likely resprout. **Manual methods** including **hand pulling or cutting** can eliminate small infestations of seedlings and saplings while **digging or cutting** larger material can be effective. Monitor and follow up with additional treatments as necessary.

Small plants or resprouting stumps can be treated with **foliar applications** of triclopyr formulations or glyphosate. **Cut stem** treatments with glyphosate or triclopyr are effective as well as **basal bark** treatments with triclopyr.

<u>Specially Regulated</u>
is a unique category.
See <u>page 74</u>.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar			When fully leafed out and actively growing.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings.							
	Don't mow									
Flowering Period										

Knotweed complex : Japanese and giant

Three knotweeds, often referred to as bamboo, are described here. They are large perennial plants with non-woody stems. Stems are smooth, green with reddish-brown blotches and hollow between swollen nodes where leaves attach. All three have branched flower structures at these leaf attachments holding many small, creamy white to greenish flowers.

Japanese knotweed Identification: *Polygonum cuspidatum* Siebold & Zucc.

Synonyms: *Fallopia japonica* (Houtt.) Ronse Decr. , *Reynoutria japonica* Houtt.

Plant: Height *5-8 feet* (*10 feet*), potentially multiple branches. Typically, only female flowers.

Leaves: Alternate, simple, can be *2 to 7 inches long* with a *truncate base* (mostly straight across). *Tips of leaves are acuminate* (narrowed to an abrupt point) and *undersides of leaves along veins* may have *brown, fuzzy ridges*.

Flowers: Typically female flowers only. Japanese knotweed has branched *flower structures that are longer than nearby leaves*, those of giant knotweed are shorter than nearby leaves.

Bohemian knotweed Identification :

Polygonum ×bohemicum (J. Chrtek & Chrtková) Zika & Jacobson [*cuspidatum* × *sachalinense*]

Synonym: *Fallopia* × *bohemica* (Chrtek & Chrtková) J.P. Bailey

Synonym: *Reynoutria* × *bohemica* Chrtek & Chrtková

Bohemian: an intermediate hybrid with characteristics of both parents, Japanese and Giant.

Plant: Heights from *6 to 16 feet*. Typically few, but potentially several branches.

Leaves: Alternate, simple, can be 2 to 12 inches long and width about ⅔ of length. Leaf bases may be straight across (see Japanese) or rounded (heart-shaped like Giant). Leaf tip may be blunt, gradually tapered or pointed. *Few to no hairs on the leaf edges* (margin) and *veins under leaves may have stiff, broad-based, small hairs*.

Flowers: Often perfect flowers (male + female). Male flowers consist of anthers attached to long stamens extending beyond a flower's petals. Structure is branched with variable length.

Giant knotweed Identification : *Polygonum sachalinense* F. Schmidt ex Maxim.

Synonym: *Fallopia sachalinensis* (F. Schmidt ex Maxim.) Ronse Decr.

Synonym: *Reynoutria sachalinensis* (F. Schmidt ex Maxim.) Nakai

Plant: Larger plant attaining heights of *9 to 20 feet*. Typically few or no branches.

Leaves: Alternate, simple, can be up to *12 inches across* and *6-14 inches long* (width about ⅔ of length) with *rounded lobes at the base* (heart-shaped). *Tips of leaves are blunt* and *undersides of leaves may have scattered* (segmented) *hairs* early in the season.

Flowers: Perfect flowers (male + female) and fertile. Branched, flower structures of giant knotweed are compact, *shorter than nearby leaves*.

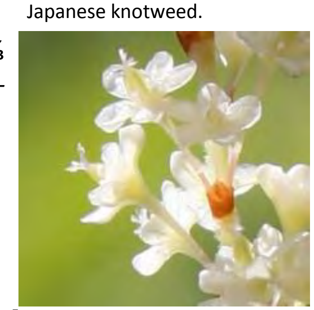
Bloom time is August to September .

Seeds: Small, black, 3-sided. Reported as not commonly produced on Japanese knotweed.

Above: Bohemian knotweed.

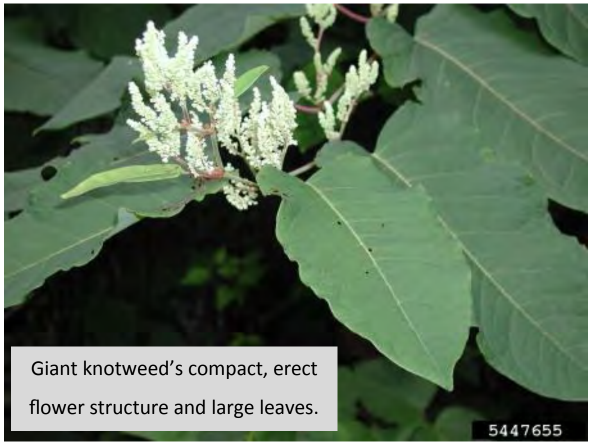
Above: Extended male stamens + anthers of Bohemian.

Below: Female flowers of Japanese knotweed.

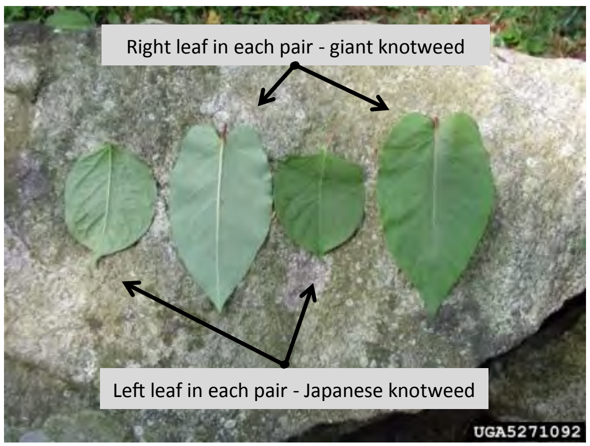


Specially Regulated

Knotweed complex : Japanese and giant



Giant knotweed's compact, erect flower structure and large leaves.



Common Name	Plant form	Leaves	Leaves, underside	Flowers
Japanese knotweed	5-10 feet multiple branches	1-4 inches long, ⅔ as wide leaf base - straight across	along veins, scabers brownish, ridges, fuzzy	branched, loose typically female
Bohemian knotweed (*hybrid*)	6-16 feet, few to several branches	2-12 inches long, ⅔ as wide leaf base - variable	along veins, short, triangular hairs	branched, variable form female or perfect
Giant knotweed	9-20 feet few or no branches	7-16 inches long, ⅔ as wide leaf base - heart shaped	along veins, hairs scattered, segmented	branched , compact perfect and fertile

Life History: It is believed that seed production is limited (especially, *Japanese*) and most reproduction is vegetative. Even small root parts will re-sprout after plants are manually removed or moved. Stem fragments resulting from mowers or other machinery can sprout if nodes are present and in contact with moist soil. Plants uprooted by flooding, digging or other mechanical means will likely re-root if left in contact with moist soil.
Seeds, if produced, are said to be viable four to five years if near the soil surface and up to 15 years if buried.
Habitat: Prefers moist soils in full sun to partial shade. Plants readily inhabit moist roadside ditches, wetlands, and areas along rivers and streams. However, plants will thrive on dry soils.
Management: Most research has been carried out on *Japanese knotweed*.
Develop a four to five year plan. **Prescribed fire** in spring can set plants back and drain some energy while **mowing** can prevent or delay seed production. However, both can stimulate vegetative reproduction, thus potentially increasing stem counts. After treatments, monitor approximately 60 feet beyond original infestations and utilize follow-up treatments of periodic mowing and/or herbicide. Reasoning, root system spread can be up to 60 feet.
Manual methods should not be considered eradication tools. These include **cutting, digging, hand pulling, grazing** or **tarping** if done repeatedly **and in conjunction** with other treatments may control infestations. Monitor and consider supplemental herbicide treatments. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read MDA's guide on removal and disposal.
Prior to **foliar herbicide** treatments with aminopyralid, glyphosate, imazapyr, triclopyr, or 2,4-D it is recommended that the plants be cut twice when 3 feet tall. Follow those cuttings with a fall **foliar application** when regrowth is 3 feet tall and still actively growing. **Cut stem applications** with glyphosate, triclopyr or triclopyr + 2,4-D can be made at anytime during active growth when the plants are over 3 feet tall. **Stem injection** treatments with glyphosate can be made anytime during active growth periods. See glyphosate's supplemental label for hollow stem injection.

Any management efforts may result in bare ground; therefore, all treatment planning should include revegetation.

Specially Regulated is a unique category. Unadvisable to plant these species within 100 feet of a water body or its designated floodplain. See *page 74*.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Inject			During active growth, treat when 3' tall.						
	Foliar	Mow / cut twice - fall treatment.								
	Cut stem			During active growth, treat when 3' tall.						
	Mow	Mowing is not recommended. If used, collect cuttings, monitor and repeat. Follow-up with herbicide treatments at 3 feet of regrowth in fall.								
	Don't mow									
Flowering Period										

Specially Regulated | Poison ivy : *Toxicodendron radicans* (L.) Kuntze

Identification: **Common poison ivy** [*T. radicans* (L.) Kuntze subsp. *negundo* (Greene) Gillis] is potentially a larger shrub (up to 10 feet) and possibly a vine in southeastern Minnesota's riparian areas.

While both species are subject to regulation, information provided below focuses on **western poison ivy** [*T. rydbergii* (Small) Green] which is a frequently occurring shrubby plant with an extensive natural range across Minnesota.

Plant: A 1-2 foot **native** shrub with gray to tan bark and little if any branching.

Leaves: Alternate, compound leaves, 3 shiny or dull surfaced leaflets. Leaflet edges are variable from smooth to very coarsely toothed. Lower leaf surfaces are pale and often hairy.

Flower: Small, greenish flowers on erect spikes (panicles). Flower spikes are borne in leaf axils on new or current years growth with male and female flowers on separate plants (dioecious).

Bloom time is June to July.

Fruit and Seed: Creamy white to tannish berry-like drupes, approximately ¼ inch diameter. Drupes mature in August through September and persist through the winter providing a good identification characteristic on female plants.

Life History: Forms dense colonies by seed and through vegetative reproduction from surface or subsurface rhizomes.

Habitat: Invades disturbed areas such as roadsides, trail sides, fencerows, parks and can also be found in prairie (full sun) and forested settings (partial shade).

Specially Regulated is a unique category. Poison ivy, although irritating to humans, is a native plant that benefits wildlife by providing a food source to birds, small mammals and large browsers. *See page 74.*

Management: Caution! Use protective clothing, rubber gloves and long sleeves, contact with the sap (urushiol) from broken plant parts can cause blistering (dermatitis), even during the winter months. Caution! Smoke from burning poison ivy can deliver urushiol to airways and lungs. Do not compost as resprouting can occur and urushiol may persist in compost. Urushiol can stay on pets, tools, toys and other objects for long periods to be effectively transferred and cause irritation at a later date.

Grazing, cutting or **mowing** can inhibit flowering but must be continued in order to deplete energy reserves in the plants and to deplete the seed bank.

Prescribed fire generates potentially harmful smoke, see cautionary note above. So, while prescribed fire can provide control and often does control infestations of poison ivy, this tool should not be the first choice.

Herbicide formulations of triclopyr, 2,4-D, glyphosate, imazapyr or aminocyclopyrachlor applied to foliage or to cut stems are effective. Repeat applications will be required to exhaust seed banks.

Left: Shrub form
Above: Vine form

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn	■	■							
Herbicide	Foliar		■	■	■					
	Cut stem					■	■	■	■	
	Mow	Mow frequently to prevent flower and seed production.								
	Don't mow									
Flowering Period				■	■					

Nonnative | Alfalfa : *Medicago sativa* L.

Identification: *Provided for comparison to crown vetch and purple flowered weeds such as thistles or knapweeds.* *Return to crown vetch (page 28).*
Return to knapweed complex (pgs. 15 and 16) or spotted knapweed (pg. 17).
Return to Canada or plumeless thistles (pgs. 19, 20).

Plant: **Fabaceae** family, 4-sided stem supports a 1-3 foot tall plant.

Leaves: Alternate, 3-parted, compound leaves with individual leaflets measuring ⅜ to 1⅜ inches long, stipulate (leaf-like appendages where leaves attach to stems).

Key difference - *Thistles and knapweeds have simple leaves not compound.*

Flower: 5-parted, purplish to blue (occasionally cream colored) and approximately ¼ to ½ inch long. Alfalfa has a clustered, somewhat conical flower head.

Key difference - *Thistles and knapweeds are disk flowers with ray flowers on the edges.*

Bloom time is June to September.

Fruit and Seed: Coiled pods, mature to a brown color.

Habitat: Introduced to North America for livestock forage and is an agriculture crop. Common in roadside ditches, and similar disturbed areas.

Nonnative | Hairy Vetch : *Vicia villosa* Roth.

Identification: *Provided for comparison to crown vetch and purple flowered weeds.*
Also compare to American vetch, a Minnesota native. *See page 50.*
Return to crown vetch (pg. 28), knapweeds (pgs. 15, 16, 17) or thistles (pgs. 19, 20).

Plant: **Fabaceae** family, hairy vetch is a nonnative, short-lived perennial (biennial) with a spreading, viny form and has tendrils that assist climbing nearby plants up to 3 feet.

Leaves: Alternate, compound leaves, pinnately divided. Hairy vetch has 5-10 pairs of leaflets and tendrils are often found terminal on the compound leaves.

Key difference - *Crown vetch has no stipules, no leaf stalk and no tendrils.*

Flower: Hairy vetch has 10-40, 5-parted, pink to purple flowers about ¾ inch in length in a one-sided cluster.

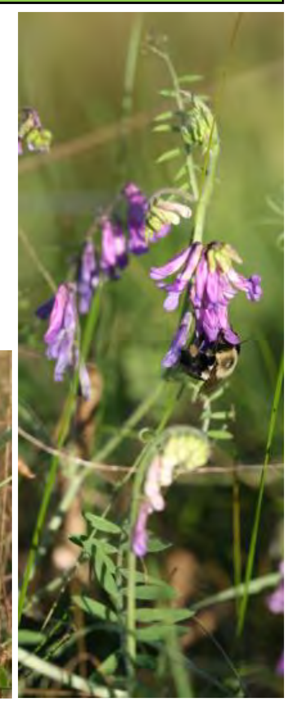
Key difference - *Crown vetch has a dense cluster (crown-like) - not one-sided or spike-like.*

Bloom time is May to September.

Fruit and Seed: Pea-like pods, ½-¾ inch long, that hang.

Key difference - *crown vetch's pods stand erect, they are angled, and multi-segmented.*

Habitat: Old fields, pastures and roadsides.



Nonnative	Balkan catchfly : *Silene csereii* Baumgarten

Identification: *Provided for comparison to Dalmatian toadflax on page 7.*

Strongly resembles Dalmatian toadflax's gray-green foliage color and form as well as habitat preference.

Plant: Similar to and often confused with bladder-campion (*Silene vulgaris*). Classed as a biennial/perennial that stands as tall as 40 inches. Stems are smooth, pale grayish-green.

Leaves: Opposite, simple leaves have entire margins (no teeth on leaf edges), smooth, waxy and grayish-green.

Key difference - *Leaves of Dalmatian toadflax are alternate on the stem, not opposite.*

Flower: Flowers are five-parted, white with petals that are often rolled. The flower typically has purple tinged stamens extending forward and behind the petals is a smooth bladder-like calyx or cup that will hold the seeds. The calyx is light green, tapers at the ends and has parallel veins.

Key difference - *Flowers are significantly different. Dalmatian toadflax has yellow snapdragon like flowers, while Balkan catchfly has creamy-white, 5-parted flowers.*

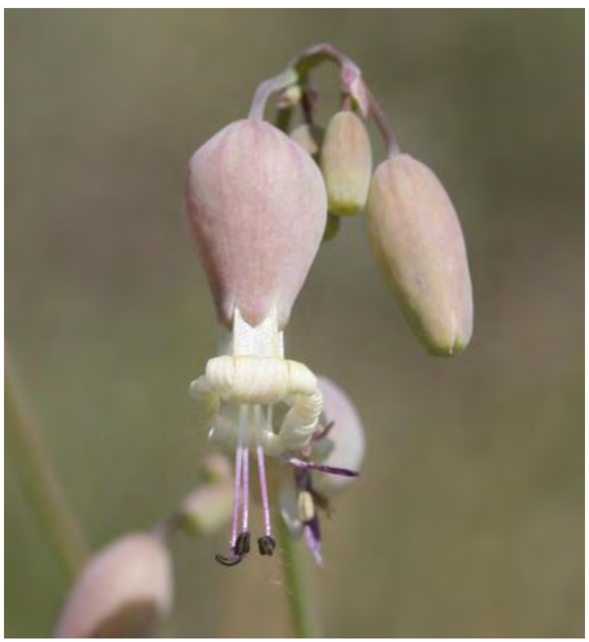
Bloom time is May to October.

Fruit and Seed: Held in the calyx or bladder behind the petals. At maturity the bladder turns light tannish-brown and the five tips curl backward.

Habitat: Full sun, dry, disturbed sites such as roadsides, abandoned lots, fields and gravel pits.

Above: Calyx tapered both ends, parallel veins.

Below: Curled petals, purplish stamens.



Opposite, simple leaves, clasping and blue-gray.

Form, opposite foliage, and plants are blue-gray.

Nonnative

Carrot look-alikes : *Apiaceae* family examples

Caraway	(*Carum carvi* L.)	[biennial, 1-4 feet tall forb]	pictures upper left,
Burnett saxifrage	(*Pimpinella saxifraga* L.)	[perennial, 2-3 feet tall forb]	pictures lower left,
Japanese hedge parsley	(*Torillis japonica* [Houtt.] DC.)	[annual, 2-6 feet tall forb]	pictures lower right,

<u>Identification</u>: *Provided for comparison to wild carrot also known as Queen Anne's lace on page 38.*

<u>Plant</u>: Herbaceous, life cycles and heights provided above. All examples on this page and including wild carrot are smaller statured members of the family. Compare floral structures, foliage, seeds and in particular bracts (presence or lack of) under the flower umbels and umbellets as defining characteristics.

<u>Leaves</u>: All have alternate foliage. Caraway has compound leaves that are deeply divided into very linear narrow segments. Burnet saxifrage has pinnately compound leaves - basal leaves in particular have oval, toothed leaflets. As leaves ascend the stem they become smaller and deeply lobed (pinnatifid). Of these three plants, Japanese hedge parsley foliage is closest in resemblance to wild carrot and basal leaves are divided in 3-5 parts.

These members of the carrot family have leaves that are smaller near the top of the plant.

<u>Flower</u>: Five-petaled, all are white and all are held as flat or slightly dome-shaped clusters (compound umbels). All have loose, open umbels unlike wild carrots tighter, denser umbel. Caraway has 5-15 umbellets.

Key differences - *Wild carrot has obvious, showy, branched bracts beneath umbels. The three plants listed on this page have few if any narrow, linear bracts. Caraway may have up to 4, Burnet saxifrage may have 1 bract while Japanese hedge parsley may have 2 or more narrow bracts at bases of compound umbels and up to 8 tiny bracts under umbellets.*

<u>Bloom time is variable - June to September.</u>

<u>Fruit and Seed</u>: All are described as schizocarps splitting at maturity to two carpels (individual seeds). Caraway has elongated ridged seeds at about ¼ inch long, Burnett saxifrage seeds are about ⅛ inch in length, flattened, rounded with slight ridges while seeds of Japanese hedge parsley are about ⅛ inch long and bristly with hooked hairs.

Key difference - *Wild carrot seeds are also about ⅛ inch with ridges covered by stiff bristles (not hooked). At maturity wild carrot folds its seed structure into what is often described as a bird's nest.*

<u>Habitat</u>: All prefer at least partial shade to full sun with caraway preferring full sun. All take advantage of disturbance to become established and all do well on roadsides. Japanese hedge parsley thrives along woodland edges.

Nonnative

Wild chervil : *Anthriscus sylvestris* (L.) Hoffm.

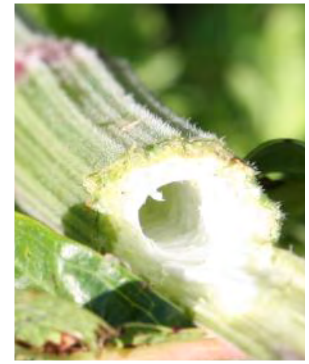
Above: Disturbed woodland edge and ribbed, hairy stems with a clasping leaf attachment.
Below: Bract-like appendages at umbel base and Bracts at umbellet bases. Inset: appendages may not persist.

Identification: Also a member of the Carrot, Parsley family (Apiaceae).
Provided for comparison to poison hemlock and wild carrot, pages 13 and 38 respectively. Compare to Carrot look-alikes and water hemlock, pgs. 45, and 64.

Plant: Herbaceous biennial that stands as tall as 5 feet (2-5 feet). Stems are hollow, ribbed, and mostly green with fine hairs, especially along the ribs.
Key difference - *Poison hemlock stems are smooth and spotted purple, not hairy or ridged.*
Leaves: Alternate, doubly pinnately compound leaves are smooth and shiny on the upper surface
with short hairs below. Vein patterns are more pronounced than on poison hemlock.
Key difference - *poison hemlock leaves have no hairs and venation is not as pronounced.*
Flower: Structure of the inflorescence is a compound umbel. Each umbel is comprised of 4-15 umbellets each with 3-10 white, 5-parted, florets.

Bloom time is April to June.

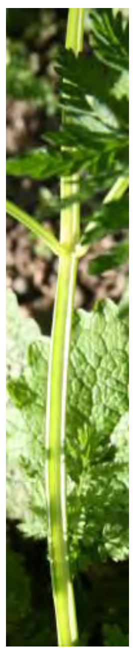
Fruit and Seed: Like other carrot family members, compound umbels of 2-parted seeds. In this species the styles persist resulting in a "beaked" seed (a pointed tip). Seed matures to ⅜ inch long and develops a dark brown color.
Habitat: Part shade to full sun, moist soils, disturbed sites such as roadsides, abandoned lots, fields and gravel pits.



Above: Hollow, ribbed stem with fine hairs.

Above: Seedlings.

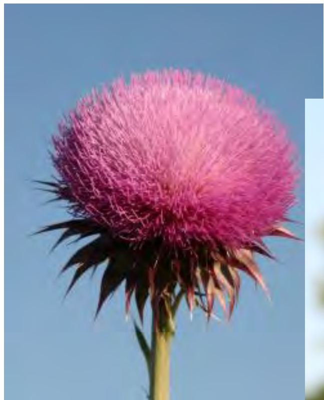
Grooved rachis.



Doubly, pinnately compound leaves with distinct venation.

A single umbellet of 2-parted, beaked seeds.

Nonnative | Musk or nodding thistle : *Carduus nutans* L.




Identification: *Provided for comparison to Canada and plumeless thistles on pages 19 and 20.*

Compare to native swamp thistle (Cirsium muticum). See page 62.

Compare to nonnatives alfalfa and hairy vetch. See page 43.

Plant: Herbaceous, biennial thistle, basal rosette in its first season. Second season, mature flowering stalks 1-7 feet tall.

Leaves: Rosettes can be twenty inches or more in diameter with rosette foliage deeply lobed, a light colored midrib and leaf edges that are light colored and spiny. Foliage on flowering stalks is alternate with spiny wings from leaf bases onto the stem and both surfaces are without hairs. *Compare to plumeless thistle foliage that is hairy below.*

Flower: Large at 1½-3 inches wide and deep pinks to purple. Composite flowers are solitary on branch ends, often nodding with large dark-colored spiny bracts beneath. *Compare to plumeless thistle's flowers that are ½ to 1½ inches wide with short spiny bracts and winged, spiny stems.*

Bloom time is June to August.

Fruit and Seed: Seeds are tufted with feathery plumes that are easily wind dispersed and most are deposited within 160 feet of plants. Do not mow after seed has developed as this strongly aids dispersal.

Life History: Plants have thick taproots but no rhizomes; thus, musk thistle is not clonal. Seed production is high with individual plants producing thousands of seed which can persist in seed banks up to 10 years.


Habitat: Infestations are found on dry to moist soils in woodlands, waste areas, roadsides, ditches and stream banks.

Management:

Cutting taproots 1-2 inches below ground is effective but time consuming for large numbers of plants. **Mowing** should be timed at flower bud stage to prevent seed production and should be repeated 2-3 times per season to be effective. Care should be taken to avoid spreading seed with hay or straw and with mowing and vehicle movement through infestations.

Prescribed fire can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.

Herbicide applications timed at the early bolting phase are foliar applications of 2,4-D ester or dicamba formulations. For foliar applications at the budding to flower stage or fall applications to basal rosettes turn to formulations of aminopyralid, clopyralid, metsulfuron-methyl or triclopyr.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

Nonnative | Yellow rocket : *Barbarea vulgaris* W. T. Aiton

Identification: *Provided for comparison to leafy spurge on page 21.*

Plant: Yellow rocket (a.k.a. winter cress, garden yellowrocket) was introduced from Eurasia and is common in Minnesota. A biennial plant (also described as perennial) that forms a basal rosette its first year. Subsequent growing seasons, flower stalks are erect at 8 to 36 inches tall, typically multi-branched and terminated by clusters of bright yellow flowers.

Leaves: Basal leaves and some stem leaves are pinnately lobed to deeply toothed and up to 6 inches in length. Often the terminal end of leaves is a larger rounded lobe in addition to 1-4 lesser side lobes. Leaves near the top of the plant are alternate, typically smaller, oval and often stalkless.

Key difference - *Leaves of leafy spurge are simple (not lobed) and narrowly linear at 1-4 inches in length.*

Flower: Crowded, rounded clusters of bright yellow stalked flowers. Flower clusters are terminal to branch ends.

Individual flowers range from ⅓ to ½ inch wide and have 4 bright yellow petals. As flower clusters elongate, flowers are produced above with seed pods produced below.

Key difference - *Leafy spurge has greenish-yellow flowers without petals. The greenish-yellow bracts beneath the true flowers provide the appearance of a petaled flower. Confusion occurs due to overlap in bloom periods.*

Bloom time is April to June.

Fruit and Seed: Slender pods develop along stems as flower clusters stretch upwards. The roundish pods are approximately 1 inch long, upward curved and contain small brown seeds at maturity.

Habitat: Considered a weed of lawns, gardens and agricultural fields. Often along roadsides and other disturbed sites. An infestation of yellow rocket indicates a disturbed site on which ground cover of native forbs and grasses is thin.

Minnesota Native | American bittersweet : *Celastrus scandens* L.

Oriental bittersweet, yellowish husks, fruit in leaf axils

American bittersweet, orange husks and bright red arils

Identification: *Provided for comparison to [Oriental bittersweet](#) on page 11.*

Plant: Woody vine, twining, no tendrils or aerial roots to assist in climbing.
Leaves: Alternate, elliptic to oblong or obovate, typically twice as long as wide. At bud break, leaf edges unroll in a scroll-like fashion.
Flower: Terminal panicles of numerous 5-parted flowers. Dioecious plants (male and female) producing small, rather inconspicuous whitish flowers.
Key difference - *terminal panicles. Flower location is observable on early growth.*

Bloom time is May to June.

Fruit and Seed: Like the flowers, ***terminal*** panicles. ***Orange*** colored husks covering bright red 3-parted arils (fleshy, berry-like fruits) containing 1-2 seeds each. Fruits persist into late winter.
Key differences - *terminal clusters, orange colored husks, bright red 3-parted arils.*
Habitat: Typically found in rich soil, full to partial sun often along roadsides and woodland edges.

Terminally clustered fruits, orange husks and bright red arils.

Foliage typically twice as long as wide. Oriental tends toward oval. Note the drawn out leaf tip.

Staminate (male) flowers with yellow pollen.

Pistillate (female) flowers clustered at branch ends

Minnesota Native | Canadian Milkvetch : *Astragalus canadensis* L.

Identification: *Provided for comparison to crown vetch on page 28.*

Plant: **Fabaceae** family, 1-3 feet tall perennial with ridged, pubescent stems.

Leaves: Alternate, odd-pinnate, compound leaves with 21-31 oblong leaflets, about 1½ inches long. Leaves measure 5 to 9 inches long and there are no tendrils.

Key difference - *crown vetch has 11-25 oval leaflets.*

Flower: 5-parted, cream colored and approximately ¾inch long. Milkvetch has a tall, spike-like, clustered, conical flower head with as many as 75 flowers.

Key difference - *Crown vetch has a purple to pink short, dense cluster (crown-like).*

Bloom time is June to September.

Fruit and Seed: Thickened, fuzzy, 2-parted pods with a pointed tip, mature to a brown color.

Habitat: Used for livestock forage and as an agriculture crop. Common in roadside ditches, and similar disturbed areas.

Minnesota Native | American vetch : *Vicia americana* Muhl. Ex Willd.

Identification: *Provided for comparison to crown vetch and purple flowered weeds.*
Also compare to alfalfa and hairy vetch, nonnative family members.

Plant: **Fabaceae** family, American vetch is a native perennial with a spreading, viny form and typically has tendrils that assist in climbing nearby plants up to 3 feet.

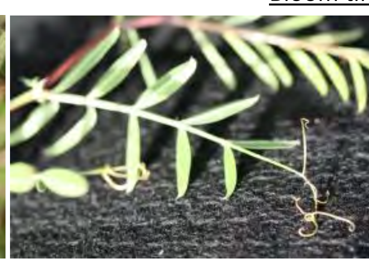
Leaves: Alternate, compound leaves, pinnately divided. American vetch has 4-8 pairs of leaflets and tendrils terminal on the compound leaves. American vetch has toothed stipules at the base of its compound leaves.

Key difference - *Crown vetch has no stipules, no leaf stalks and no tendrils.*

Flower: American vetch has 2-9 flowers in a one-sided cluster. Flowers are 5-parted, pink to purple and about ¾ inch in length.

Key difference - *Crown vetch has a dense crown-like flower cluster.*

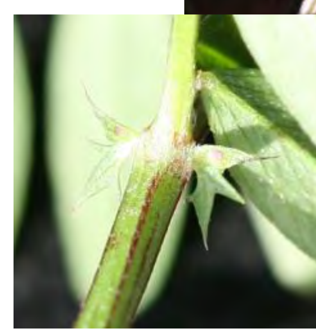
Bloom time is May to September.



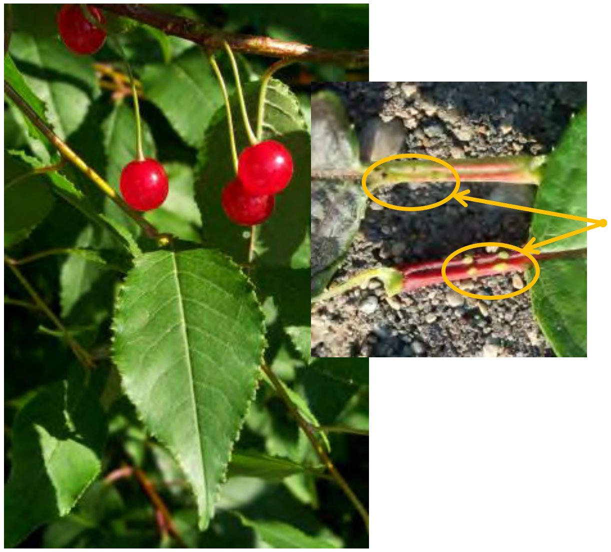
Fruit and Seed: Pea-like pods that hang. American vetch's pods are about 1 inch long. Similar to hairy vetches pea-like pod.

Key difference - *crown vetch's pods stand erect, they are angled, and multi-segmented.*

Habitat: Old fields, pastures and roadsides.



Minnesota Native | Cherries and American plum : *Prunus* spp.



Above: Mature, bright red, solitary or paired fruit and foliage of pin cherry.

Below: Flower of black cherry and maturing fruit of chokecherry.

Black cherry (*P. serotina* Ehrh.)
Choke cherry (*P. virginiana* L.)
Pin cherry (*P. pensylvanica* L. f.)
American plum (*P. americana* Marshall)

<u>Identification</u>: *Provided for comparison to common and glossy buckthorn on pages 29 and 30.*

<u>Plant</u>: Plums, chokecherry and fire or pin cherry are small sized trees. Black cherry may be a small tree, but reaches medium to large tree status. All have smooth, gray to brown bark that is often shiny and lenticeled. Couple that bark and American plum's thorn-like twigs and it is no surprise that these species are frequently confused with buckthorn.

<u>Leaves</u>: Alternate, elliptic to oblong or ovate, typically finely toothed with acuminate or drawn out leaf tips.

Key difference - *Prunus species have glands on the leaf petioles. Additionally, arcuate venation of common buckthorn.*

<u>Flower</u>: Numerous 5-parted, white, fragrant flowers are fairly showy or obvious. Cherries have panicles of white fragrant flowers while the plum's white flowers are clustered along the stem. In Minnesota American plum (wild plum) is one of the earliest trees to bloom, typically small groups of trees clumped along forest edges.

Key difference - *5-parted, white, fragrant flowers are fairly showy or obvious.*

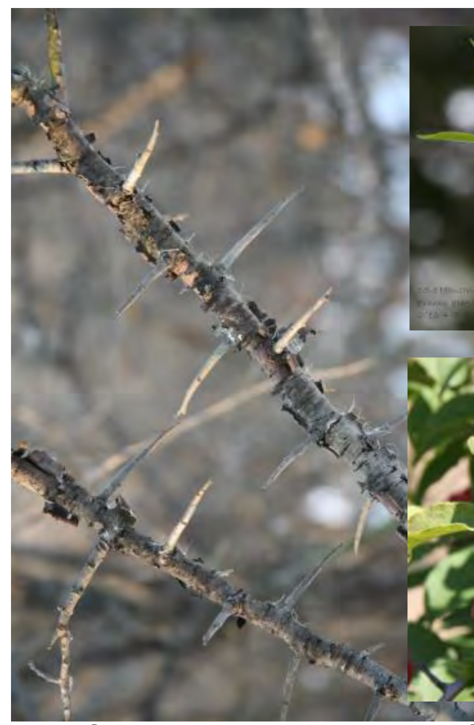
<u>Bloom time is May to June</u>.

<u>Fruit and Seed</u>: Choke and black cherries panicles (loose, hanging clusters) of black fruit are readily taken by birds. Pin or fire cherry fruits mature to a bright red. Plums have a ¾-1 inch, reddish to purplish fruit that contains a large seed.

Key difference - *birds eat fruits of cherries and plums after ripening. Buckthorn fruits remain on shrubs into late winter.*

<u>Habitat</u>: Typically found in rich soil, full to partial sun often along roadsides and woodland edges.

Below: Thorns of wild plum on dead branches. Wild plum flowers and fruit.



Minnesota Native	Common hops : *Humulus lupulus* L.

Hooked stem hairs early spring (May).

Male flowers, 3-lobed, opposite leaves.

Identification: *Provided for comparison to Japanese hops on page 10.*

Plant: Herbaceous, perennial vine, rhizomatous (spreads by rhizomes). Leaf petioles and annual stems with stout hooked hairs. Image at left is of developing, hooked hairs in May.

Leaves: Opposite, for the most part 3 lobed (up to 5 lobes), higher on the vine leaves may be unlobed. Typically, a cordate (heart shaped) base to the leaf and leaves nearly as broad as long.

Key difference - *3 (maybe 5) lobed leaves, higher on the vine leaves may be unlobed*.

Flower: Inconspicuous, wind pollinated and dioecious (male and female) plants.

Bloom time is July to August.

Fruit and Seed: Fruiting structure is cone like, comprised of papery bladders covering individual seeds. Fragrant when crushed. Fruit persists into late winter (see image at right).

Key difference - *native common hops fruit structure is fragrant when crushed.*

Habitat: Moist soils, disturbed sites in woodlots and along fencerows.

Opposite leaves.

Winter fruit, fragrant.

Fruit, 3-lobed and un-lobed leaves.

Male flowers, 3-lobed, opposite leaves.

Female flowers, 3-lobed, and un-lobed opposite leaves.

5-lobed, 3-lobed, opposite leaves.

Minnesota Native	Cow-parsnip : *Heracleum maximum* W. Bartram

Synonym: Common cow-parsnip (*Heracleum lanatum* Michx.)

Identification: *Provided for comparison to giant hogweed on page 8.*

Plant: Perennial, single-stemmed large plants at 3-10 feet tall. Fuzzy stems are hollow and described as foul smelling. **Key difference** - *hogweed has purplish stems with coarse hairs.*
Leaves: Alternate, compound, 3-parted with toothed, palmate leaflets. The petiole or leaf stalk has an enlarged base that clasps the stem.
Key difference - *hogweed has strongly dissected leaves up to 5 feet wide.*
Flower: 8-30 small, white, 5-parted flowers with notched petals, in a 4-8 inch flat umbel, 8-30 umbellets. *Cow parsnips outer flower petals are often larger, irregular, and notched.*
Bloom time is June to July.
Fruit and Seed: Many flattened fruits that when dry split into 2 seeds. See left-hand image.
Habitat: Often found in rich, moist soils along streams or river bottoms in full to partial sun.
Caution: Although to a lesser extent, cow parsnip can cause blistering rashes similar to giant hogweed. Again, plant sap reacting with sunlight - phytophotodermatitis.

Clasping, 3-parted leaf, fuzzy stems.

Outer flowers, larger, notched and irregular.

Minnesota Native | Cucumbers : *Echinocystis lobata* Michx. and *Sicyos angulatus* L.

Above: Bur cucumber foliage and flowers.
Below: Bur cucumber foliage and prickly seed structure.

Key difference - Both cucumber species have prickly seed structures. Below: Wild cucumber

Wild cucumber (*Echinocystis lobata*) and bur cucumber (*Sicyos angulatus*).

Identification: *Provided for comparison to Japanese hops on page 10.*
Compare to native common hops. See page 52.

Plant: Annual vines (non woody) with tendrils, often found covering shrubs and small trees to approximately 20 feet.
Leaves: Simple, alternate, 3-5 triangular lobed wild cucumber leaves have small teeth along the leaf edge. Bur cucumber differs with its 3-5 shallowly lobed leaves having hairy undersides as well as sticky hairs on its stems.
Flower: Wild cucumber has creamy white flowers with 6 strap-like petals. These are male flowers. One rarely noticed female flower is at the end of the flower spike. Bur cucumber has 5-petaled greenish-white male flowers clustered and separate from the female flowers clustered elsewhere on the plant.

Bloom time is July to September.

Fruit and Seed: Solitary, prickly bladders distinguish wild cucumber from bur's grouped, up to 10, prickly pods.
Habitat: Can be found growing side-by-side. Plants can be found in partial shade to full sun along the edge of the woods or in thickets or open areas with moist soils.

Above: Wild cucumber hanging on a fence in winter
Key difference - cucumber vines have tendrils.

Above: Bladder-like seed pod remaining in winter, seeds dispersed.
Below: Wild cucumber foliage and flowers.

Minnesota Native

Fireweed : *Chamerion angustifolium* (L.) Holub ssp. *angustifolium*

Synonym: *Epilobium angustifolium* L.

Identification: *Provided for comparison to* *purple loosestrife* *on page 23*.

Plant: Perennial, erect, rounded, single stems reaching 2-6 feet tall. **Key difference** - *rounded stem, not 4-6 sided.*

Leaves: Alternate, crowded leaves that are lance-like and stalkless. **Key difference** - *alternate (not opposite).*

Flower: Four-parted, colors range from pink to purple. The flowers are showy at ¾ to 1½ inches wide and arranged along a tall terminal spike. **Key difference** - *Fireweed has four-parted flowers (purple loosestrife has 5-parted flowers)*.

Bloom time is June to August.

Fruit and Seed: Long, slender capsules or pods that split to release small seeds with long tufted hairs.

Habitat: Often present following burns on moist soils at forest edges or in clearings.

Minnesota Native	Golden alexanders : *Zizia* spp.

Golden alexander [*Z. aurea (L.) W.D.J. Koch*] and
heart-leaved golden alexander [*Z. aptera (A. Gray) Fernald*].

Identification: *Provided for comparison to wild parsnip on page 25.*

Plant: Herbaceous, perennial reaching 1-2 feet tall.
Key difference - *golden alexanders smooth, shiny stems compared to the grooved stem of wild parsnip.*
Leaves: Alternate 2-3 inch stem leaves, mostly 3-parted with finely toothed edges. Basal leaves of heart-leaved golden alexanders are simple and oval (heart-shaped) while those of golden alexanders are compound like upper stem leaves.
Key difference - *the basal leaves of wild parsnip are pinnately compound with 5-15 leaflets.*
Flower: Terminal panicles of numerous 5-parted, yellow flowers.

Bloom time is May to July.

Fruit and Seed: Similar to wild parsnips. Ridged - when mature appears dry and splits into 2 parts.
Key difference - *wild parsnip seeds are typically larger and flatter.*
Habitat: Moderately moist to wet - sandy, loamy soils, full sun to shade.

Z. aptera heart-shaped basal leaves.

Ridged seed, few if any bracts.

Minnesota Native	Goldenrods : *Solidago* spp.

Pyramidal inflorescence of Canada goldenrod

Identification: *Provided for comparison to common tansy on page 24.*
In particular, compare common tansy to stiff goldenrod (*Solidago rigida* L.).

Plant: Perennial plants, often clumped, typically erect, single stems. Species typically ranges in height from 1-4 feet while species may reach heights of 7 feet.
Leaves: Alternate, simple, depending on species leaves are lance shaped, may or may not be toothed and may or may not be hairy.
Key difference - *tansy foliage is pinnately divided, toothed and aromatic when crushed.*
Flower: Yellow ray flowers typically arranged in branched clusters. Depending on species the inflorescence may be pyramidal, flat-topped or one-sided.
Key difference - *goldenrod flowers have* ***ray petals*** *surrounding central, disk-like florets.*
Bloom time is late July through September.

Ray petals of stiff goldenrod

Fruit and Seed: Dry, light seeds often tufted with light-colored to brownish hairs easily carried by wind.
Key difference - *Tansy seed is not tufted and persists into winter in the flower heads.*
Habitat: goldenrod species thrive in a variety of sites. They can be found in dry to wet prairies, dry to moist forests and on a variety of roadsides. Partial to full sun.

Flat-topped inflorescence of stiff goldenrod

One-sided inflorescence of gray goldenrod

Minnesota Native | Riverbank Grape : *Vitis riparia* Michx.

Identification: *Provided for comparison to porcelain berry on page 36.*

Plant: Perennial, woody, vines climbing into trees and structures or spreading over low growing vegetation. Height can be variable and up to 80 feet. Tendrils opposite some leaves assist climbing and support. Stems of grape vines can attain diameters of 7-8 inches with bark maturing to dark brown and shredding from stems in narrow strips.

Key difference - *Porcelain berry's bark does not shed in vertical strips.*

Leaves: Alternate, simple, cordate (heart-shaped) leaves are sharply toothed and palmately lobed, often three distinct lobes. Leaves may be up to 6 inches long and 4 across. Upper leaf surface is typically dark green and smooth while underside may be whitish. There may or may not be hairs along the major veins.

Key difference - *Porcelain berry's leaves are often deeply divided by sinuses.*

Flower: Often dioecious, male and female flowers on separate plants, occasionally flowers are perfect (all reproductive parts). Hanging panicles of greenish-yellow, 5-parted flowers are not showy. Most are held opposite a leaf.

Bloom time is May to late June.

Fruit and Seed: Green berries (grapes), covered by a whitish film (glaucous), that mature to a purple color. Berries contain 1 to 4 seeds.

Key difference - *Porcelain berry has shiny, berries in hues of blue/purple.*

Habitat: Grapes prefer full sun but will tolerate partial shade. Preference is moist soils and as the name implies, riverbank grapes are often found in river bottoms climbing into trees where there is good sunlight at forest edges and in openings.

Above and below: June 13 - flowers, leaves and tendrils of grape on the Anoka sandplain.

Minnesota Native | Honeysuckles : *Diervilla lonicera* and *Lonicera* spp.

Above: Landscape use of northern bush honeysuckle.
Yellow tubular flowers, and serrated, lance shaped foliage.

Below:
Left 2 images - fly honeysuckle foliage, fruit and flower.
Second from right - rounded foliage of vining hairy honeysuckle and extreme right is red flower, fused foliage of wild honeysuckle.

Northern bush honeysuckle [shrub] (*Diervilla lonicera* Mill.) - pictures upper right and left,
fly honeysuckle [shrub] (*Lonicera canadensis* Marsh.) - pictures lower left,
swamp fly honeysuckle [shrub] (*L. oblongifolia* [Goldie] Hook.) - not pictured,
mountain fly honeysuckle [shrub] (*L. villosa* [Michx.] J. A. Schultes) - not pictured,
hairy honeysuckle [vine] (*L. hirsuta* Eat.) - picture second from lower right,
wild honeysuckle [vine] (*L. dioica* L.) - picture lower right.

Above: northern bush honey-suckles beaked, capsule fruit.

Below: Vining honeysuckles fused terminal leaves.

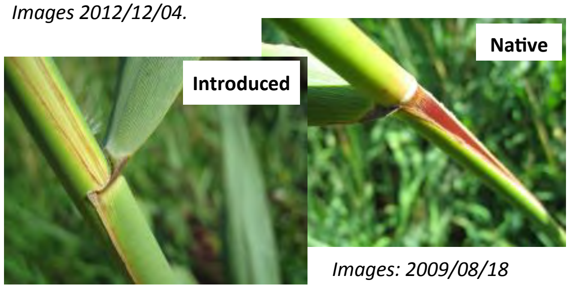
Identification: *Provided for comparison to Asian bush honeysuckles on page 26.*
Plant: Shrubs range in heights up to 3 feet for northern bush honeysuckle on up to 6 feet for fly honeysuckles. Twining vines may be sprawling, standing weakly or climbing to heights of 9-15 feet (hairy and wild) on up to 24 feet for the uncommon grape honeysuckle.
Key difference - *Native bush honeysuckles have solid piths, typically white. Vine forms have hollow stems, white piths.*
Leaves: Opposite. It is difficult to generalize leaf types and shapes for these species. Bush honeysuckle has lance-shaped leaves with a long tip, serrated and ciliated margins with hairs possibly present on surfaces or mid-veins. Fly honeysuckles have elliptical to oblong shapes with blunt or acute tips. Vining honeysuckles tend to have rounded or ovate leaves except terminal leaf pairs tend to be fused (see image at right).
Key difference - *Northern bush honeysuckle has serrated, lance shaped foliage. Vining honey-suckles tend to have rounded foliage with the terminal pair fused.*
Flower: Tubular. Northern bush honeysuckles have a yellow flower (image left) while wild honeysuckles are red (image lower right). Others, like fly honeysuckle, vary from pale yellow to white.
Bloom time is typically May to July. Northern bush honeysuckle as late as September.

Fruit and Seed: Typically berry-like, typically red except for bush honeysuckles beaked, capsule with sepals attached.
Habitat: Woodland habitats with some species tolerant of deeper shade while others require partial sun. Swamp fly and mountain fly honeysuckles are typically found in moist soils such as forested swamps or bogs.

Minnesota Native

Native phragmites : *Phragmites australis* ssp. *americanus* Saltonstall

Left: Introduced - diffuse fungal spots and leaf sheaths intact on yellow winter stems.
Right: Native - sharply defined fungal spots may be present on some stems and note the maroon to pink color.
Images 2012/12/04.



Images: 2009/08/18

Left: Introduced - green stems at the nodes.
Right: Native - maroon to pink color at the stem nodes.

Above: Introduced - larger, grayish, fuzzy seed head.
Right: Native - smaller, golden, some fuzziness to seed heads.

Complete nomenclature from USDA GRIN: *Phragmites australis* (Cav.) Trin. ex Steud. subsp. *americanus* Saltonstall

Identification: *Provided for comparison to* *nonnative phragmites* *on page 35*.

Plant: Perennial grass. Stand density can be similar to introduced common reed but, stands often have other native plants interspersed. In comparison to introduced form, native plants are typically shorter and foliage appears yellowish.

Leaves: Summer leaves are yellowish. Leaves and leaf sheaths will drop from plants in winter leaving bare reddish stems (photo at left). Ligule length determined under a dissecting microscope is diagnostic, typically > 1.0mm.

Flower: Approximately 3-4 months after spring growth begins.

Bloom time is June-September.

Fruit and Seed: Plumes are sparse and likely not persistent through winter. Glume lengths are diagnostic and as with ligules a dissecting microscope is useful for measurement and comparison.

Habitat: Native phragmites occurs near water sources such as rivers, streams, shorelines of ponds and lakes as well as within wetland systems including wet roadside ditches.

Native phragmites seed heads tend to be less dense, less fuzzy and typically not as large.

Left foreground: Introduced - dark green foliage with larger, grayish, seed heads.
Right background: Native - yellowish foliage with smaller, golden, seed heads.

Native phragmites has maroon stems at the nodes or segment joints. *Image 2009/11/02*

Minnesota Native

Sumacs : *Rhus typhina* L. and *R. glabra* L.


Staghorn sumac

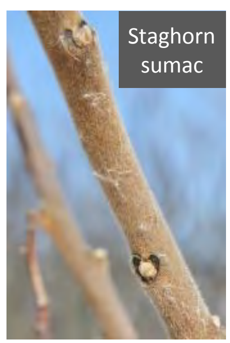
Height can exceed the 25-30 feet shown here.

Staghorn sumac [shrub] (*R. typhina* L.) - pictures left.
Smooth sumac [shrub] (*R. glabra* L.) - pictures right,

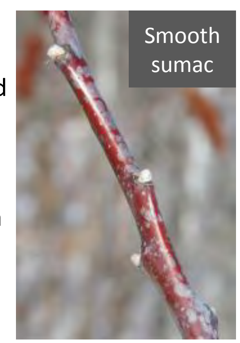
Identification: *Provided for comparison to tree-of-heaven on page 37.*
Plant: Shrubs ranging in heights up to 18 feet for smooth sumac and staghorn sumac considered a shrub or small tree at heights up to 36 feet (or taller). Both smooth and staghorn sumac develop clonal, multi-stemmed, colonies. The names are indicative of the hairiness of the plants. Smooth sumac has smooth bark, fruits and foliage while staghorn has very fuzzy twigs, fruit and leaf parts.
Key difference - *Tree-of-heaven has smooth twigs similar to smooth sumac, but twigs and small branches of tree-of-heaven are very stout with very large leaf scars.*
Leaves: Alternate, odd pinnate compound. Smooth sumac has 9-23 hairless, sessile (no stalk) leaflets while staghorn sumac has 13-27 hairy, sessile leaflets. In particular the petioles (stalks that leaflets attach to) of staghorn sumac are fuzzy as is the mid-vein on the underside of the leaflet. Both species have serrated (toothed) leaflet edges. Leaflet color of the sumacs is darker green on top surface and pale green, almost whitish, on the bottom.
Key difference - *Tree-of-heaven has 11-25 or more smooth leaflets that have smooth edges and glands near leaf bases. Leaf color is a consistent green top and bottom.*
Flower: Dioecious species, male and female flowers on separate plants. Pyramidal multi-branched, stalks of greenish, 5-parted flowers. Many ¼ inch greenish flowers are somewhat showy as they are held on terminal, pyramidal structures that can be up to 15 inches tall by 9 inches wide.

Bloom time is typically late June into July.

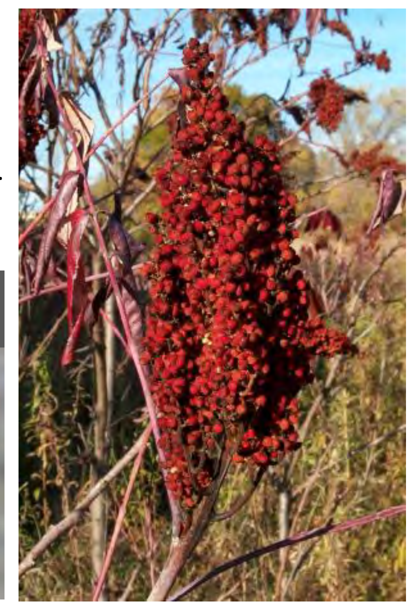
Fruit and Seed: The pyramidal structure of female flowers will be replaced by red fruits called drupes, each contains a single seed. Individual fruits of smooth sumac are covered by very short red hairs while those of staghorn are covered by very noticeable fuzzy, reddish hairs. Fruits of both species while rounded are slightly flattened and will hold on through winter and potentially into the following summer.
Key difference - *Tree-of-heaven, clusters of slightly twisted, single-seeded samaras.*


Staghorn sumac

Habitat: Both sumac species prefer full sun. Both are found along forest edges and in forest openings. However, they may also be found near lakes or rivers or even on the drier extremes of rocky outcrops, prairie and savanna habitats. Sumacs are a common sight along dry roadsides.


Smooth sumac

Above: Greenish male flowers of smooth sumac. July 18, BWCAW. Below: Smooth sumac fruit October 15th near Mankato.



Minnesota Native | Swamp thistle : *Cirsium muticum* Michx.

Identification: *Provided for comparison to nonnative thistles; Canada and plumeless thistle on pages 19, 20.*

See also: BWSR Featured Plant: Minnesota's Thistles, Publication date 2013-3-6.

Plant: Biennial, mature plants from 2-7 feet tall with multiple-branches terminated by many heads. Stems are not spiny but woolly, especially lower portions of the plant.
Leaves: Alternate, deeply divided leaves have lance-like or oblong segments that are described as softly spiny.
Flower: Purples to pinks typically not white. Composite flowers are 1½ inches wide held together by whitish, woolly, non-spiny bracts that have a visible light-colored dorsal (central) ridge.

Bloom time is July to October.

Fruit and Seed: Tufted seed matures and is wind-dispersed late summer into autumn.
Habitat: Swamps, bogs and areas like wet meadows, moist woods and thickets.

Key difference - *Woolly, non-spiny bracts with a light colored dorsal ridge.*

Key difference - *Deeply divided foliage that is softly spiny. Stems are hairy or wooly, not spiny.*

Minnesota Native

Woodbine : *Parthenocissus* spp.

Woodbine, palmately compound leaves.

Virginia creeper [*Parthenocissus quinquefolia* (L.) Planch.] and
woodbine [*P. vitacea* (Knerr) Hitchc.], synonym: *P. inserta* (Kerner) K. Fritsch.

Identification: *Provided for comparison to Japanese hops on page 10.*
Compare to native common hops on page 52.

Plant: Woody, perennial vines, with tendrils that assist climbing into trees and onto structures (Virginia creeper and woodbine) or sprawling on the forest floor (woodbine). Virginia creeper may develop aerial roots while woodbine does not. Tendrils of Virginia creeper develop adhesive disks while tendrils of woodbine usually attach by wrapping around an object, seldom developing adhesive disks.

Leaves: Alternate, palmately compound with 4-5 leaflets (typically 5). Leaflet bases are tapered and the leaf edges are toothed (possibly doubly toothed).

Key difference - *Leaves of Japanese hops are simple not palmately compound*.

Flower: Both species have greenish flowers held on compound cymes (branched, flat-topped structures with terminal flowers opening first). Virginia creeper's structure has a central axis while woodbine's does not.

Bloom time is June to July.

Fruit and Seed: Fruits are berries, bluish at maturity and held on red structures.

Key difference - *Japanese hops does not produce berries.*

Habitat: Virginia creeper is often found in forest interiors where it climbs high into the canopy. Woodbine on the other hand will sprawl over the ground, on fences, rock piles unless it encounters a structure or tree suitable for climbing.
Full sun to partial shade of the forest, moist soils, along fencerows or found growing on disturbed sites where animals and birds have dropped the seeds.

Woodbine climbing a fence post.

Virginia creeper, aerial roots holding onto elm bark.

Welby Smith describes the flower petals as "Boat-shaped."

Fall foliage and blue berries.

Adhesive disks at tendril ends.

Minnesota Native	Water Hemlock : *Cicuta maculata* L.

United States Dept. of Agriculture fact sheet states: "the most violently toxic plant that grows in North America."

Caution All plant parts (foliage, seeds, stems, roots) are ***poisonous to humans*** and livestock. Caution

Reported that toxin can be absorbed through bare skin! Wear appropriate PPE - gloves, long sleeves, and long pants.

Identification: *Provided for comparison to wild carrot on page 38. Also, compare to poison hemlock on page 13.*

Plant: Herbaceous, biennial (short-lived perennial), first year as a basal rosette and second year water hemlock is a lightly branched, 3-6 feet tall, plant. Stems are smooth (no hairs), hollow (lower portion), appear ridged due to veins and are light green or pinkish or reddish purple.

Key difference - *wild carrot stems are hollow and sparingly hairy to hairy. Stems are not spotted, see poison hemlock.*

Leaves: Alternate, generally triangular in form. Compound leaves are pinnate or doubly pinnate with 3-7 leaflets. Leaflets are not fern-like. Leaflets are 1-4 inches long by ½- 1¼ inches wide. Leaflets are toothed and veins appear to terminate in the notch between teeth - not at the tip. Petiole to stem attachments are partially covered by a sheath.

Flower: Petals are notched at the tip and narrowed at the base. Flowers are five-petaled, white and held as flat or slightly dome-shaped, loose, open compound umbels. Each umbel is comprised of 10-20 domed umbellets each holding 12-15 flowers. Main branches (rays) of umbels are not subtended by bracts. Secondary branches of umbellets have lanceolate bracts with scarious (thin, dry, membranous) margins.

Key differences - *wild carrot has obvious, showy, branched bracts beneath flower umbels and umbellets.*

Bloom time is variable - June to August.

Fruit and Seed: Seeds are schizocarps splitting at maturity to two carpels (individual seeds). Seeds are ⅛ inch long and angular. There are no hairs.

Key difference - *Wild carrot seeds are also about ⅛ inch with ridges covered by stiff bristles. At maturity wild carrot folds its seed structure into what is often described as a bird's nest.*

Habitat: Partial shade is tolerated but preference is full sun with wet to moist fertile soils with organic material. Often found in wet meadows and pastures and other similar sites like moist to wet roadside ditches. Prefers more moisture than poison hemlock and typically, does not compete or occur with poison hemlock.

Minnesota Native	Common yarrow : *Achillea millefolium* L.

Identification: *Provided for comparison to poison hemlock and wild carrot, pages 13 and 38 respectively. Compare to Carrot look-alikes, wild chervil and water hemlock, pgs. 45, 46, and 64.*

Plant: Perennial, herbaceous plant reaching heights of 1-2 (3) feet. Stems are pale green, hollow and typically covered with fine hairs. Plants are often unbranched except near the top.

Leaves: Alternate, narrow and finely divided - single or double pinnate - very fern like. Stem leaves are sessile (no leaf stalk) and near top of plants, typically smaller. Leaflets are longest at the middle of the rachis and shorter near the tip and base.

Flower: Terminal branched flower structures (compound corymb) of numerous 5-parted flower heads. Each flower head consists of 5 ray florets and 5 disk florets. Florets are typically whitish to pale cream. White flowers on a flat-topped structure brings about confusion with the carrot family.

Key difference - *terminal* ***branched*** *panicles or compound corymb versus carrot families compound umbels.*

Bloom time is June to September.

Fruit and Seed: Like the flowers, terminal panicles. Florets are replaced by seeds (achenes) lacking hairs. Roots are rhizomatous - thus colonies can be formed.

Habitat: Mesic to dry soils, full to partial sun often in prairies, along roadsides and woodland edges.

Leaf Bases to ----------------------- > Leaf Tips

Typical form with flowers terminal to branches. Branches may be few.

Images of pinnately, compound foliage. Very finely divided, very fern-like.

Top leaf - sessile stem leaf. Bottom leaf - petioled basal leaf.

End of season, dry flower structure. Historically used in architectural modeling as trees.

Citations / Resources:

Prohibited: Eradicate

Black swallow-wort: *Cynanchum louiseae* Kartesz & Gandhi Page 4
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
https://www.invasive.org/weedcd/pdfs/wgw/blackswallowwort.pdf
http://www.invasive.org/browse/subinfo.cfm?sub=3398

Common teasel: *Dipsacus fullonum* L. Page 5
Image citations – Bugwood.org:
Flowering head close-up - David Cappaert, Michigan State University,
Flower group, basal rosettes, seed head - Steve Dewey, Utah State University.
Identification and management:
http://www.illinoiswildflowers.info/weeds/plants/teasel.htm
http://www.fs.fed.us/database/feis/plants/forb/dipspp/all.html
http://www.invasiveplantatlas.org/subject.html?sub=3018

Cutleaf teasel: *Dipsacus laciniatus* L. Page 6
Image citations: Dave Hanson and Tina Markeson, MnDOT.
Identification and management:
http://dnr.wi.gov/topic/Invasives/fact/CutLeavedTeasel.html
http://www.invasiveplantatlas.org/subject.html?sub=5545
http://www.missouriplants.com/Whiteopp/Dipsacus_laciniatus_page.html

Dalmatian toadflax: *Linaria dalmatica* (L.) Mill. Page 7
Image citation: all images - Dave Hanson, MnDOT
Identification and management: http://www.cwma.org/Dalmation.html
http://wiki.bugwood.org/HPIPM:Dalmatian_toadflax
http://www.invasiveplantatlas.org/subject.html?sub=5939
https://www.cabi.org/isc/datasheet/30827

Giant hogweed: *Heracleum mantegazzianum* Sommier & Levier Page 8
Image citations – Bugwood.org:
Flower - Leslie J. Mehrhoff, University of Connecticut,
Flower and pen - USDA APHIS PPQ Archive, USDA APHIS PPQ,
Leaf - Donna R. Ellis, University of Connecticut,
Foliage to human - Thomas B. Denholm, New Jersey Department of Agriculture.
Identification and management:
http://www.invasiveplantatlas.org/subject.html?sub=4536
http://dnr.wi.gov/topic/Invasives/fact/GiantHogweed.html

Grecian foxglove: *Digitalis lanata* Ehrh. Page 9
Image citations: Dave Hanson and Tina Markeson, MnDOT,
Identification and management:
http://www.minnesotawildflowers.info/flower/grecian-foxglove
http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/foxglove.aspx

Japanese hops: *Humulus japonicus* Siebold & Zucc. Page 10
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
https://science.nature.nps.gov/ . . .NPS_Field_Guide_JapaneseHop.pdf
http://dnr.wi.gov/topic/Invasives/fact/JapaneseHops.html

Oriental bittersweet: *Celastrus orbiculatus* Thunb. Page 11
Image citations: Ken Graeve and Dave Hanson, MnDOT.
Identification and management: https://www.cabi.org/isc/datasheet/12009
https://www.invasive.org/weedcd/pdfs/wgw/orientalbittersweet.pdf
http://dnr.wi.gov/topic/Invasives/fact/OrientalBittersweet.html
http://www.invasive.org/browse/subinfo.cfm?sub=3012

Palmer amaranth: *Amaranthus palmeri* S. Watson Page 12
Foliage images: Aaron Hager, University of Illinois at Urbana-Champaign.
Image citations from Bugwood.org:
Leaf/petiole and plant form - Ross Recker, University of Wisconsin - Madison,
Female seed spike and thick stem - Rebekah D. Wallace, University of Georgia.
Identification and management:
Becker, Roger. University of Minnesota. Herbicide recommendations. Email.
http://www.ksre.ksu.edu/bookstore/pubs/s80.pdf
http://www.extension.org/pages/65209/palmer-amaranth-amaranthus-palmeri
http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/palmeramaranth.aspx
http://www.weeds.iastate.edu/mgmt/2014/Palmer%20amaranthICMv2.0.pdf

Poison hemlock: *Conium maculatum* L. Page 13
Image citation: all images - Dave Hanson, MnDOT.
Identification:https://gobotany.newenglandwild.org/species/conium/maculatum/
http://www.illinoiswildflowers.info/weeds/plants/poison_hemlock.htm

Yellow starthistle: *Centaurea solstitialis* L. Page 14
Image citations – Bugwood.org: Bolting stage - Cindy Roche,
Flower up-close - Peggy Greb, USDA Agricultural Research Service,
Mature foliage, basal rosette - Steve Dewey, Utah State University.
Identification and management:
https://www.invasive.org/weedcd/pdfs/wgw/yellowstarthistle.pdf
http://www.invasive.org/browse/subinfo.cfm?sub=4390
https://www.fs.fed.us/foresthealth/technology/pdfs/ . . . _Biocontrol_Yellow_Starthistle.pdf

Knapweed complex: Page 15-16
Identification and management: http://wiki.bugwood.org/Archive:Knapweed
http://www.ag.ndsu.edu/pubs/plantsci/weeds/w1146.pdf
http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/knapweed.pdf

Brown knapweed: *Centaurea jacea* L. Page 15-16
Image citations – Bugwood.org:
Flower - Rob Routledge, Sault College; Flower side view - Cindy Roche.
Foliage and form - Bruce Ackley, The Ohio State University,
Identification and management:
http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250066298
http://www.invasiveplantatlas.org/subject.html?sub=5278
http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artmar06/bj-knapweed.html

Citations / Resources continued:

Meadow knapweed: *Centaurea moncktonii* C. E. Britton Page 15-16
Image citation: all images - Tom Jacobson, MnDOT.
Identification and management:
http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250068128
http://www.mda.state.mn.us/en/plants/pestmanagement/weedcontrol/noxiouslist/meadowkw.aspx

Diffuse knapweed: *Centaurea moncktonii* C. E. Britton Page 15-16
Image citation: Steve Dewey, Utah State University, Bugwood.org
K. George Beck and James Sebastian, Colorado State University, Bugwood.org
Identification and management:
http://www.cwma.org/DiffuseKnapweed.html

Russian knapweed: *Acroptilon repens* (L.) DC. Page 15-16
Currently not listed in Minnesota.
Identification and management:
http://extension.colostate.edu/topic-areas/natural-resources/russian-knapweed-3-111/

Prohibited: Control

Spotted knapweed: *Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek Page 17
Image citation:
Flower top/side views, basal rosette, rosette foliage - Dave Hanson, MnDOT.
Image citations – Bugwood.org: Foliage - James H. Miller, USDA Forest Service.
Images and good identification write-up: Minnesota wildflowers
http://www.minnesotawildflowers.info/flower/spotted-knapweed
Discussion and management considerations:
http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250068126
http://dnr.wi.gov/topic/Invasives/fact/SpottedKnapweed.html
http://wiki.bugwood.org/Centaurea_stoebe_ssp._micranthos
http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/spottedknapweed.aspx

Barberry, common: *Berberis vulgaris* L. Page 18
Image citations: Bugwood.org: Leslie J. Mehrhoff, University of Connecticut.
Identification and management:
https://gobotany.newenglandwild.org/species/berberis/vulgaris/
https://gobotany.newenglandwild.org/dkey/berberis/ (dichotomous key)
Japanese Barberry control information:
https://mipncontroldatabase.wisc.edu/search?name=Berberis thunbergii#plants

Canada thistle: *Cirsium arvense* (L.) Scop. Page 19
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
http://www.minnesotawildflowers.info/flower/canada-thistle
http://dnr.wi.gov/topic/Invasives/fact/CanadaThistle.html

Plumeless thistle: *Carduus acanthoides* L. Page 20
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
http://www.minnesotawildflowers.info/flower/plumeless-thistle
Identification and management:
http://dnr.wi.gov/topic/Invasives/fact/PlumelessThistle.html
http://wiki.bugwood.org/HPIPM:Plumeless_thistle

Leafy spurge: *Euphorbia esula* L. Page 21
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
http://www.minnesotawildflowers.info/flower/leafy-spurge
http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/leafyspurge.aspx

Narrowleaf bittercress: *Cardamine impatiens* L. Page 22
Image citations – Bugwood.org: Leslie J. Mehrhoff, University of Connecticut.
Identification and management:
http://www.minnesotawildflowers.info/flower/narrow-leaf-bittercress
http://www.invasive.org/browse/subinfo.cfm?sub=11539

Purple loosestrife: *Lythrum salicaria* L. and *Lythrum virgatum* L. Page 23
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
http://www.minnesotawildflowers.info/flower/purple-loosestrife
Write-up on identification and control options:
https://www.invasive.org/weedcd/pdfs/wgw/purpleloosestrife.pdf
http://wiki.bugwood.org/Archive:Loosestrife
http://dnr.wi.gov/topic/Invasives/fact/PurpleLoosestrife.html
http://www.dnr.state.mn.us/invasives/aquaticplants/purpleloosestrife/index.html

Common tansy: *Tanacetum vulgare* L. Page 24
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
http://www.minnesotawildflowers.info/flower/common-tansy
Identification and management:
http://dnr.wi.gov/topic/Invasives/fact/Tansy.html
http://www.fs.fed.us/database/feis/plants/forb/tanvul/all.html

Wild parsnip: *Pastinaca sativa* L. Page 25
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
http://www.minnesotawildflowers.info/flower/wild-parsnip
Identification and management:
http://dnr.wi.gov/topic/Invasives/fact/WildParsnip.html
http://wiki.bugwood.org/Pastinaca_sativa

Citations / Resources continued:

Restricted Noxious weeds:

Asian bush honeysuckles: *Lonicera* spp. Page 26
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)
Smith, Welby R. 2008. *Trees and shrubs of Minnesota: the complete guide to species identification*. Minneapolis, MN: University of Minnesota Press.

Black locust: *Robinia pseudoacacia* L. Page 27
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)
http://mipncontroldatabase.wisc.edu/
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_015112.pdf

Crown vetch: *Securigera varia* (L.) Lassen Page 28
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
http://www.illinoiswildflowers.info/weeds/plants/crown_vetch.htm
http://mipncontroldatabase.wisc.edu/

Common buckthorn: *Rhamnus cathartica* L. Page 29
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
http://dnr.wi.gov/topic/Invasives/fact/CommonBuckthorn.html
http://wiki.bugwood.org/Rhamnus_cathartica

Glossy buckthorn (and all cultivars): *Frangula alnus* Mill. Page 30
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
http://dnr.wi.gov/topic/Invasives/fact/GlossyBuckthorn.html
http://wiki.bugwood.org/Frangula_alnus
http://www.fs.fed.us/database/feis/plants/shrub/fraaln/all.html

Garlic mustard: *Alliaria petiolata* (M. Bieb.) Cavara & Grande Page 31
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
http://www.minnesotawildflowers.info/flower/garlic-mustard
Management:
http://www.ipm.msu.edu/invasive_species/garlic_mustard

Japanese barberry: *Berberis thunbergii* DC. Page 32- 33
Image citation: all images - Dave Hanson, MnDOT.
Identification and Management: http://www.mipn.org/control.html
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)
http://dnr.wi.gov/topic/Invasives/fact/JapaneseBarberry.html
Seed viability: http://www.invasive.org/weedcd/pdfs/srs/2008/barberry.pdf

Multiflora rose: *Rosa multiflora* Thunb. Page 34
Image citation: all images - Dave Hanson, MnDOT.
Identification and Management:
http://dnr.wi.gov/topic/Invasives/fact/MultifloraRose.html
http://wiki.bugwood.org/Rosa_multiflora#MANAGEMENT.2FMONITORING

Nonnative phragmites: *Phragmites australis* (Cav.) Trin. Ex Steud. Page 35
Image citations: Ken Graeve and Dave Hanson, MnDOT.
Identification and Management:
http://dnr.wi.gov/topic/Invasives/fact/Phragmites.html
http://www.nmca.org/PHRAG_FIELD_GUIDE.pdf
https://www.invasive.org/weedcd/pdfs/wgw/commonreed.pdf

Porcelain berry: *Ampelopsis brevipedunculata* (Maxim.) Trautv. Page 36
Image citations: Foliage image - Paul Kortebein.
Other images - Dave Hanson, MnDOT.
Identification and management:
https://www.nps.gov/plants/alien/pubs/midatlantic/ambr.htm

Tree-of-Heaven: *Ailanthus altissima* (Mill.) Swingle Page 37
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
https://www.invasive.org/weedcd/pdfs/wgw/treeofheaven.pdf
http://www.ecolandscaping.org/05/invasive-plants/tree-of-heaven-an- . . .-fact-sheet
http://mipncontroldatabase.wisc.edu/

Wild carrot: *Daucus carota* L. Page 38
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
https://www.minnesotawildflowers.info/flower/queen-annes-lace
Controlling Wild Carrot in Hay fields and Pastures
Controlling wild carrot

Specially Regulated Plants:

Amur maple: *Acer ginnala* Maxim. Page 39
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
http://www.invasiveplantatlas.org/subject.html?sub=3965
http://dnr.wi.gov/topic/Invasives/fact/AmurMaple.html

Citations / Resources continued:

Specially Regulated Plants:

Knotweed, Japanese: *Polygonum cuspidatum* Siebold & Zucc. Page 40-41
Image citation: all images - Dave Hanson, MnDOT.
Identification and Management:
http://www.mipn.org/control.html
http://dnr.wi.gov/topic/Invasives/fact/JapaneseKnotweed.html
http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/invasive-knotweeds/japanese-knotweed.aspx

Knotweed, giant: *Polygonum sachalinense* F. Schmidt ex Maxim. Page 40-41
Image citation: all images -
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Identification and Management:
http://www.mipn.org/control.html
http://dnr.wi.gov/topic/Invasives/fact/GiantKnotweed.html
http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/invasive-knotweeds.aspx

Knotweed, Bohemian: *Polygonum xbohemicum* (J. Chrtek & Chrtkova) Zika & Jacobson
Image citations: Dave Hanson, MnDOT and
see citations for Japanese and giant knotweeds, pages 40-41.
Identification and management:
https://www.for.gov.bc.ca/hra/publications/invasive_plants/Knotweed_key_BC_2007.pdf
http://www.kingcounty.gov/s. . . ./weed-identification/invasive-knotweeds/bohemian-knotweed.aspx
Download Montana State university Guide:
Biology, Ecology and management of the Knotweed complex (*Polygonum* species)

Poison ivy: western [*Toxicodendron rydbergii* (Small) Green] Page 42
common [*T. radicans* (L.) Kuntze ssp. *negundo* (Greene) Gillis]
Image citation: all images - Dave Hanson, MnDOT.
Identification and Management:
http://www.nps.gov/public_health/info/factsheets/fs_pivy.htm
https://mdc.mo.gov/trees-plants/problem-plant-control/nuisance-native-plants/poison-ivy-control
http://www.dnr.state.mn.us/trees_shrubs/deciduous/poisonivy.html

Web links verified January, 2018.

Miscellaneous images: Dave Hanson, MnDOT
Cover photo: Oriental bittersweet in Winona, County on October 26, 2017..
Photos page 2: Dalmatian toadflax, Japanese hops and garlic mustard.
Photos page 3: field thistle, cow parsnip and stiff golden rod.

Page 69: Dave Hanson, MnDOT
Biological control images including: spotted knapweed root weevil, loose-strife beetle, leafy spurge flea beetle and spotted knapweed seedhead weevil.

Miscellaneous image: MnDOT
Page 69: herbicide application.

Miscellaneous images: Ken Graeve, MnDOT
Page 69: mowing and prescribed fire.

Nonnative Plants:

Alfalfa: *Medicago sativa* L. Page 43
Image citations – Bugwood.org:
Foliage - Gerald Holmes, Valent USA Corporation,
Flower - Keith Weller, USDA Agricultural Research Service.
Identification:
http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=4213

Hairy vetch : *Vicia villosa* Roth Page 43
Image citation: all images - Dave Hanson, MnDOT.
Identification:
http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=5382
http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=Coronilla%20varia

Balkan catchfly: *Silene csereii* Baumgarten Page 44
Image citation: Dave Hanson and Ken Graeve, MnDOT.
Identification:
http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=5045
http://www.minnesotawildflowers.info/flower/balkan-catchfly

Carrot look-alikes: Various species of carrot family members Page 45
Image citation: all images - Dave Hanson, MnDOT.
Identification:
https://www.minnesotawildflowers.info/flower/caraway
https://www.minnesotawildflowers.info/flower/burnet-saxifrage
http://www.invasiveplantatlas.org/subject.html?sub=12275
https://www.minnesotawildflowers.info/flower/japanese-hedge-parsley

Chervil, wild: *Anthriscus sylvestris* (L.) Hoffm. Page 45
Image citation: all images - Dave Hanson, MnDOT.
Identification:
https://www.minnesotawildflowers.info/flower/wild-chervil

Musk or nodding thistle: *Carduus nutans* L. Page 46
Image citation: all images - Dave Hanson, MnDOT.
Other images and good identification write-up: Missouri Plants
http://www.missouriplants.com/Pinkalt/Carduus_nutans_page.html

Yellow rocket: *Barbarea vulgaris* W. T. Aiton. Page 47
Image citation: Dave Hanson and Tina Markeson, MnDOT.
Identification:
http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=2718
http://www.minnesotawildflowers.info/flower/garden-yellow-rocket

Citations / Resources continued:

Minnesota Native Plants:

American bittersweet: *Celastrus scandens* L. Page 48
Image citation: all images - Dave Hanson, MnDOT.
Identification:
http://dendro.cnre.vt.edu/dendrology/syllabus/factsheet.cfm?ID=913

American vetch: *Vicia americana* Muhl. Ex Willd. Page 49
Image citation: all images - Dave Hanson, MnDOT.
Identification:
https://www.minnesotawildflowers.info/flower/american-vetch

Canadian milkvetch: *Astragalus canadensis* L. Page 49
Image citation: all images - Dave Hanson, MnDOT.
Identification:
http://www.illinoiswildflowers.info/prairie/plantx/can_milkvetchx.htm
https://www.minnesotawildflowers.info/flower/canada-milkvetch

Cherries and wild plum: *Prunus* spp. Page 50
Image citation: all images - Dave Hanson, MnDOT.
Identification: http://wisflora.herbarium.wisc.edu/imagelib/index.php
Genera: Prunus

Common hops: *Humulus lupulus* L. Page 51
Image citation: all images - Dave Hanson, MnDOT.
Identification:
http://www.hort.purdue.edu/newcrop/duke_energy/humulus_lupulus.html

Cow-parsnip: *Heracleum lanatum* Michx. Page 52
Image citation: all images - Dave Hanson, MnDOT.
Identification: http://www.minnesotawildflowers.info/flower/common-cow-parsnip

Cucumbers, wild and bur: *Echinocystis lobata* Michx. and *Sicyos angulatus* L. Page 53
Image citation: all images - Dave Hanson, MnDOT.
Identification: http://www.minnesotawildflowers.info/flower/wild-cucumber
http://www.minnesotawildflowers.info/flower/bur-cucumber

Fireweed: *Chamerion angustifolium* (L.) Holub ssp. *angustifolium* Page 54
Image citation: all images - Dave Hanson, MnDOT.
Identification: http://www.minnesotawildflowers.info/flower/fireweed

Golden alexanders: *Zizia aurea* (L.) W.D.J. Koch and *Z. aptera* (A. Gray) Fernald Page 55
Image citation: all images - Dave Hanson, MnDOT.
Identification:
http://www.minnesotawildflowers.info/flower/golden-alexanders
http://www.minnesotawildflowers.info/flower/heart-leaved-alexanders

Goldenrods: *Solidago* spp. Page 56
Image citation: all images - Dave Hanson, MnDOT.
Identification: http://www.minnesotawildflowers.info/
Search plant name: solidago

Grape, riverbank:. *Vitis riparia* Michx. Page 57
Image citations: all images - Dave Hanson, MnDOT.
Identification:
Smith, Welby R. 2008. *Trees and shrubs of Minnesota.* (full citation page 69).

Native honeysuckles: *Diervilla lonicera* Mill. and *Lonicera* spp. Page 58
Image citation: all images - Dave Hanson, MnDOT.
Identification:
Smith, Welby R. 2008. *Trees and shrubs of Minnesota.* (full citation page 69).

Page 59
Native phragmites: *Phragmites australis* (Cav.) Trin. ex Steud. ssp. *americanus* Saltonstall
Image citations: Ken Graeve and Dave Hanson, MnDOT.
Identification: http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?451454
https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmctn11494.pdf
http://greatlakesphragmites.net/basics/native-vs-invasive/

Sumac, Staghorn and Smooth: *Rhus typhina* L. and *R. glabra* L. Page 60
Image citation: all images - Dave Hanson, MnDOT.
Identification:
Smith, Welby R. 2008. *Trees and shrubs of Minnesota.* (full citation page 69).

Swamp thistle: *Cirsium muticum* Michx. Page 61
Image citation: all images - Dave Hanson, MnDOT.
Identification: http://www.minnesotawildflowers.info/flower/swamp-thistle

Virginia creeper and woodbine: *Parthenocissus* spp. Page 62
Image citation: all images - Dave Hanson, MnDOT.
Identification:
Smith, Welby R. 2008. *Trees and shrubs of Minnesota.* (full citation page 69).

Water hemlock: *Cicuta maculata* L. Page 63
Image citation: all images - Dave Hanson, MnDOT.
Identification:
http://www.illinoiswildflowers.info/wetland/plants/water_hemlock.htm

Yarrow, Common: *Achillea millefolium* L. Page 61
Image citation: all images - Dave Hanson, MnDOT.
Identification:
https://www.minnesotawildflowers.info/flower/common-yarrow
http://www.illinoiswildflowers.info/weeds/plants/yarrow.htm

Additional Book and Web Resources:

Black Merel R., Emmet J. Judziewicz. 2009. *Wildflowers of Wisconsin and the Great Lakes Region: a comprehensive field guide*. Univ of Wisconsin Press. 275 pages.

Dirr, Michael. 2009. *Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation and uses*. Champaign, Ill: Stipes Pub.

Invasive.org – images at Bugwood. Online. http://www.invasive.org/species/forbs.cfm Factsheets. Online. Weeds Gone Wild: Alien Plant Invaders of Natural Areas.

Midwest Invasive Plant Network. Online. http://www.mipn.org/ Education, identification, control and management.

Minnesota Department of Agriculture. Online.
- Noxious weed list and Fact sheets - Noxious weed law
- Biological control - Pest management

Minnesota Department of Transportation. 2011. *Herbicide Options for Vegetation Control on Mn/DOT Rights-of-Way.* Internal Document. herbicidepreseasontables.pdf

Mortenson, Carol. 2003. *Noxious Weeds of Minnesota*. Leech Lake Division of Resources Management.

PCA Alien Plant Working Group. 2010. *Least Wanted: Alien Plant Invaders of Natural Areas*. Factsheets. Online. https://www.invasive.org/weedcd/html/wgw.htm

Sarver, Matthew. et al. 2008. *Mistaken Identity? Invasive plants and their native look-alikes*. online. http://www.nybg.org/files/scientists/rnaczi/Mistaken_Identity_Final.pdf 12/2012.

Smith, Welby R. 2008. *Trees and shrubs of Minnesota: the complete guide to species identification*. Minneapolis, MN: University of Minnesota Press.

USDA Plants Database. https://plants.usda.gov/java/. United States Department of Agriculture, Natural Resources Conservation Service.

Wisconsin DNR. 2010. *A field Guide to Terrestrial Invasive Plants in Wisconsin*. Ed. Thomas Boos, Kelly Kearns, Courtney LeClair, Brandon Panke, Bryn Scrivner, and Bernadette Williams.

Wisconsin Department of Natural Resources factsheets: Online. Terrestrial Invasive Species: List, Factsheets, Images

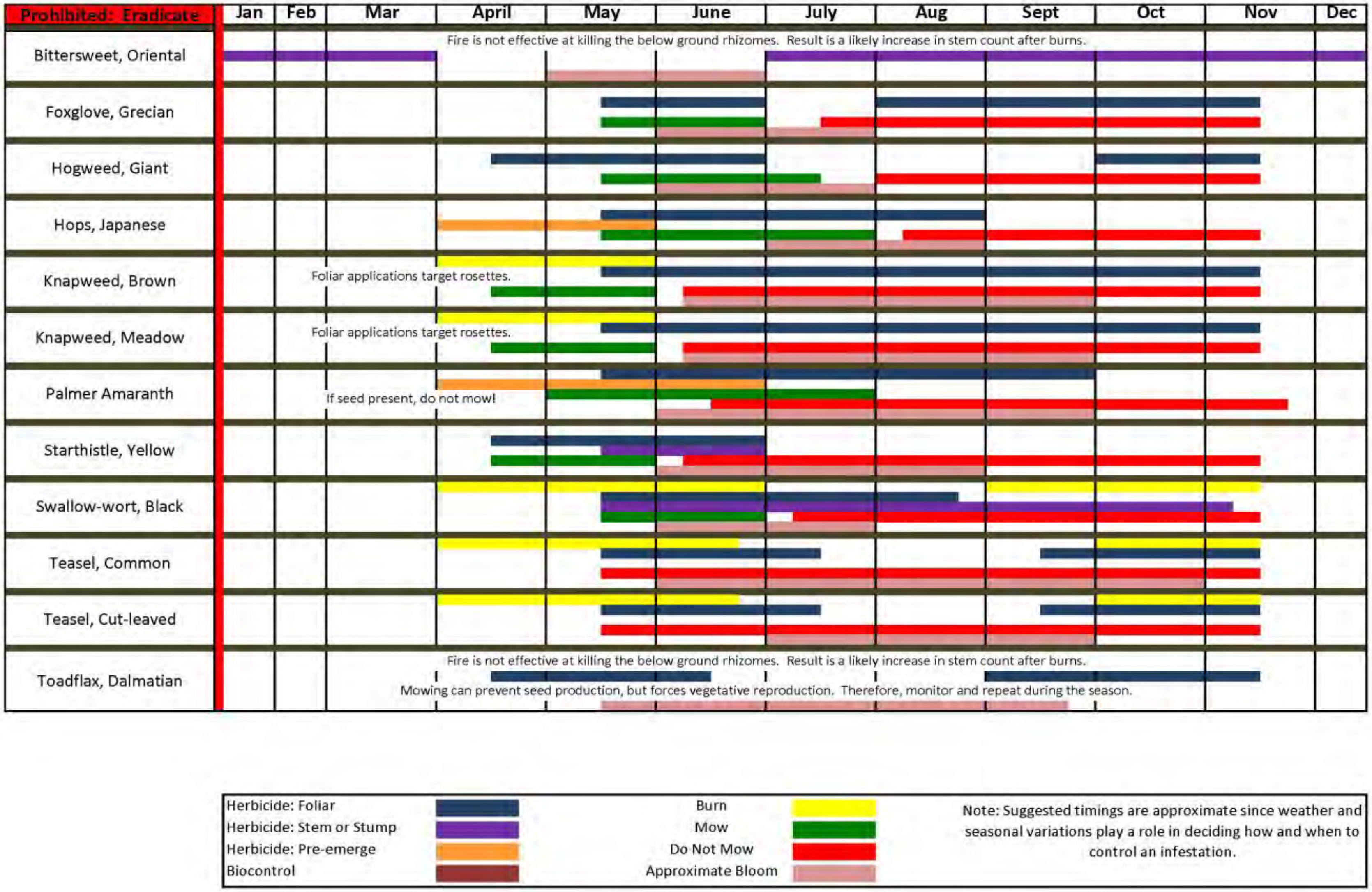



Biological Controls **Mowing or Other Mechanical Means** **Herbicide** **Prescribed Fire**

Management tactics can take many forms and should be based on predefined vegetation management goals.

Suggested timing of management tactics or control options can be found in graphical form on the following two pages. Timings are based on recommendations described in the many resources listed on the previous pages.

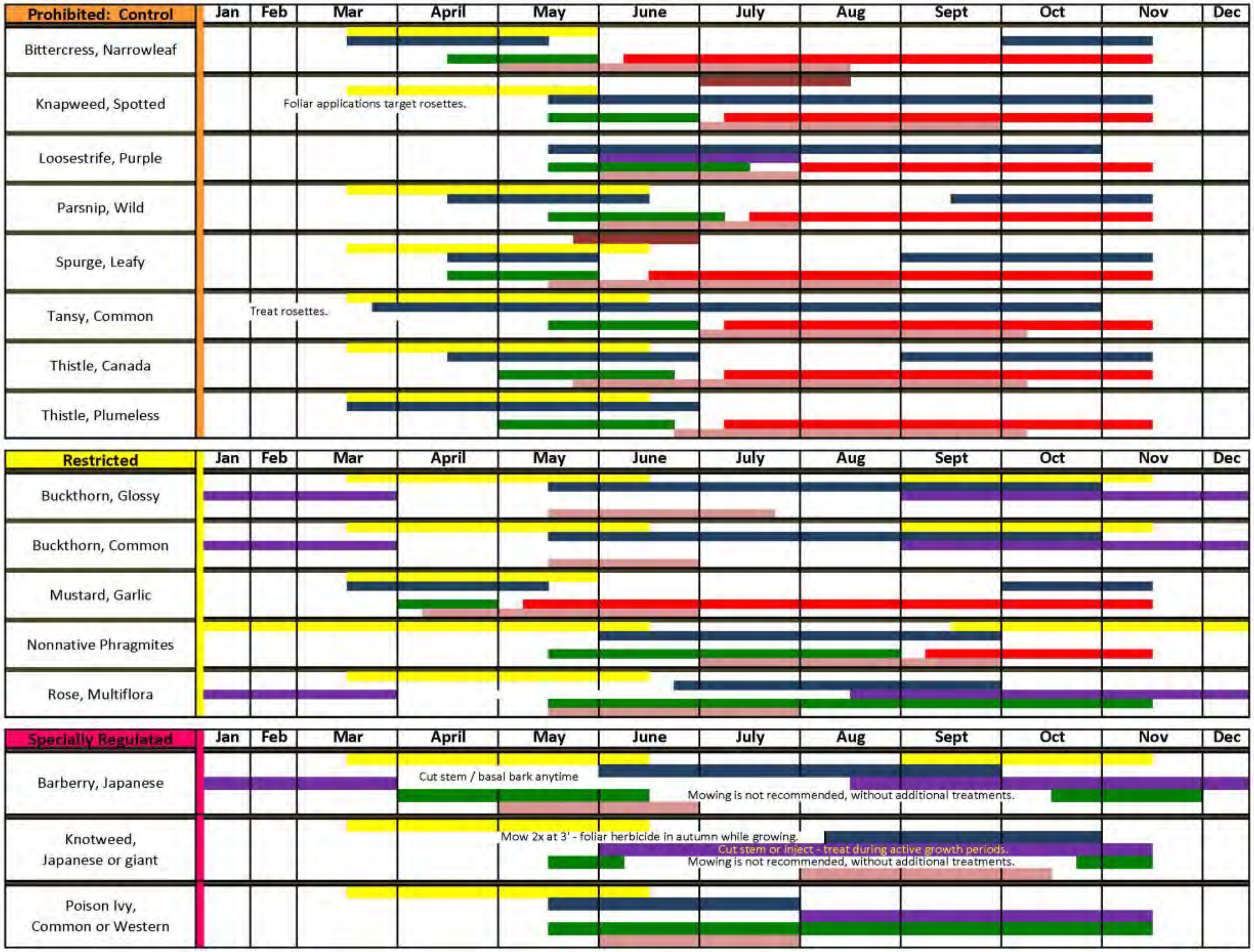
Suggested Timing of Control Options for Minnesota Noxious Weed Species (2016)



N:_Programs\Roadside_Veg_Mngt\Pesticide\Herbicide-options-calendar\2016-Herbicide_tables-cheat-sheets\2016_Management-calendar.xlsx

dlh (March, 2016).

Suggested Timing of Control Options for
Minnesota Noxious Weed Species (2016)



N:_Programs\Roadside_Veg_Mngt\Pesticide\Herbicide-options-calendar\2016-Herbicide_tables-cheat-sheets\2016_Management-calendar.xlsx

dlh (March, 2016).

Definitions of the noxious weed categories from the Minnesota Department of Agriculture web page:
http://www.mda.state.mn.us/en/plants/pestmanagement/weedcontrol/noxiouslist.aspx

State Prohibited Noxious Weeds

Prohibited noxious weeds are annual, biennial, or perennial plants that the commissioner designates as having the potential or are known to be detrimental to human or animal health, the environment, public roads, crops, livestock or other property. There are two regulatory listings for prohibited noxious weeds in Minnesota:

1. Eradicate List: Prohibited noxious weeds that are listed to be eradicated are plants that are not currently known to be present in Minnesota or are not widely established. These species must be eradicated, meaning all of the above and below ground parts of the plant must be destroyed, as required by Minnesota Statutes, Section 18.78. Additionally, no transportation, propagation, or sale of these plants is allowed. Measures must also be taken to prevent and exclude these species from being introduced into Minnesota.
2. Controlled List: Prohibited noxious weeds listed to be controlled are plants established throughout Minnesota or regions of the state. Species on this list must be controlled, meaning efforts must be made to prevent the spread, maturation and dispersal of any propagating parts, thereby reducing established populations and preventing reproduction and spread as required by Minnesota Statutes, Section 18.78. Additionally, transportation, propagation, or sale of these plants is prohibited.

Restricted Noxious Weeds

Restricted noxious weeds are plants that are widely distributed in Minnesota and are detrimental to human or animal health, the environment, public roads, crops, livestock or other property, but whose only feasible means of control is to prevent their spread by prohibiting the importation, sale, and transportation of their propagating parts in the state except as allowed by Minnesota Statutes, Section 18.82. Plants designated as Restricted Noxious Weeds may be reclassified if effective means of control are developed.

Specially Regulated Plants

Specially regulated plants are plants that may be native species or have demonstrated economic value, but also have the potential to cause harm in non-controlled environments. Plants designated as specially regulated have been determined to pose ecological, economical, or human or animal health concerns. Plant specific management plans and or rules that define the use and management requirements for these plants will be developed by the Minnesota Department of Agriculture for each plant designated as specially regulated. Measures must also be taken to minimize the potential for harm caused by these plants.

Amur maple: Sellers shall affix a label that advises buyers to only plant Amur maple and its cultivars in landscapes where the seedlings will be controlled by mowing or other means. Amur maple should be planted at least 100 yards from natural areas. Return to Amur maple.

Knotweeds, giant and Japanese: Any person, corporation, business or other retail entity distributing Japanese and/or giant knotweeds for sale within the state, must have information directly affixed to the plant or container packaging that it is being sold with, indicating that it is unadvisable to plant this species within 100 feet of a water body or its designated flood plain as defined by Minnesota Statute 103F.111, Subdivision 4. Return to knotweeds.

Poison ivy: Must be eradicated or controlled for public safety along rights-of-ways, trails, public accesses, business properties open to the public or on parts of lands where public access for business or commerce is granted. Must also be eradicated or controlled along property borders when requested by adjoining landowners.

Return to poison ivy.

Minnesota Noxious Weeds

http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf

This book has two parts; part 1 (index pg. 2) contains terrestrial noxious weeds and part 2 (index pg. 3) contains look-alike plants.

For example, compare:

Left: Noxious weed, Oriental bittersweet (*Celastrus orbiculatus*) that has flowers and fruits in leaf axils along its vine (white arrows).

Right: Native plant, American bittersweet (*Celastrus scandens*) has flowers and fruits only at the terminus of branches.

Index on page 2 contains terrestrial noxious weeds listed under:

Minnesota Noxious Weed Law:
Find more information at:
Minnesota Department of Agriculture.

Index on page 3 contains a list of terrestrial nonnative and native species often mistaken for the associated noxious weeds.

These terrestrial plant descriptions are provided in an effort to prevent mistaken identities.

Scientific names (genus and species) were sourced from : USDA Plants Database

Minnesota Noxious Weeds

http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf

The index on page 2 contains
terrestrial noxious weeds listed under
Minnesota Noxious Weed Law

Prepared by:
Dave Hanson
Minnesota Department of Transportation,
Office of Environmental Stewardship,
Roadside Vegetation Management Unit.
Phone: 651-366-3632
e-mail: David.L.Hanson@state.mn.us

395 John Ireland Boulevard,
Saint Paul, Minnesota, 55155-1899

Edited by: Ken Graeve, MnDOT
and Tina Markeson, MnDOT

January, 2018

DEPARTMENT OF TRANSPORTATION

Play Clean Go
STOP INVASIVE SPECIES IN YOUR TRACKS.
PlayCleanGo.org

Attachment F

Equipment Cleaning Log

Equipment Cleaning Log

Form Completed By: ____

Date: ______________________________ Time: ________________________

Location of Equipment (tract & milepost): ________________________________

Equipment Type: ____

Equipment ID (e.g., company, unique ID number): ___________________________

Cleaning Method: (check all that apply)

- ☐ Scrape Down
- ☐ Steam Wash Blow Down (compressed air)
- ☐ Power/Pressure Wash (water)
- ☐ Other (Describe): ____

Comments: ____

____

____

____

____

Attachment G

Minnesota Aquatic Invasive Species Guide

(Large-size file available for download in PDF format here: https://www.maisrc.umn.edu/sites/maisrc.umn.edu/files/ais_id_guide_2018.pdf)

MNRD Non-Local Beings Report

Attachment 2

Mapping Standards For Program Managers

Approved by:
North American Invasive Species Management Association

October 17, 2018

NAISMA
North American Invasive Species Management Association

Table of Contents

Contents

Introduction

"Standards are something established for the use of a rule or basis of comparison in measuring or judging capacity, quantity, quality, content, extent, value, etc." - Webster's New World Dictionary

The definition above served as a guiding reminder of purpose to the original Mapping Standards Committee of the North American Weed Management Association (NAWMA). The standards were officially adopted by NAWMA in early 2001, after years of development by the committee. Their reason for creating the minimum mapping standards for invasive weeds was to increase the ability to share weed-mapping information - to create minimum standards so that the most basic information on infestations would be compatible between organizations and jurisdictions. The standards addressed the minimum base information necessary to compare and combine invasive weed maps across tribal, county, state/provincial, national, and even international borders:

The Five Basic Elements of Invasive Species Inventories:

1. What species was documented?
2. Where on the landscape was this species documented?
3. How large was the area infested by the species documented?
4. When was the information on this species infestation documented?
5. Who collected the documentation of this species infestation?

These standards were enthusiastically adopted by many North American weed management agencies and have been modified since their 2001 origins after feedback from those using them. Invasive species mapping and data sharing technology has improved and expanded considerably since the standards were first adopted, in ways that the original NAWMA Mapping Standards Committee could scarcely have imagined. NAWMA itself has evolved and expanded in scope to become the North American Invasive Species Management Association (NAISMA). In 2014, the NAISMA Mapping Standards Committee was charged with amending and expanding their existing weed mapping standards to encompass all invasive species. In this 2018 version, the standards now include considerations for mapping aquatic invasive species, based on recommendations provided by the USGS – Nonindigenous Aquatic Species database, and for mapping biocontrol.

Why Use These Standards?

These standards are intended to be compatible with most existing invasive species inventories. They are not intended to discourage other organizations from collecting additional information on invasive infestations. By using these minimum standards, information collected can be incorporated within inventories serving other purposes, thereby widening the usefulness of the collected information. These standards are intended to be as user friendly as possible, while still providing information essential at every level of invasive species management, from the site of the infestation to regional, national, and international levels. By adopting these standards you will be joining the invasive species community in making data more shareable across boundaries.

Inventory and Monitoring Standards

This chapter describes the basic information necessary to inventory and monitor populations of invasive species. These data and mapping standards represent the minimum or core information necessary to characterize a population of invasive species.

There are basic elements to invasive species inventories that enable them to be easily shared. This chapter contains those data fields required to satisfy these basic inventory elements, as well as optional fields that may be included. A sample field form can be obtained at the NAISMA web site, www.NAISMA.org.

Each data field/subject area is divided into the following subheadings:

Field Name(s): This is the name that will appear on the inventory form and on requests for information between agencies, states, and management areas. It will be the name used to share equivalent information between users. It will provide common vocabulary for sharing information. Words separated by commas are recommended to be in separate columns, form fields, or database fields. Words separated by "OR" allow for one field name or the other alternative name to be used.

Definition: Provides a description and explanation of the data field.

Why it is Useful: Describes why this information may be important and how it will be useful in describing infestations.

Core Element: This tells you whether this is a 1) required (core), 2) recommended, or 3) optional data field. Some data elements are very common and useful for invasive species inventories but will not be required for information sharing; these will be called optional fields. Recommended fields are optional fields of high importance.

Coding: Describes the proper way information should be entered.

Data Value: Describes the types of characters that will be accepted by a field. Options include numeric, text, or alphanumeric (consisting of both text and numbers).

Example: Provides a sample of the proper coding.

Record Level Identifiers

Universally Unique Identifier

Field Name: UUID

Definition: A universally unique identifier that can be assigned to each record to ensure that as data is collected, each record is distinct and can be referenced and queried. There is not a single database of assigned UUIDs (many UUID generator services are freely available on the web), but the chance of a generated UUID being duplicated is extremely small.

Why it is useful: This will allow for records to be shared and ensure that duplicates are not entered into any dataset aggregating system. Users and database managers alike will be able to reference a specific record across databases as the UUID travels with the record.

Core Element: This is a required field as of 2020.

Coding: The Version 4 UUID is a 128-bit number used to identify information that is made of alphanumeric characters in an 8-4-4-4-12 format. These can often be generated within a database (e.g. SQL, ArcGIS, etc.) or through a variety of websites. A listing of resources on how to generate UUID in databases and websites for UUID generation can be found in the Technical Resources section at the end of the document.

Data Value: Alphanumeric

Example:

UUID: defeaa69-703d-403a-a3cd-69eee650fd8c

Persistent Identifier

Field Name: PID

Definition: A unique identifier that can be assigned to each record to ensure that as data is entered into a database and published each record is distinct and can be referenced and queried back to a resolvable location or reference. This can include a website URL for a specific record, such as those created in iNaturalist or EDDMapS, a DOI to a journal article documenting the first occurrence of a newly introduced species, or other systems of publishing a record in a persistent manner. There is not a sole generator of PIDs, but most generators of these identifiers utilize technologies to ensure they remain unique.

Why it is useful: This will allow records to be traced back to the original record or source and, when shared, it can help to ensure that duplicates are not entered into an aggregate system.

Core Element: Recommended

Coding: There are many different formats and sources that can serve as PIDs: URL, URN, DOI, URI, etc. are examples of resolvable identifiers that can link back to an original source for an individual record.

Data Value: Alphanumeric

Example:

PID: https://doi.org/10.1109/5.771073

Catalog Number

Field Name: Catalog Number

Definition: A unique identification number within a dataset that records the museum/herbarium catalog number or other collection number

Why it is Useful: This number can help to locate data or place it within an existing dataset. Many contributors to herbaria and museums will include numbers or identifiers for records within a collection. The Catalog Number can also come from herbaria and museum collections.

Core Element: Optional

Coding: Enter the information as provided; generally a unique value within a dataset.

Data Value: Alphanumeric

Example: Record comes from a digitized account of a specimen submitted to Harvard University Herbaria with an ID of HVD-154356

Catalog Number: HVD-154356

Species Name

Field Name(s): Kingdom (required), Family (required), Genus (required), Species (recommended), Subspecies (optional), variety (optional) Authorship (optional)

Definition: The scientific or taxonomic name of the species of the occurrence. The scientific name follows the standard of binomial nomenclature and consists of the genus name followed by the species name, expressed together and written in italics. Some species are further classified into subspecies, variety, or hybrids. Lastly, the individual who first classified the species and assigned the scientific name (formatted according to the conventions of the applicable nomenclature code) is called the scientific name authorship.

Why it is Useful: Scientific names may seem intimidating and cumbersome for some to learn, but they have a decided advantage over common names. They provide a universal code or language for naming species, so people all over the world will use the same name. Even when the name changes due to new discoveries or new information, a trail of synonyms or conserved scientific names is retained, so the species can still be identified. Scientific names also show how groups of species are related.

Core Element: Kingdom, Family, and Genus are required elements, species is highly recommended (and required if known), subspecies or variety as appropriate or known. Authorship is optional.

Coding: Enter as in field guide, ITIS (https://www.itis.gov), USDA PLANTS Database http://plants.usda.gov, or other reputable or published source.

Data Value: Text

Example: Scientific name for yellow star thistle: *Centaurea solstitialis* L.

Kingdom: Plantae Family: Asteraceae Genus: Centaurea Species: solstitialis Authorship: L.

Common Name

Field Name: Common name

Definition: The species name expressed in the common language(s) of the country and/or region, which is generally English, but may also be another language in North America. Common names are not capitalized unless they are based on a place or a person’s name.

Why it is Useful: These are the names most commonly used in conversation. They are often descriptive, like Asian carp, and are always in the spoken language(s) of the country. The common names are easy to pronounce and remember. The common name cannot be used alone because there may be several common names for the same species, and/or, the same name may refer to several different species.

Core Element: Optional

Coding: Enter common name from field guide or another reputable source.

Data Value: Text

Example: For *Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek, you would record:

Common Name: spotted knapweed

Taxonomic Serial Number

Field Name: TSN

Definition: The Taxonomic Serial Number from the Integrated Taxonomic Information System.

Why it is Useful: This is a universal identifier for species' names; it is helpful for database matching of species. The ITIS database also contains synonyms and older names. This is helpful especially when sharing historic data or between databases, so that names are easily referenced, checked for validity, and are made current while not eliminating the provided scientific name.

Core Element: Optional, but highly recommended

Coding: The codes used in the Integrated Taxonomic Information System can be found at: https://www.itis.gov.

Data Value: Numeric

Example: The TSN for zebra mussel, *Dreissena polymorpha*, would be as follows:

TSN: 81339

Location Data

Country

Field Name: Country Code

Definition: The abbreviation for the nation or country in which the infestation is located. Separate records or mapping polygons will be created for infestations that cross international boundaries.

Why it is Useful: This information facilitates free exchange of information across international boundaries. Information can be separated or summed based on national affiliations. Statistics on infested area of an individual species within and/or across country borders can easily be obtained.

Core Element: Required

Coding: ISO 3166-1 alpha-2 is a two-character code for the country. These are the same as country-level internet domain names or postal codes.

Data Value: Text

Example: An African rue (*Penganum harmala* L.) infestation was found on the Sonoran Desert in northern Mexico. The information would be entered as follows:

Country: MX

State OR Province

Field Name: State Code OR Province Code

Definition: The two-letter code for the next largest political division below country (state, province, territory, etc.) where the infestation is located.

Why it is Useful: This allows the infestation to be located within a geographic area. It also allows the easy and quick summation of information on invasive species at a political boundary below the country level.

Core Element: This is a required field.

Coding: ISO 3166-2 is coding within the 3166-1 system that denotes the principal subdivision within a country. This field uses the two-character code after the country code, which is also the standard postal code.

Data Value: Required

Example: Dalmatian Toadflax (*Linaria dalmatica* L.) was found in Vancouver, British Columbia.

Province: BC

County OR Municipality

Field Name: County OR Municipality

Definition: The county, Parish, Borough (US, Mexico, and Canada) or municipality (Canada) where infestation is located.

Why it is Useful: Allows the infestation to be located in a sub-state/province political boundary area. It also allows the easy and quick summation of information on invasive species at the county, parish, borough, or municipality level.

Core Element: Required

Coding: This is a text-based field to note the county or municipality of the infestation. There is no standardization across North America for coding of these legal designations, but it is suggested that the words County, Parish, Borough, or Municipality not be included.

Data Value: Text

Example: There is an infestation in Humboldt County, Nevada.

County: Humboldt

Location

Field Name: Location

Definition: A text based description of the place of the occurrence.

Why it is Useful: Location information is essential for invasive species mapping. It allows invasive species sites to be located when exact location coordinates are not obtainable or recorded.

Core Element: Location is an optional field, but highly recommended when coordinates or other spatial information are not recorded.

Coding: Enter description as in data record unless field size will not allow full description.

Data Value: Text

Example: Zebra mussels were observed in Lake Powell on a boat dock on the east side of the lake.

Location: Dock on east side of Lake Powell.

Coordinates

Field Name(s): Latitude, Longitude, and Datum

Definition: The exact place of the location of an infestation (in decimal degrees), which will refer to the center of the infestation, or the center of the polygon that defines it. The field Centroid Type will be used to denote the centroid status of the coordinates. The Datum, the geodetic data system that the coordinates are based on, is required and can be found on the GPS unit, smartphone, or other technology used for recording the coordinates. If the geodetic Datum is not known, enter Unknown.

Why it is Useful: Location information is essential for invasive species mapping. It allows invasive species sites to be located on a map, be plotted across landscapes, and allows users to relocate a site.

Core Element: Coordinates are a required, if available, field. If polylines or polygons are mapped with the report, the user must also use the Data Type field, note the spatial type there, and enter the center location information for the center of the polygon or polyline as Latitude, Longitude, and Datum.

Coding: Enter the Latitude and Longitude fields as numbers in decimal degrees, with negative signs used where appropriate. Enter the Datum field as text.

Data Value: Latitude and Longitude: Numeric, with negative symbol allowed; Datum: Text.

Example:

Location: Latitude: 42.608897 Longitude: -114.332635 Datum: WGS84

Geographic Well-Known Text

Field Name: WKT

Definition: A text representation of the exact geographic shape of the infestation. This can be provided by the spatial reference system or software used to document the infested area (e.g. ArcGIS, SQL Spatial, etc.). WKT offers a compact machine- and human-readable representation of geometric objects.

Why it is useful: The Well-Known Text can be shared easily and is interchangeably usable in a variety of spatial software to draw the shape of the infestation.

Core Element: This is a recommended field for sharing records with polygons and linestrings. Datum must be included to be able to interpret the WKT.

Coding: Software should generate the WKT in the ISO 19162:2015 (WKT 2) format.

Data Value: Alphanumeric

Example:

WKT: POINT (-84.306466 32.565250)

Centroid Type

Field Name(s): Centroid type

Definition: A descriptor for records with non-point spatial information. To clarify that any occurrence coordinates representing the center of a non-point spatial shape is a centroid, Centroid Type must be included in the data set.

Why it is Useful: Subsequent users will be notified that the coordinates represent the center of a larger shape as opposed to an exact point.

Core Element: This field is required if coordinates represent a centroid. If there is no value provided, Latitude and Longitude values are assumed to be point locations.

Coding: If coordinates represent an actual point, this field can be ignored or the field left empty. If coordinates are the centroid of a non-point shape, enter a descriptor for the type of shape, such as 0.1 Degree, City, County, HUC8, Zipcode, Unknown, etc. in this field for those records.

Data Value: Alphanumeric

Example: Location is a polygon of a pond infested with hydrilla. Latitude, Longitude, and Datum were noted in the appropriate fields representing the centroid of the polygon

Centroid Type: HUC12

Data Type

Field Name: Data Type

Definition: The nature of the geographic mapped shape of the infestation (not the same as Area Surveyed). Shapes can be described as Point, Polyline, or Polygons by the mapping program used. Point records will have one definite and specific Latitude and Longitude in the decimal degrees format. Polyline records have a series of latitude and longitudes with a defined beginning and end that do NOT connect (e.g. rivers, trails, fencerows, etc.). Polygon records can be any shape with a definite interior area bound by “sides” (e.g. rectangle, circle, etc.).

Why it is Useful: Allows for documentation of the kind of shape of an infestation, which provides more context for other fields, such as Infested Area.

Core Element: This is a required field if the provided location for the record is a polyline or polygon. If not provided, locational information is assumed to be a point.

Coding: Point, Polyline, or Polygon are the available options.

Data Value: Text

Example: Eastern red cedar growing in the fencerows of pastures

Data Type: Polyline

Coordinate Uncertainty in Meters

Field Name: Coordinate Uncertainty

Definition: The variability of a pair of latitude and longitude values, in meters. Due to availability of satellites and surrounding geography, there may be some variability in the accuracy of coordinates. Often, smartphones, GPS-enabled tablets, and GPS units record this information automatically. The term provides an estimate of the number of units (coordinate uncertainty) of distance in meters within which the actual occurrence may be found.

Why it is Useful: Allows for the documentation of the accuracy of a location.

Core Element: Optional

Coding: Do not include 'meters' because it is understood. Enter number value.

Data Value: Numerical.

Example: A GPS unit with a coordinate uncertainty of 10 meters was used to plot the latitude and longitude in decimal degrees of an infestation.

Coordinate Uncertainty: 10

Georeferenced Protocol

Field Name: Source of Location

Definition: How the Latitude and Longitude coordinates of the observation were determined. Describes process by which survey was conducted (aerial survey, ground survey, helicopter, etc.).

Why it is useful: Knowledge of how the location information was collected can help data reviewers evaluate the technology used, and track changes in data collecting.

Core Element: Required

Coding: Enter how the location was recorded.

Data Value: Text

Example: Observation was recorded on a ground survey with a smartphone application.

Source of Location: Ground Survey, Smartphone GPS

Ecosystem

Field Name: Ecosystem

Definition: A descriptive term for the environment where the subject was observed. Determination of ecosystem type can include vegetation, soil-type, climate/weather patterns, management, etc.

Why it is useful: Knowledge of ecosystem where species are currently found can be utilized in future surveying and modeling of potential species spread. Documentation of ecosystem can also aid in identification of species, as many species will only infest areas that are similar to their native habitat.

Core Element: Optional

Coding: Enter brief ecosystem description, preferably from an established system with a controlled vocabulary.

Data Value: Text

Example: Observation occurred in an area surrounded by pine trees.

Ecosystem: Conifer Forest

Record Status

Occurrence Status

Field Name: Occurrence Status

Definition: Whether or not a species is found at a location during a survey. Invasive species can be mapped as a Detected or Undetected. Detected indicates that the species was found during the survey. Undetected indicates that the species was surveyed for and not found; this covers instances where the organism was previously found at the location but not detected at time of this survey (disappeared/not detected), instances where the organism was previously treated and has not reoccurred, and instances where it has not yet been found.

Why it is useful: Detected will allow for surveys with positive results to be documented. Undetected will allow for surveys with negative results to be documented, which allows for more precise identification of when a range expansion occurs, and when monitoring areas where the species was historically found, but that could be reinvaded due to a history of known invasion.

Core Element: Required

Coding: A text field with options: Detected or Undetected.

Data Value: Text

Example: Silver carp (*Hypophthalmichthys molitrix*) was surveyed for in the Suwannee River within Woods Ferry Conservation Area and not found at time of the survey, but has been known to occur for the last several years and has been determined to be self-sustaining.

Occurrence Status: Undetected

Population Status

Field Name: Population Status

Definition: Whether or not a group of a species is observed in an area. Populations can be mapped as: Recently Introduced, Established, Extirpated, Failed, or Unknown. Recently Introduced indicates an occurrence that is not (yet) self-sustaining. Established indicates that the population is self-sustaining or is constant or continuous due to repeated introduction. Extirpated is defined as a local extinction of a population; in this document it is expected to be due to human intervention (e.g., pesticide/mechanical treatments, biological control agent releases, trapping, etc.). Failed indicates that the population is no longer present and did not successfully establish due to inability to reproduce or influence by other species (e.g., predation, competition, parasitism, etc.). Unknown indicates that the current status of the population is not known or undetermined at time of survey.

Why it is useful: This will allow for the overall population status to be documented independent of the physical presence at time of survey.

Core Element: Recommended

Coding: A text field with these options: Extirpated, Established, Failed, Unknown.

Data Value: Text

Example: Silver carp (*Hypophthalmichthys molitrix*) was surveyed for in the Suwannee River within Woods Ferry Conservation Area and not found at time of the survey, but has been known to occur for the last several years and has been determined to be self-sustaining.

Population Status: Established

Management Status

Field Name: Management Status

Definition: Allows the collector to denote if the organism or population, at time of observation, is being managed or if control efforts are being conducted. Management Status can be mapped as Newly Discovered and Treated, Newly Discovered and Untreated, Untreated, Previously Treated, Treated, Possibly Eradicated, Not Found, or Unknown. Newly Discovered indicates a first occurrence at the site, which is either treated or untreated. Untreated indicates that the organism or population have not been and are not treated. Previously Treated means some form of treatment has occurred in the past. Treated means treatment is applied at time of survey (e.g., chemical, mechanical, etc.). Possibly Eradicated indicates prior treatment may have eliminated the population because it was not found. Not Found means the organism was searched for but was not present at time of survey, and no previous treatment is known. Unknown means status of prior treatments is unknown at time of survey.

Why it is useful: This will allow for subsequent users of the data to know if the population is being monitored or treated. Users could filter for the exact data that they are interested in for their needs.

Core Element: Required

Coding: A text field with these options: Newly Discovered and Treated, Newly Discovered and Untreated, Untreated, Previously Treated, Treated, Possibly Eradicated, Not Found, or Unknown.

Data Value: Text

Example: Cogongrass (*Imperata cylindrica*) was sprayed with glyphosate on April 5, 2013.

Management Status: Treated

Basis of Record

Field Name: Record Basis

Definition: Many reports come from in-field observation, but new technology is allowing for other methods of observation and data collection. This field, which comes from the Darwin Core Metadata Standard, allows the collector to document how the occurrence was determined. Basis of Record can be mapped as Human Observation, Living Specimen, Machine Observation, Moving Image, Physical Object, Preserved Specimen, Sound, Still Image, or Unknown. Human Observation means the record was collected by a person viewing the organism. Living Specimen means the organism is within a collection such as a zoo, bacterial culture, or botanical garden. Machine Observation means the data was collected by an aerial photo, animal/motion detection camera, remote sensing, image recognition, DNA sensor, or similar. Moving Image means the record is a video or similar. Physical Object means the record consists of a material sample (or resample) which may be either preserved or destructively processed (e.g. for DNA analysis). Preserved Specimen is a part or whole of the organism that is preserved and included as part of a formal collection. Sound is a record of an audio recording (such as a bird or insect call). Still Image is a visual record of all or part of the organism. Unknown is only included for purposes of historic datasets, because this is a required field.

Why it is useful: This will allow for subsequent users of the data to know how the occurrence was determined. Users could filter for the exact kind of data that they are interested in for their needs.

Core Element: Required

Coding: A text field with these options: Human Observation, Living Specimen, Machine Observation, Moving Image, Physical Object, Preserved Specimen, Sound, Still Image, or Unknown.

Data Value: Text

Example: Spotted wing drosophila (*Drosophila suzukii*) was surveyed by setting traps and counting captured individuals which were not collected/preserved.

Record Basis: Human Observation

Record Type

Field Name: Record Type

Definition: Conveys the purpose of the record. This field helps to describes the broad scope of data that could be collected using these standards, especially since more than invasive species occurrences may be mapped with these standards.

Why it is useful: This will allow for subsequent users to know the purpose of the record and the reason the data is being collected. Users could filter for the exact data that they are interested in for their needs.

Core Element: Required

Coding: Select from the following options: Biological Control Agent Survey, Biological Control Agent Release, Invasive Species Survey, Invasive Species Treatment, Monitoring, Other, Unknown.

Data Value: Text

Example: Examiners released black dot spurge flea beetle (*Aphthona nigriscutis*) as a biological control agent on leaf spurge (*Euphorbia esula*).

Record Type: Biological Control Agent Release

Data Collection Method

Field Name: Method

Definition: A descriptor for the methodology by which the data was collected. This covers data collected by field surveys, including the survey method, but also data collected by other methods, such as aerial surveys, sketch mapping, animal camera, LiDar analysis, etc.

Why it is Useful: Noting how data is collected lets the subsequent users include desirable or eliminate undesirable data methods and provides the verifier with additional information.

Core Element: Optional

Coding: Enter the methodology used to take the data, preferably choosing terms from a list.

Data Value: Text.

Example:

Method: Digital Aerial Sketch Mapping

Verification Method

Field Name: Verification Method

Definition: How the species was identified or verified. This can include everything from expertise based on education and training to photographs, samples, or laboratory procedures such as DNA testing.

Why it is useful: Due to the inability for everyone to inspect every report of invasive species, documenting how the species was identified lends additional credibility to the report. Noting the method used provides more information especially for outliers, first in region, and difficult to identify species.

Core Element: Recommended

Coding: Text based field due to the number of ways to identify invasive species, but suggested values are: Expertise, Photographs, DNA Testing, Diagnostic Laboratory Sampling, and Specimen

Data Value: Text

Example: Identification of kudzu bug (*Megacopta cribraria* (Fabricius)) based on the reporter's knowledge of species' unique characteristics.

Verification Method: Expertise

Information Source

Reference

Field Name: Reference

Definition: A citation or descriptive method of finding the source of literature that data comes from.

Why it is useful: This will allow for subsequent users of the data to know the source of the data and examine it, if needed. Users could filter for the exact data that they are interested in for their needs.

Core Element: This is a recommended field for literature based data.

Coding: An open text field that follows any widely-accepted and consistent format for citations.

Data Value: Text

Example: Canada thistle (*Cirsium arvense*) in Philips County, Montana was documented in *Flora of Montana*.

Reference: Booth, W.E., and J.C. Wright. 1966. Flora of Montana. Montana State University, Bozeman

Examiner

Field Name: Examiner

Definition: The full name of the individual who collected the information in the field or is the contact person for the data. Also known as Collector, Observer, or Recorded By.

Why it is Useful: Within a management area, many different public and private sector individuals may all have contributed to the survey. A name allows the person compiling the inventory to serve as a contact person and to verify and correct any questions on the information.

Core Element: Optional, though it may be useful at the field office level or to estimate how many people have contributed to the dataset over time.

Coding: Enter the full name of the individual who collected the data.

Data Value: Text

Example:

Examiner: Ronald J. Weed

Data Source

Field Name: Data Source

Definition: The owner or manager of the data (either a person of an organization). This may be a different person or entity from the owner, or the person who collected the data. It may be an office manager or a database specialist. This is the entity responsible for answering questions about the data, or for responding to data requests.

Why it is Useful: Provides contact point for questions about data. Allows consolidation/coordination of information requests. Bridges gap between those collecting information, and those managing the data.

Core Element: Required

Coding: Names are written out with no acronyms or abbreviation, because those may vary.

Data Value: Text

Example: Banff National Park in Alberta, Canada has been mapping invasive plants.

Data Source: Parks Canada, Banff National Park

Date and Time

Collection Date

Field Name: Collection Date

Definition: The date the observation was made in the field. It does not refer to the date information was entered into the computer (that can be an optional additional field, often 'Last Update' or similar. If the date is estimated, choose a date at the mid-point of the estimated date range and include the accuracy of the selected date in the Date Accuracy in Days field.

Why it is useful: This field tells you when the occurrence was observed. Phenology and morphology can change over the course of the year, so notation of observation/collection date is important. This field also tells you how old the information is. These cues will help you decide how reliable the information is and whether a follow-up visit to the site may be warranted.

Core Element: Required

Coding: A date field; because data is liable to be shared internationally, ISO 8601 is recommended. Increasingly, data is being collected directly in GPS units, smartphone applications, online forms, and other data logging technology. Date formatting can be established within the logging units and forms without having to train collectors in a new format. The ISO 8601 format for reporting dates with time is yyyy-mm-ddThh:mm:ss.ffffff, where yyyy=4-digit year, mm=2-digit month, dd=2-digit day, T=time value follows, hh=2-digit hour, mm=2-digit minute, ss=2-digit second, and ffffff=fraction of a second with up to six digits of accuracy. Time should be standardized to local time zone of collection. For data without time known coding is yyyy-mm-dd.

Data Value: Alphanumeric

Example: A knapweed site was visited on October 3, 2002. You would record:

Collection Date: <u>2002-10-03</u>

Date Accuracy in Days

Field Name: Date Accuracy in Days

Definition: The range of days within which the data was collected. The exact date may not always be obtainable, so collectors can mark the accuracy of the observation date with the number of days around the noted observation date the observation could have been made.

Why it is useful: This allows subsequent users to know that the observation data is not exact, but an estimation. As date is sometimes used in verification, an out of place date could cause concern without the additional information that the observation date is an estimation.

Core Element: Optional

Coding: A number that represents the estimated accuracy to the nearest day (within the month = 15;

within the year = 182).

Data Value: Numeric

Example: Survey was conducted during an undefined period in June 2015, Collected Date is recorded as June 15, 2015 (2015-06-15) and accuracy is ± 15 days:

Date Accuracy in Days: 15

Quantifying the Infestation

Infested Area

Field Name(s): Infested Area, Infested Area Units

Definition: The calculated area containing one invasive species type. An infested area is defined by drawing a line around the actual perimeter of the infestation. It is highly recommended that only a single species be entered for each infested area. Different areas and programs will use different units for area, so it is important to know which unit of measure (Infested Area Units) was used to measure the infestation.

Why it is Useful: Infested area can be defined in many ways and there is little consistency between individuals, counties, states, and countries. Is an acre of weeds: one weed plant in an acre, an acre covered with weeds, or all the lands threatened with invasion from an existing infestation? This definition provides a consistent and common method of describing infestations; the calculated perimeter of one species' infestation. This is the data field that will be used to sum and report total infested area across all ownerships.

Core Element: Both Infested Area and Infested Area Units are required fields for invasive plant species that were detected.

Coding: Infested Area: Enter the number that correctly reflects the area infested. Infested Area Units is selected from the following options: Square Feet, Acres, Square Meters, Square Kilometers, Hectares, Other.

Data Value: Infested Area: Numeric; Infested Area Units: Text.

Example: 1.6 hectares of oxeye daisy (*Leucanthemum vulgare Lam.*) found outside Vancouver, BC.

Infested Area: 1.6 Infested Area Units: Hectares

Area Surveyed

Field Name: Area Surveyed, Area Surveyed Units

Definition: The entire land area surveyed for an invasive species, whether or not invasive species were found. Information will be recorded in two fields, Area Surveyed and Area Surveyed Units.

Why it is Useful: These fields record information on the extent, or the total area that was surveyed. It allows landowners and land managers to maintain records on the areas that have been surveyed for invasive species, and those areas where no surveys have occurred. This field can be used in tandem with Report Status to denote a specific area surveyed for an invasive species that was (detected) or was not (undetected) found.

Core Element: Optional

Coding: Area Surveyed: Enter number that correctly reflects the area surveyed. Area Surveyed Units: Enter as appropriate: Square Feet, Acres, Square Meters, Square Kilometers, Hectares, or Other.

Data Value: Area Surveyed: Numeric; Area Surveyed Units: Text.

Example: In the summer of 2000, Jasper National Park completed a 17-hectare survey in and around park headquarters facilities for Canada thistle (*Cirsium arvense*), which was found sporadically throughout the survey area.

Area Surveyed: 17 Area Surveyed Units: Hectares

Incidence

Field Name: Incidence

Definition: The proportion (as a percentage) of the host community that is affected by an insect or pathogen, or the proportion of an area that is infested by independent living organisms (e.g., plants, wildlife, etc.). The Area Surveyed would provide context for the area considered and the Incidence notes the percentage within is infested/infected.

Why it is Useful: These fields record information on the extent of the spread of an insect or pathogen within a population or an area, or describes the extent of an infestation within an Area Surveyed.

Core Element: This is an optional field.

Coding: Incidence is considered a percentage of the whole Area Surveyed and is coded as a number not to exceed a maximum value of 100.

Data Value: Numeric

Example: An area within Paynes Prairie State Preserve was evaluated for laurel wilt (*Raffaelea lauricola*) on red bay trees (*Persea borbonia*) and the area had 20 percent of the trees affected.

Incidence: 20

Severity

Field Name: Severity, Severity Units

Definition: The proportion (percentage) of an individual sample (i.e. one plant, one leaf, one animal, etc.) that is affected by a pathogen. Incidence and Severity are independent from each other. A pathogen may be wide spread within a population (a high Incidence), but may not be very impactful to the individual plants/sample (a low Severity). Or, the converse may be true, only a few plants affected (low Incidence) but the plants are killed (high Severity). This data can be used to describe "hot spots" for areas of targeted management (low Incidence/high severity).

Why it is Useful: These fields (taken together) provide context for how injurious a pathogen is to the individual sample.

Core Element: Optional

Coding: Severity can be marked as a percentage or as a number relative to a sampling amount. Severity Units it describes the methodology of either the percent or the number of the Severity.

Data Value: Severity: Numeric; Severity Units: Text.

Example: Twenty leaves of one red bay tree (*Persea borbonia*) with laurel wilt (*Raffaelea lauricola*) were assessed for the amount of disease signs and 10 leaves of 20 were showing signs.

Severity: 50 Severity Units: percent of sampled leaves from one plant

---

Organism Quantity

Field Name(s): Organism Quantity, Organism Quantity Units

Definition: A count of subjects observed, captured, treated, or released (for biological control agents) within the surveyed/infested area (Organism Quantity); a descriptor of what kind of quantity was measured (Organism Quantity Units). Enter an exact or estimated number of observed subjects. The Quantity Units can be a description of the life stage of the subject (e.g., adults, eggs, nymphs, etc.), or if more practical, description of the organism or object that the subjects were observed on (e.g., trees, dock posts, bridge piers, etc.).

Why it is useful: A count of the species observed is more appropriate for invasive species populations that may migrate or experience population changes quickly.

Core Element: This is a required field for insect, animal, plant pathogen, and biocontrol surveys.

Coding: Enter an exact or estimated number of observed subjects and description of the organism life stage or description of what the subject was observed on.

Data Value: Organism Quantity: Numeric; Quantity Units: Text

Example: Observed 50 hemlock trees infested with hemlock wooly adelgid

Organism Quantity: 50 Organism Quantity Units: Trees

Subject Characteristics

Life Stage

Field Name: Life Stage

Definition: A brief description of the phenological or life stage of development of the plants, animals, insects, biocontrol agents, or pathogens observed. Individuals or entire infestations can express multiple life stages at once, so multiple options can be used.

Why it is useful: The life stage at time of observation can be important in identification and management of the infestation. Notation of the phenological aspects or life stage of subjects observed, e.g. nymph, mature, adult, eggs, in flower, in fruit, seedling, etc., can be utilized, in combination with other data (e.g. the date of observation, host species, etc.) by future surveyors, can help determine appropriate treatment, or can be incorporated into modeling programs and aid in determining the timing of the life cycle for that species in a particular environment.

Core Element: Optional

Coding: Using the singular, enter a description of the observed subject from a list of options with multiple stages separated by a comma; seed, seedling/rosette, sapling/immature, mature, in flower, in fruit, dormant/dead, egg, nymph, larva, pupa, juvenile, adult, or other.

Data Value: Text

Example: Several life stages of emerald ash borers were found infesting ash trees.

Life Stage: Adult, Larva, Egg

Sex

Field Name: Sex

Definition: A brief description of the sex of the organism observed. For one organism observed, one option may be chosen. Individual species or entire populations can express multiple sexes at once, so multiple options can be used.

Why it is useful: The sexes observed can be utilized by data managers to note trends or frequency of the sex of observed subjects. Some species have different coloration or patterns between males and females; identification of some species is therefore easier with one gender over the other. This information can be utilized in combination with other fields to lend certainty to identification.

Core Element: Optional

Coding: Enter a description of the sex of the observed organism(s): male, sterile male, female, sterile female, hermaphrodite, asexual, other, or unknown.

Data Value: Text

Example: The observed wild boar was male.

Sex: Male

Host Species

Field Name: Host Genus, Host Species, Host Subspecies OR Host Variety, Host Authorship

Definition: Scientific name of the host of the observed subject (infestations or diseases or biological control agent). Include genus, species, subspecies/variety (if applicable), and the authorship (if applicable).

Why it is useful: The use of the scientific name provides a definite label to the host species. Knowledge of the host for biocontrol agents, insects, and pathogens can aid in positive identification for the observed species. It can also influence areas searched in future surveys, and help to predict a potential range of spread for pathogens and biocontrol agents.

Core Element: This is a required field for biocontrol observations, invasive insects, and pathogens, unless collected in traps or otherwise unassociated with host. Host genus and species (if known) are required. Subspecies/variety and authorship are optional.

Coding: Enter name of species as it appears in a reliable taxonomic authority, such as ITIS.

Data Value: Text

Example: For a biocontrol agent found on Dalmatian Toadflax: *Linaria dalmatica* ssp. *dalmatica* (L.) Mill. you would record:

Host Genus: Linaria HostSpecies: dalmatica
Host Subspecies: dalmatica Host Authorship: (L.) Mill.

Comments

Field Name: Comments

Definition: Additional notes to be included with the record to document important information which cannot be assigned to another field.

Why it is useful: It is not possible for all of the important data to be accounted for in a standard, so comments allow users to include additional data that does not have to conform to the parameters described in an existing field.

Core Element: Recommended

Coding: This field should be able to accommodate open ended, longer entries of data. It is recommended that unrelated comments for one record be separated by periods. Do not use tab characters within a comment (or any other) field in the dataset.

Data Value: Alphanumeric.

Example:

Comments: Population appears to have some unknown insect herbivore feeding on it; revisit with supplies to sample insect population.

Glossary of Terms

Area Surveyed: Intended to show general location and population information. It is an area that was surveyed for specific species. Unlike *Infested Area,* the area is defined by drawing a line around the general perimeter of the survey, not the area covered by individual or groups of invasive species. Area surveyed may contain significant parcels of land that are not occupied by the target organism.

Collection Date: The date the record's information was collected in the field. It does not refer to the date the record's information was entered into the computer.

Datum: A model of the earth's shape. Geodetic datums define the size and shape of the earth and the origin and orientation of the coordinate system used to map the earth. The most common Datums used will be NAD83 and WGS84, but there are older and more locally specific systems which may have been or be used.

Georeference: Defining the location of an object using coordinates and assigning

GIS (Geographic Information System): A computerized system for the collection, storage, management, retrieval, changing, modeling, analysis and display of spatial data, used to create a representation of the real world.

GPS (Global Positioning System): A global navigation system based on a system of high orbiting satellites. The GPS receiver uses at least 4 satellites to compute position.

Infestation: The presence of an unusually large number of invasive species in a place, typically enough to cause damage or disease.

Infested Area: Calculated or estimated area containing one invasive species. Defined by drawing a line around the actual perimeter of the infestation as defined by the area covered by the target organism, excluding areas not infested. An area containing only occasional target organisms per acre does not equal one acre infested. Generally, the smallest area of infestation mapped will be 1/10th (.10) of an acre (or 0.04 hectares).

Latitude: The angular distance (distance measured in degrees) north or south of the equator. Latitude is 0 degrees at the equator, 90 degrees at the north pole, and –90 degrees at the south pole. Latitude is also described by N or S (direction north or south of the equator) instead of + or -.

Longitude: The angular distance (distance measured in degrees) east or west of the prime meridian. Longitude is 00 at the prime meridian, and is measured + 180 going east, and –180 going west. Longitude is also described by E or W (direction east or west) of the prime meridian, instead of + or -.

Persistent Identifier: A globally unique identifier that is a reference to a digital object. They are often actionable, allowing a user to accesses the original digital resource using a long-term, persistent link through an internet browser. There are many formats for Persistent Identifiers (PIDs), the most common of which is Digital Object Identifiers (DOI), but also include Uniform Resource Identifier (URI), of which Uniform Resource Locator (URL) and Uniform Resource Name (URN) are two specializations of URI, and Uniform Resource Characteristic (URC).

Universally Unique Identifier: Following the version 4 UUID format of 32 alphanumeric characters in five groups of characters separated by hyphens in 8-4-4-4-12 form (a total of 36 characters), the probability of a duplicated UUID is negligible. A UUID is used to ensure that an individual record can be positively identified within a system or across systems and to help prevent duplications when aggregating data across many datasets and between aggregate databases. UUID (called Global Unique Identifier [GUID] in Microsoft products) can be generated in many software and database programs, as well as through UUID generator websites.

Well-Known Text: Well-Known Text (WKT) is a text based representation of the geometry of objects on a map and should use the ISO 19162:2015 (WKT 2) format. WKT can be used to represent points, polygons, linestrings, and more. Most common mapping programs can accommodate WKT and draw a geometric shape from the text, which can be a way for groups using different or proprietary mapping software to share data.

Technical Resources

Persistent Identifier – PID can be any number of ways that a record is resolvable to a definite source. This can include Digital Object Identifiers (DOI) links to an individual resource (e.g., journal article, press release, data set, etc.) that describes the record, a website URL that links to the original record on a state, county, or other website (such as EDDMapS, iNaturalist, GISIN, etc.), and more. DOI are under the domain and maintenance responsibility of specific registering agencies, which can be accessed via https://www.doi.org/registration_agencies.html. URL may be more inconsistent, as those are reliant upon the domain holder for upkeep and so broken links and dead-ends may be more of an issue.

Universally Unique Identifier – UUID can be generated in a variety of programs and databases, but this process can differ from version to version as software is updated. Below are some websites with instructions on how to generate UUID for each common program used to collect and/or store invasive species data.

Excel: https://www.idigbio.org/wiki/images/0/03/GUIDgeneration.pdf
ArcGIS: http://moravec.net/2015/08/5-ways-to-make-a-guid-or-uuid-in-arcgis/
SQL: https://docs.microsoft.com/en-us/sql/t-sql/functions/newid-transact-sql?view=sql-server-2017

As there may be some instances where a program is using another software or may be less technologically inclined, there are many websites that generate UUID and those can been added to files and databases as data is entered.

https://www.guidgenerator.com/
https://www.uuidgenerator.net/version4

MNRD Non-Local Beings Report
Attachment 3

Wisconsin Department of Natural Resources

LOCATIONAL DATA STANDARDS

VERSION 1.1

This document updates
DNR Locational Data Standards (version 1.0 - dated 11/29/00).
For more information about this document, please contact:

Lisa Morrison
GIS Data Specialist
morrila@dnr.state.wi.us

John Laedlein
GIS Data Specialist
laedlj@dnr.state.wi.us

This document is also available on DNR's web site:
http://www.dnr.state.wi.us/org/at/et/geo/location/loc_stds.html

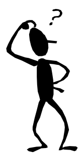
Attachment 3 to MNRD Non-Local Beings Report

I. TABLE OF CONTENTS

II. BACKGROUND INFORMATION

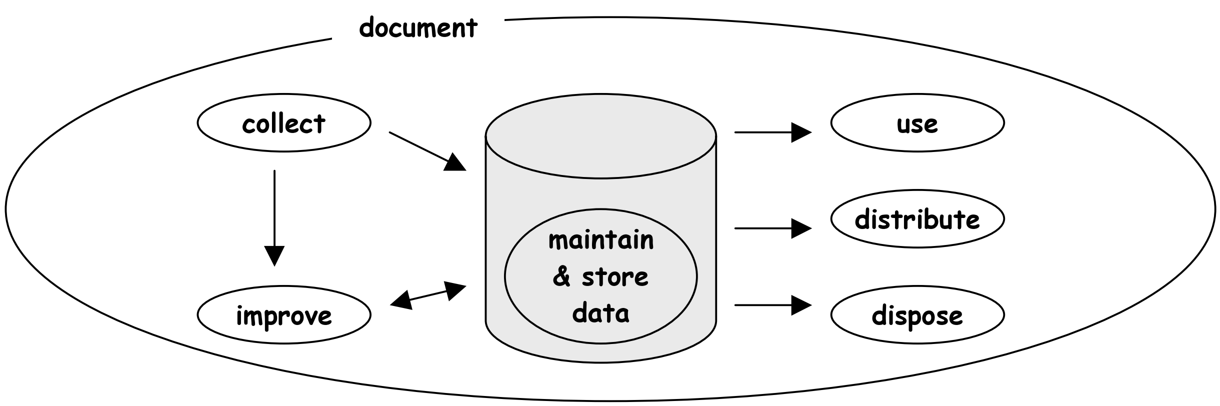
1. WHAT ARE LOCATIONAL DATA?

Locational data identify the "absolute" or "relative" position and position-related attributes of natural or man-made features and boundaries of Earth. Coordinates are an example of absolute feature locations, while street address and management unit are examples of relative locations. Locational data are sometimes referred to as "spatial" or "geospatial" data. Locational data and their "metadata" (i.e., descriptive data about data) can help answer questions such as…



What type of feature was located?
Where is that feature located on, above, or below the Earth's surface?
Which tool/technique was used to collect the location of that feature?
How accurate is the location of that feature?

Like all data, DNR's locational data have a life cycle that involves collection, improvement, maintenance and storage, use, distribution, and disposition activities. Proper and thorough documentation of each activity is important to ensure consistency, reduce redundancy, and promote integration of locational data throughout the agency.



DNR's locational data exist in a variety of formats and systems - paper maps and reports, tabular databases, spreadsheets, statistical and modeling applications, and geographic information systems (GISs). GIS tools and applications are specifically designed for collecting, improving, maintaining and storing, and using spatial data. The use of these tools by DNR programs and external partners continues to grow.

Agency staff, external partners, and other users need accurate locational data to make informed decisions about many different resource and facility management activities. DNR's goal is for locational data producers within the agency to continue to improve the quality of their data and metadata, and, as a result, continue to increase user confidence in those data and metadata. Both producers and users must consider the quality of the locational data in a "data set" (i.e., a collection of related data) in order to ensure that they can be used to support their specific business goals and needs.

2. ABOUT THIS DOCUMENT

Sections of this document are intended to provide information to specific audiences. ***Sections II -IV*** contain general information about locational data standards and considerations for all audiences. ***Sections V-VI*** contain information for DNR staff collecting locational data. ***Sections VIII-X*** provide information for users and distributors of DNR's locational data. Finally, ***Section VII*** and ***Appendices A-C*** are primarily intended for system and application developers.

It is hoped that this ***Locational Data Standards*** document becomes the foundation for all locational data related materials and activities within DNR. This document revises and replaces the existing *DNR Locational Data Policy* (Information Management Policy, Standards and Procedures Handbook, 9/19/96). These standards also update and replace sections of DNR's 1994 *GIS Database User's Guide*.

The reworking of these existing documents was done in response to concerns and needs expressed by DNR office and field staff, BEITA staff, external partners, and others. DNR's goal is to adopt locational data standards that are robust and compatible with other department-wide data and application standards, yet are flexible enough to support the unique business needs of each program. Producers and users of DNR's locational data must also find these standards easy to understand and use!

The contents of this document are dynamic. They will be reviewed regularly, and revised as necessary, to reflect changing DNR business needs, new technology, and the development of related standards and guidance. Full implementation of these locational data standards across DNR is expected to occur incrementally over time. Finally, this document references locational data materials and information from external sources where appropriate (see ***Section XII***).

> **Visit DNR's GIS Sections Intranet homepage for more information about the locational data topics covered in this document, or to contact us with questions!**
> **http://intranet.dnr.state.wi.us/int/at/et/GEO/**

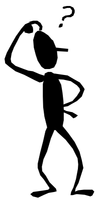
3. WHY ARE DNR's LOCATIONAL DATA STANDARDS IMPORTANT?

Although developing and implementing standards can be somewhat controversial, department-wide adoption of these locational data standards can help:

- Facilitate access to and sharing of locational data among DNR programs, external partners, and other users, by providing a consistent, robust structure for:
  - Producers to collect, store and document their data.
  - Users to understand and assess the content and quality of the data.
  - Users to integrate data from different sources to meet their unique business needs.

- Minimize time, money and other resource costs associated with the collection, improvement, use, storage and maintenance, distribution, and documentation of redundant (and possible contradictory) locational data.

4. WHEN DO THESE LOCATIONAL DATA STANDARDS APPLY?



DNR's locational data standards apply to all department database systems and applications that describe the locations of real-world features or boundaries using any of the absolute or relative referencing systems described in this document! These standards do not mandate that any DNR program collect or use locational data!

a) Who Is Responsible for Implementing DNR's Locational Data Standards?

DNR program and BEITA staff are responsible for reviewing their locational data and related systems and applications, and determining if and how these standards apply to them. They are also responsible for adhering to these standards, as appropriate, throughout the life cycle of their data sets and database systems and applications. BEITA's Enterprise Data Management Section and the GIS Analysis and Mapping Services Section can help in these efforts. The following considerations can help producers and users determine when these standards apply to a specific data set, system, or application:

- The activity associated with the locational data in the data set, system or application.
- Whether the data element or field is required, recommended, or optional.
- Whether the data set, system or application is new/redesigned or existing.
- Differences in how x-y coordinates for features are stored in tabular and GIS applications and systems.
- How features in a data set are geometrically represented.
- Whether the data set is homogeneous or heterogeneous.

b) Standards for Locational Data Activities

The standards in this document are organized into sections, based on the activity with which the locational data are associated: collection, storage, use, documentation, and distribution. Although these standards focus primarily on data collection activities, standards for the other activities are discussed and defined as appropriate.

c) "Required", "Recommended", and "Optional" Locational Data

How and if locational data components are collected and stored depends, in part, on whether the data elements (i.e., for data collection) or the data fields (i.e., for data storage) are required, recommended, or optional. These conditions are also important in determining when these locational data components can be documented at the record level or at the data set (i.e., metadata) level (see ***Section II.4.g*** below).

d) New Versus Existing Data Sets, Applications, and Systems

These standards apply "day-forward" to **new and rewritten** database applications and systems that contain locational data. This means that applicable locational data fields in these "new" systems and applications must conform to these standards. In addition, all related data entry screens and procedures must perform checks to assure the entry of valid data into appropriate data fields (unless entry of non-standard data is required for specific business needs).

Whenever possible, **existing** database applications and systems must be brought into conformance with these standards. These standards acknowledge, however, that the improvement or conversion of existing data sets, applications and systems will occur over time. And, that these efforts are dependent on factors such as: (1) program business needs and priorities, (2) available resources, (3) regulatory or technical requirements, and (4) interdependence among existing data sets, systems and applications.

e) Feature Coordinates in Tabular Versus GIS Applications and Systems

DNR's locational data related systems and applications are developed using tabular database tools (e.g., Oracle, Microsoft Access), GIS tools (e.g., ArcView, ArcInfo), or a combination of the two. One of DNR's goals is to improve user access to all agency data by better integrating tabular and GIS data, systems and applications. Several strategic projects and new software tools (e.g., Spatial Database Engine and ArcIMS) will help facilitate these integration activities.

f) Geometric Feature Representation:

A real-world feature may be geometrically represented as a point, line, area, or as a collection of points, lines or areas on a map or in a GIS data layer. Each feature has x-y coordinates and associated attributes, which are all "linked" (or related) to each other by a "unique feature identifier", as illustrated below.

The unique identifer for this point feature is "1290".

FEATURE COORDINATES

Feature Identifer	X-Coordinate	Y-coordinate
1290	540,923.85	533,112.78

← **one data record**

FEATURE ATTRIBUTES

Feature Identifier	Attribute 1 (e.g., Feature Type)	Attribute 2 (e.g., Collection Date)	Attribute 3 (e.g., Collection Method)
1290	Monitoring Well	12/17/95	GPS004

In both tabular and GIS applications and systems, feature attributes, including relative referencing system data, are managed in one or more linked "data records" (i.e., rows of data) in related data tables. X-Y coordinates, however, are managed differently in tabular and GIS applications and systems. This, in turn, affects the applicability of the *x-y* coordinate collection and storage standards defined in this document.

GIS Applications: A GIS automatically defines *x-y* coordinate data fields and internally maintains the "topology" (or spatial relationships) among these coordinates! Therefore, the standard *x-y* coordinate data fields in this document do not apply to GIS data layers, applications or systems.

Tabular Database Systems and Applications: Tabular database systems and applications do not maintain the topology among feature *x-y* coordinates, and, therefore, they can store the *x-y* coordinates of point features only! The standard *x-y* coordinate data fields defined in this document do apply for point features in tabular database systems and applications.

g) Homogeneous Versus Heterogeneous Data Sets

All **required** data elements must be collected for all features being located, while all **recommended** data elements should be collected as applicable! However, deciding when to apply record-level versus metadata-level standards for storing and documenting locational data depends, in part, on the "homogeneity" (or uniformity) of the data set containing the locational data.

Homogeneous Data Sets: A data set is considered homogeneous, with respect to its locational data, if: (1) the following data elements are identical for all features in that data set, or (2) the differences among values in a particular element are so minor that they have little or no effect on the accuracy of feature locations in the data set. See ***Section V*** for more information about collecting these standard data elements.

HOMOGENEOUS DATA ELEMENT	EXAMPLE
Program-defined Feature Identifier	All features in the data set are assigned a Wisconsin unique well number (WUWN).
Feature Type Code (or set of related types)	All features in the data set are monitoring wells or are some type of public water supply well.
Feature Geometric Representation Code	All features in the data set are represented as points.
Original Horizontal (or Vertical) Referencing System Code	All feature locations in the data set are originally collected in WTM91 coordinates.
Original Horizontal (or Vertical) Collection Method Code	All feature locations in the data set are originally collected using mapping-grade GPS and differentially corrected using post-processing techniques.
Original Horizontal (or Vertical) Source Year, Denominator Amount, or Resolution Amount	If feature locations are digitized on-table or on-screen, the source maps or images (e.g., scanned topographic maps, or DRGs) have the same scale or resolution.

All **required** data fields must be stored and documented at the **record level** for homogeneous data sets! All other data elements may be documented at the metadata level, assuming that the metadata meet appropriate DNR standards (see ***Section IX***).

Heterogeneous Data Sets: A data set is considered "heterogeneous" if it does not meet the conditions for a homogeneous data set as described in the table above. Additional data fields are **required** and **recommended** for storing and documenting heterogeneous data sets at the record level.

III. CHANGES FROM PREVIOUS *LOCATIONAL DATA POLICY*

Refer to the companion documents, *Location Matters: Locational Data Basics* and *Location Matters: Data Accuracy Basics*, (expected completion in Spring, 2001) for detailed explanations of related topics!

1. STANDARDS ORGANIZED BY LOCATIONAL DATA ACTIVITY

The standards in this document are organized into sections by the activity with which the locational data are associated: collection, storage, use, documentation, and distribution. Although these standards focus primarily on data collection activities, standards for the other activities are discussed and defined as appropriate.

2. NEW VERTICAL LOCATIONAL DATA STANDARDS

The collection, use, and storage of altitude data (i.e., elevation and depth) are becoming more common in DNR. This document defines new vertical data standards. Vertical and horizontal data fields are defined separately because different referencing systems are used for each.

3. NEW "ORIGINALLY COLLECTED" LOCATIONAL DATA FIELDS

Several new data fields have been defined to capture characteristics about DNR's locational data as they were originally collected. Because most significant error is introduced during original collection activities, these data can help users determine the quality and, therefore, appropriate uses of the locational data.

4. STANDARDIZATION OF LOCATIONAL DATA FIELDS

Whenever possible, this document defines generic coordinate and attribute data fields. The only exceptions are explicitly defined data fields for Wisconsin Transverse Mercator and Latitude/Longitude coordinates, which are needed to meet specific DNR business needs and reporting requirements.

Standard Oracle abbreviations have been used in data field names and code values when available and appropriate, and new abbreviations have been developed and implemented as needed. Two sets of data field names have also been created: (1) one reconciled with DNR's standard Oracle classwords and 30-character maximum length requirements and (2) another reconciled with ArcView's 10-character maximum length for shapefiles using dBase tables. Finally, when possible, data fields containing numeric values (e.g., year) have been defined as numeric types, rather than as character types.

Both Oracle and Microsoft Access can accommodate data field names of 30 characters. Other commonly used database, spreadsheet, statistics, and modeling packages, however, may have different requirements (e.g., SAS allows 8). In these cases, users should define data fields names that meet that software's length requirements, but that have the same definitions and characteristics as the comparable fields defined in this document. A data field name *alias* (i.e., alternative name) table can help programs track these aliases, and better integrate data from different database systems and applications.

5. REQUIRED, RECOMMENDED, AND OPTIONAL LOCATIONAL DATA

These standards define when collecting specific locational data elements is required, recommended, or optional. It also describes if and how (i.e., record-level or metadata-level) the storage and documentation of collected data elements are required, recommended, or optional.

6. LOCATIONAL DATA QUALITY CONSIDERATIONS

Users must assess the **quality** of the locational data in a data set in order to determine if the data will adequately support their business needs. "Unknown data quality leads to tentative decisions, increased liability and loss of productivity. Decisions based on data of known quality are made with greater confidence and are more easily explained and defended."[1] The following components must be considered together when assessing the quality of locational data in a particular data set (also from Minnesota Land Management Information Center, 1999):

- ***Positional Accuracy:*** How closely the coordinate descriptions of features compare to their actual location.
- ***Attribute Accuracy:*** How thoroughly and correctly features in the data set are described.
- ***Logical Consistency:*** The extent to which geometric problems and drafting inconsistencies exist within the data set.
- ***Completeness:*** The decisions that determine what is contained in the data set.
- ***Lineage:*** What sources are used to construct the data set and what steps are taken to process the data.

This document addresses each of these data quality components to some extent, although most users tend to focus on the "positional accuracy" of locational data. DNR programs are required to define their data accuracy and related business requirements ***before*** collecting data, including:

- identifying the features to be located.
- ascertaining the degree to which those features can be "resolved" (i.e., clearly identified and delineated).
- ensuring that an appropriate data collection method (tool) is used.
- facilitating documentation of standard data collection procedures.

> **Refer to the companion document, *Location Matters: Data Accuracy Basics*, (expected completion in Spring, 2001) for a detailed explanation of locational data accuracy and related quality considerations!**

7. DATA CONVERSION "CROSS-WALK" TABLES

Appendix C of this document contains "cross-walk" tables to help DNR programs convert existing locational data elements and fields (i.e., as defined in the 9/96 *DNR Locational Data*

[1] Minnesota Land Management Information Center, 1999.

Policy) to conform to these standards. These crosswalk tables must be used in conjunction with program-developed "data conversion rules" to help ensure that all converted data and data fields continue to support that program's business needs. Because improvement and conversion of DNR's existing data sets, applications and systems will occur over time, BEITA intends to maintain "old" standard codes and data fields as long as necessary.

8. NEW AND UPDATED "LOOK-UP" CODE TABLES

DNR's data architect/administrator maintains "look-up" tables that contain standard "enterprise" data codes, including several that relate to locational data. These codes must be used in all DNR database systems and applications. These department-wide (DW) tables are currently accessed through the Oracle-based *DAMenu* application (💻 http://intranet.dnr.state.wi.us/int/at/et/).

This document updates existing codes and defines new codes for several existing look-up tables. It also defines new look-up tables and associated domains. The *DAMenu* application lists these look-up tables (also see description below and in ***Appendix B***). Equivalent U.S. Environmental Protection Agency (EPA) codes are also listed, where appropriate, to help users meet reporting requirements. BEITA intends to review *DAMenu* and its related procedures (e.g., How can a program request new codes to be added?). Modifications will be designed and implemented, as needed, to provide better integration and access for all users.

a) Data Collection Method Codes - Appendix B.1

This code describes the method by which the feature location was originally collected. Codes for horizontal data are stored in [ORIG_HRZ_COLL_MTHD_CODE]. Vertical data codes are stored in [ORIG_VRT_COLL_MTHD_CODE]. Equivalent EPA codes are also listed. This table also indicates if and how recommended data fields must be filled in for specific collection methods.

b) Referencing System Codes – Appendix B.2

This code describes the coordinate system or relative referencing system in which the data were originally collected. Codes for horizontal are stored in [ORIG_HRZ_REF_SYS_CODE]. Vertical data codes are stored in [ORIG_VRT_REF_SYS_CODE]. Referencing system name, datum, zone (as applicable), and unit are incorporated into the code values. Equivalent EPA codes are also listed.

c) Feature Type Codes – Appendix B.3

This code describes the type of feature being located, and is stored in [FEAT_TYPE_CODE]. The examples in ***Appendix B.3*** were compiled from several existing feature type lists within DNR. A comprehensive, department-wide feature type list does not exist! Developing an "enterprise" feature type list would help DNR programs consistently identify the types of real-world features being located, and help users better integrate data from multiple DNR sources. It would also facilitate object-oriented data modeling, and the development of standard symbol sets for presenting data to the public via the Internet.

d) Feature Geometric Representation Codes – Appendix B.4

This code describes how a feature is geometrically represented, and is stored in [FEAT_GEOM_REP_CODE]. Equivalent EPA codes are also listed. ***Note:*** A feature may be *stored* or *displayed* in a different geometric representation from the one in which it was *collected* in order to meet specific user needs.

e) Data Collection Tool Codes – Appendix B.5

This code describes the specific software or hardware tool used during original collection of the locational data. Codes for horizontal data codes are stored in [ORIG_HRZ_COLL_TOOL_CODE]. Vertical data codes are stored in [ORIG_VRT_COLL_TOOL_CODE]. These codes provide more detail about data collection activities and data quality.

f) County Codes – Appendix B.6

The DNR and Wisconsin Department of Revenue (DOR) county codes are stored in [DNR_CNTY_CODE] or [DOR_CNTY_CODE], as described in ***Sections V.3.a & b***.

g) Minor Civil Division (MCD) & Federal Information Processing System (FIPS) Codes

MCD and FIPS codes for Wisconsin's incorporated cities, towns and villages are listed in the ***DW_MCD*** table - accessed through the *DAMenu* application as described in ***Section III.8***. (💻 http://intranet.dnr.state.wi.us/int/at/et/). These codes are stored in [MUNI_TYPE_CODE], [MCD_CODE] and [FIPS_CODE] data fields, and are used in parcel identifiers.

IV. LOCATIONAL DATA QUALITY CONSIDERATIONS

Producers and users of DNR's locational data must consider the following factors and situations when assessing the quality of feature locations in a DNR data set, application or system.

1. "ORIGINALLY COLLECTED" VERSUS "DERIVED" FEATURE LOCATIONS

a) Originally Collected Feature Locations

Capturing the following data about how a feature's location was originally collected is critical for determining the quality of the data. Because most significant error is introduced during data collection activities, noting the following conditions and characteristics is as important as collecting the original *x-y* coordinates! See ***Section V.1*** for descriptions of the standard data fields in which these data must be stored.

- **Program-defined feature identifier**
- **Original horizontal/vertical data collection method**
- **Original horizontal/vertical referencing system**
- **Original data collection date**
- **Original data source year**
- **Original data source scale or resolution**
- **Program-defined site identifier**
- **Feature type**
- **Feature geometric representation**
- **Original data collection tool**
- **Original data collector name**

b) Derived Feature Locations – Projection & Geo-Coding

Many times, a feature's x-y coordinates are derived from originally collected feature locations – or – from other derived coordinates in a different referencing system. For example, many private drinking water wells are originally located by Public Land Survey System (PLSS) description (e.g., NE NW S.34 T.12N R.23E). Wisconsin Transverse Mercator (WTM) coordinates are then derived from these PLSS descriptions, so that the data can be used in enterprise GIS applications and systems. Latitude/Longitude values may also be derived from the WTM coordinates for EPA reporting purposes.

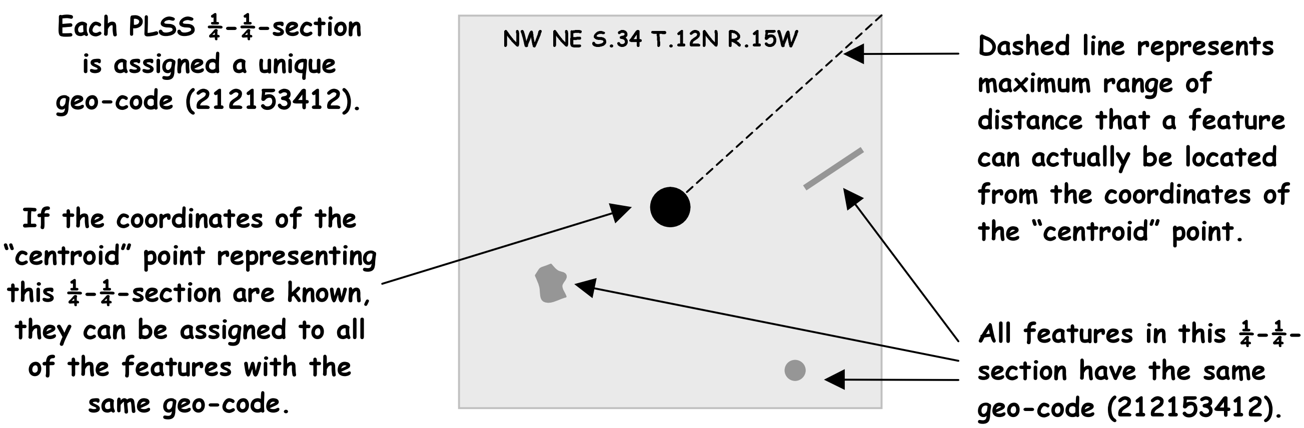
In this case, knowing the referencing system in which the well data were *originally collected* is vital for assessing the accuracy of the derived coordinates. The accuracy of derived coordinates is no better than the accuracy of the originally collected feature location from which they are derived! So…the WTM91 coordinates and latitude/longitude values for these wells are no more accurate than the PLSS descriptions from which they were derived. Deriving coordinates from other derived coordinates must be done carefully in order to avoid compounding errors and losing track of the real accuracy of the data! Coordinates are derived from other referencing systems using *projection* or *geo-coding* methods, as described below.

> **Refer to the companion document, *Location Matters: Locational Data Basics*, (expected completion in Spring, 2001) for more information about coordinate and relative referencing systems, GIS framework data layers, and related topics!**

Projecting X-Y Coordinates from Other Coordinates: Because a coordinate system is a mathematically derived framework of *x-y* coordinates, coordinates stored in tabular databases and GIS data sets can be "projected" to derive other coordinates. Projection involves mathematically converting coordinates into another coordinate system (e.g., WTM into Latitude/Longitude), or changing the spheroid or datum to which the coordinates are referenced (e.g., NAD27 into NAD91). When using appropriate GIS tools and methods, projection errors for *x-y* coordinates are generally less than one meter. DNR does not have the capability to project vertical data between different vertical datums at this time!

DNR's *Projection Service* can help DNR staff project their locational data. Information about this service can be found at http://intranet.dnr.state.wi.us/int/at/et/GEO/prj_srvc.htm. Future releases of ArcGIS products are also expected to include "projection-on-the-fly" functionality. These products are not yet widely available, and their projection capabilities must still be tested and documented for use with DNR data sets, systems and applications!

Geo-coding Coordinates from Relative Referencing System Locations: Relative referencing systems assign a unique *geo-code* to specify the horizontal location of a feature. Public Land Survey System description, street address, and various management units are examples of commonly used relative referencing systems. The location of the feature is considered "relative" because the same geo-code references *all* of the features within a "unit" of the specified referencing system (e.g., PLSS grid cell, street address, management unit). The following diagram shows how geo-codes are assigned to features in a PLSS ¼-¼-section.



Each referencing system "unit" is represented by its "centroid" point, which is also assigned the geo-code of the unit. The x-y coordinates of that centroid point can be assigned to *all* the features within that unit. One result is that the true location of features in the unit may be some distance away from the centroid (see dashed line in the above illustration). In addition, all features in the same geo-coded unit will have identical x-y coordinates, and will appear "stacked" when displayed in a GIS.

DNR has added a centroid look-up table to ArcSDE/Oracle which allows users to get *x-y* coordinates, in either latitude/longitude or WTM91, that match PLSS descriptions (see

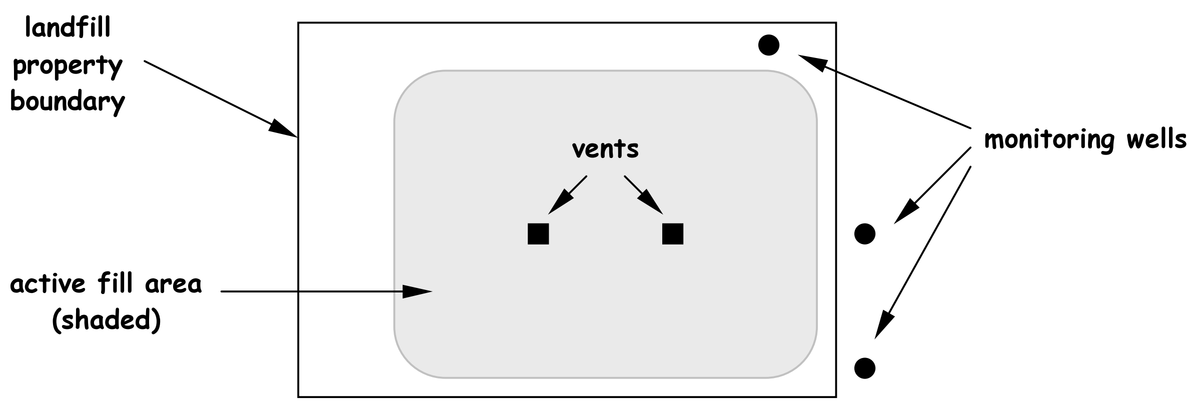
Section VII.2). DNR has also acquired software for deriving latitude/longitude coordinates from street addresses (see ***Section VII.4***).

c) DNR Framework GIS Data Layers

Linking locational data to one of the DNR GIS "framework" data layers is another way to derive feature coordinates. When appropriate, existing locational data in a tabular database or in another GIS data layer can be "snapped" to a framework layer (e.g., surface water, PLSS landnet) via customized tools. This method facilitates quality checking, integration and display of the data. See ***Section V.4*** and ***Section VIII.5*** for more information about GIS framework data layers.

2. AVOIDING CONFUSION: MULTIPLE FEATURES AT ONE SITE

The locations of several different types of features are often collected at or associated with one "site" (e.g., facility, property), as shown in the landfill example below. Depending on specific business needs, features of interest at a site can be located *individually*, or the site *as a whole* can represent some or all of the features located within or associated with it. Assigning a unique *Program-defined Site Identifer*, a unique *Program-defined Feature Identifier*, and a *Feature Type Code* to each feature can minimize any potential confusion. The link between the *Program-defined Site Identifier* and the *Program-defined Feature Identifier* can be thought of as a "parent-child" relationship (e.g., one or more "child" features associated with a "parent" site).



3. AVOIDING CONFUSION: MULTIPLE LOCATIONS FOR ONE FEATURE

The location of one feature is often collected many times by different DNR programs using different data collection methods to meet different business needs. The result is multiple locations for one feature that may (1) exist in different referencing systems, (2) have different accuracy, (3) characterize the feature differently (e.g., represent the feature as a point versus an area), or (4) exhibit some combination of 1–3 above. This approach can complicate the ability of producers and users of DNR's locational data to:

- know which location is the most accurate for a feature.
- keep multiple locations for a feature "in sync" (e.g., in the same general vicinity).
- retire/replace appropriate locational data when more accurate data become available.
- decide if multiple locations represent the *site as a whole* or if they represent *individually located features* associated with that site (see ***Section IV.2*** above).

Ideally, the following recommendations can help producers and users avoid confusion associated with multiple locations originally collected or derived for one feature.

➢ Whenever possible, capture the location of a feature only once, using the most applicable, accurate data collection method for the project. (*Assumes that the data may be re-captured if a more accurate data collection method and resources become available*).

➢ Whenever possible, use existing feature location data originally collected by another producer. (*Assumes that the data will adequately support the user's specific needs*).

➢ Whenever possible, derive coordinates from a feature's originally collected location, and not from other derived coordinates. (*Assumes that if multiple locations for one feature exist, the most accurate location is used as the source for deriving other coordinates*).

➢ Always capture the required and recommended "originally collected" data elements described in ***Section V.I***.

➢ Whenever possible, retire/replace a feature's locational data when more accurate data become available. (*DNR must develop and document department-wide procedures and rules for retiring/replacing feature location data. And, these rules and procedures must support program specific business needs.*)

V. COLLECTING HORIZONTAL LOCATIONAL DATA

Horizontal locational data describe the *x-y* positions of real-world features on a horizontal datum that represents the surface of the Earth. This section describes the required, recommended, and optional data elements associated with horizontal locational data collection activities. For the purposes of these standards, ***horizontal data collection activities*** involve the capture of feature locations and related data ***in the field*** (e.g., GPS or terrestrial surveying) or ***in the office*** (e.g., on-table or on-screen digitizing).

> **Refer to the companion document, *Location Matters: Locational Data Basics*, (expected Spring, 2001) for more detailed explanations about coordinate systems, relative referencing systems, GIS framework data layers, and related topics!**

Locational and non-locational data for a feature may be collected separately, or at the same time, depending on the collector's specific business needs and the data collection method used. For example, programs often assign unique identifiers to features prior to data collection activities, and these identifiers may reside in existing database systems or applications along with related attribute data. Noting the assigned unique identifier during data collection activities can help the collector link all locational and non-locational data for that feature together.

1. "ORIGINALLY COLLECTED" HORIZONTAL DATA ELEMENTS

Regardless of the data collection method or referencing system used, capturing data about *how* a feature's horizontal location was "originally collected" is critical for assessing the quality of the data, and the quality of any other data derived from them. The following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

"ORIGINALLY COLLECTED" HORIZONTAL DATA ELEMENTS

DATA ELEMENT DESCRIPTION	COLLECTION REQUIREMENT
A program intending to collect horizontal feature locations is required to collect, assign, know, or otherwise note the following 10 data elements (shaded) for all features.	
Program-defined Feature Identifier: Program-defined unique character or numeric identifier assigned to the feature being located. Example: WI Unique Well Number.	**Required for all located features**
Original Horizontal Collection Method Code: Code indicating the method by which the feature's horizontal location was originally collected. See ***Appendix B.1***.	
Original Horizontal Referencing System Code: Code indicating the referencing system in which the feature's horizontal location was originally collected. See ***Appendix B.2***.	
Original Horizontal Collection Date: Date on which the feature's horizontal location was originally collected.	

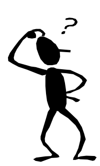
Attachment 3 to MNRD Non-Local Beings Report

Original Horizontal X-Axis Coordinate Amount: Originally collected *x-axis* coordinate for point features in a tabular database system or application. *X-axis* coordinates include Easting and Longitude values.	**Required for applicable referencing systems**
Original Horizontal Y-Axis Coordinate Amount: Originally collected *y-axis* coordinate for point features in a tabular database system or application. *Y-axis* coordinates include Northing and Latitude values.	
Original Horizontal Source Year: The year that the source (e.g., map, imagery, DOP), from which the feature's horizontal location was originally collected, was created, published, updated, revised, flown, etc.	
Original Horizontal Source Denominator Amount: Scale denominator of the source (e.g., map, DOP photo base) from which the feature's horizontal location was originally colleted. Example: 24000 for 1:24,000 scale.	
Original Horizontal Image Resolution Amount: Pixel resolution of the raster source (e.g., satellite imagery, DOP, DRG) from which the feature's horizontal location was originally collected.	
Original Horizontal Image Resolution Units: Pixel resolution unit of the raster source (e.g., satellite imagery, DOP, DRG) from which the feature's horizontal location was originally collected.	

A program intending to collect horizontal feature locations is recommended to collect, assign, know, or otherwise note the following 6 data elements for all features.

Feature Type Code: Code indicating the type of feature being located. See ***Appendix B.3***. Required for some EPA reporting activities.	**Recommended for all located features**
Program-defined Site Identifier: Program-defined unique character or numeric identifier assigned to the site (e.g., facility, property, area) at which the feature is being located. Examples: FID, DNR Property Code.	
Feature Geometric Representation Code: Code indicating how the feature being located is geometrically represented. See ***Appendix B.4***. Required for some EPA reporting activities.	
Original Horizontal Collection Method Text: Additional detail about the method by which the feature's horizontal location was originally collected. See ***Appendix B.1***.	
Original Horizontal Collection Tool Code: Code indicating the tool used during the original collection of the feature's horizontal location. See ***Appendix B.5*** for domain.	
Original Horizontal Collector Name: DNR user ID (e.g., SMITHJ) or name of the person who originally collected the feature's horizontal location.	

The location of a feature may be originally collected in one of the following referencing systems:



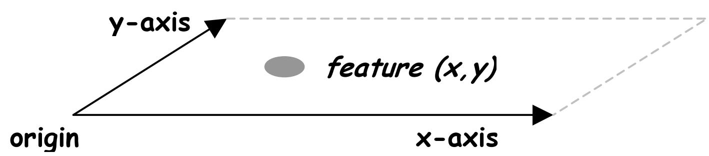
x-y coordinate system
"relative" referencing system
GIS "framework" data layer

Refer to the companion document, *Location Matters: Locational Data Basics*, (expected completion in Spring, 2001) for more detailed explanations of map projections, datums/spheroids, and specific coordinate systems!

2. COLLECTING *X-Y* COORDINATES

A coordinate system is a mathematically derived framework of *x-y* coordinates. Each coordinate system is defined by its unique combination of (1) *x-axis* and *y- axis* origins, (2) measurement unit, (3) reference datum or spheroid, and (4) map projection (if applicable). Theoretically, the location of *every* point on Earth's surface can be described by a unique *x-y* coordinate. DNR programs and external partners commonly collect the locations of features in one of the following *x-y* coordinate systems:

- **Wisconsin Transverse Mercator (WTM)**
- **Latitude/Longitude (LL)**
- **Universal Transverse Mercator (UTM)**
- **State Plane (SP)**
- **County Coordinate System (CCS)**



a) Collecting Wisconsin Transverse Mercator (WTM) Coordinates

Wisconsin Transverse Mercator (WTM) eastings (*x-axis*) and northings (*y-axis*) are always expressed in meters, and can be referenced to any datum. The WTM coordinate system referenced to NAD91/HPGN is known as the ***WTM91*** referencing system. All of DNR's GIS framework data layers are stored and managed in the WTM91 referencing system to simplify access to and use of these data sets. This also minimizes costs associated with developing and maintaining redundant data in multiple referencing systems. Please note that published USGS maps typically only show LL, UTM, and SP coordinates, and the Public Land Survey System section grid, but do not show WTM coordinates, because they are based on a "custom" map projection!

A DNR program intending to collect feature locations in a WTM referencing system should capture WTM91 coordinates, whenever possible. If a data collection method or tool does not allow WTM coordinates to be referenced to NAD91/HPGN, these coordinates should be referenced to (*in order of preference*): (1) NAD83 – the *WTM83* referencing system or (2) NAD27 - the *WTM27* referencing system.

WTM91 eastings and northings must have eight digits, with two to the right of the decimal point (e.g., 345678.12). Valid WTM91 coordinate ranges are:

	WTM91 NORTHING	WTM91 EASTING
Minimum Value:	211,000.00 m	285,000.00 m
Maximum Value:	740,000.00 m	776,000.00 m

If a DNR program intends to capture WTM91 coordinates, the following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

WISCONSIN TRANSVERSE MERCATOR (WTM) DATA ELEMENTS	
DATA ELEMENT DESCRIPTION	**COLLECTION REQUIREMENT**

A program intending to collect WTM91 coordinates is required to capture the following 2 data elements (shaded), in addition to all other required "originally collected" data elements.

WTM91 Easting (X) Amount: WTM91 Easting defined as meters East of the WTM coordinate system y-axis based on the 1991 adjustment of the North American Datum of 1983 – GRS80 spheroid. Example: 652342.12.	**Required for all feature locations collected in WTM91**
WTM91 Northing (Y) Amount: WTM91 Northing defined as meters North of the WTM coordinate system x-axis based on the 1991 adjustment of the North American Datum of 1983 – GRS80 spheroid. Example: 652342.12.	

b) *Collecting Latitude/Longitude (LL) Coordinates*

In Wisconsin, latitudes (*y-axis*) are unsigned, positive values that increase from south to north, and are assumed north (N) of the Equator (e.g., 43.2936076 N). Longitudes (*x-axis*) are signed values (negative in the western hemisphere, e.g., -89.2534610 W), that increase from west to east (i.e., as the numeric value gets smaller, or closer to 0), with 0 degrees longitude being set at the Prime "Greenwich" Meridian in England.

Technically, latitude/longitude (LL) coordinates are referenced to a "spheroid" rather than to a "datum" since LL is a *spherical* system and not a *planar* one like WTM (i.e., datums only apply to planar coordinate systems). Whenever possible, non-survey level LL coordinates should reference (*in order of preference*): (1) the WGS84 spheroid or (2) the GRS80 spheroid. The difference in horizontal accuracy between these two common spheroids is in the millimeters range. Therefore, noting the particular spheroid is only necessary for survey-level applications, or when a spheroid other than WGS84 or GRS80 is used.

Some data collection methods or tools do not allow LL coordinates to be referenced to the WGS84 or GRS80 spheroid, or they only allow the data to be referenced to a datum rather than a spheroid. In these cases, LL coordinates should reference (*in order of preference*): (1) NAD91/HPGN, (2) NAD83, or (3) another spheroid. Valid Wisconsin LL coordinate ranges (WGS84 or GRS80 spheroid) are:

	LATITUDE	LONGITUDE
Minimum Value:	42.5000000 (DD) 42° 30′ 00.0000″ (DMS)	-93.0000000 (DD) -93° 00′ 00.0000″ (DMS)
Maximum Value:	47.5000000 (DD) 47° 30′ 00.0000″ (DMS)	-86.5000000 (DD) -86° 30′ 00.0000″ (DMS)

Decimal Degrees (DD) Versus Degrees/Minutes/Seconds (DMS) Notation: LL coordinates can be collected and stored in decimal degrees (DD), degrees/minutes/seconds (DMS), or other notations. Examples of DD and DMS notation for the same coordinates are shown below.

	DD NOTATION	DMS NOTATION
Latitude	43.2936076	43° 17' 36.9878
Longitude	-89.2534610	-89° 15' 12.4597

Whenever possible, LL coordinates should be collected and stored in decimal degrees. DD notation is much easier to use in mathematical calculations and in GIS applications. If LL coordinates are collected in DMS or other notation, they can be converted into DD as shown in the example below (e.g., converting 43° 17' 36.9878 DMS into 43.2936076 DD).

$$43\,\text{deg} + \left(\frac{17\,\text{min}}{60\,\text{min/deg}}\right) + \left(\frac{36.9878\,\text{sec}}{3{,}600\,\text{sec/deg}}\right) = 43\,\text{deg} + 0.2833333\,\text{deg} + 0.0102743\,\text{deg} = 43.2936076\,DD$$

LL Precision & Accuracy Considerations: DNR programs should collect LL coordinates to the appropriate accuracy level, based on their specific business needs and the capabilities of the data collection method or tool. As indicated in the table below, LL coordinates accurate to the centimeter level would have nine digits, with seven digits to the right of the decimal point (e.g., 45.1234567). However, the data collection method, and not the number of "significant digits" in coordinates, should be used to assess the accuracy of feature locations in a data set!

LL "Unit"	Accuracy Level (in meters)	Digit left/right of decimal point (in DD notation)	Latitude* (along Y-axis) Average Distance		Longitude** (along X-axis) Average Distance	
			meters	*feet*	*meters*	*feet*
Degree	10,000s – 100,000s meters	1st & 2nd left	111,045	364,316	78,849	258,688
Minute	1,000s meters	1st & 2nd right	1,851	6,072	1,314	4,311
Second	10s meters	3rd & 4th right	31	101	22	72
10th Second	1s meters	5th right	3	10	2	7
100th Second	10th meter	6th right	0.3	1	0.2	0.7
1,000th Second	100th meter (centimeter)	7th right	0.03	0.10	0.02	0.07

* (Conversion table from: Brinker, R.C. and P. R. Wolf, 1984) ** (Conversion table from: Robinson, A. H., *et. al.*, 1984)

If a DNR program intends to capture LL coordinates, the following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

LATITUDE/LONGITDUE DATA ELEMENTS	
DATA ELEMENT DESCRIPTION	**COLLECTION REQUIREMENT**

A program intending to collect LL coordinates (referenced to WGS84 or GRS80 spheroid) is required to capture the following 2 data elements (shaded), in addition to all other required "originally collected" data elements.

Latitude Decimal Degree Amount: Decimal degrees of latitude North of the equator based on the WGS84 or GRS80 spheroid. Example: 42.1234567.	**Required for all feature locations collected in LL**
Longitude Decimal Degree Amount: Decimal degrees of longitude West of the Prime (Greenwich) Meridian based on the WGS84 or GRS80 spheroid. Example: -93.1234567.	

The following 6 data elements are optional for programs intending to collect LL coordinates in degrees, minutes, and seconds (DMS) notation (referenced to WGS84 or GRS80 spheroid).

Latitude Degree Amount: Degrees of latitude north of the equator based on the WGS84 or GRS80 spheroid.	**Optional**
Latitude Minute Amount: Minutes of latitude north of the equator based on the WGS84 or GRS80 spheroid.	
Latitude Second Amount: Decimal seconds of latitude north of the equator based on the WGS84 or GRS80 spheroid.	
Longitude Degree Amount: Degrees of longitude West of the Prime (Greenwich) Meridian based on the WGS84 or GRS80 spheroid.	
Longitude Minute Amount: Minutes of longitude West of the Prime (Greenwich) Meridian based on the WGS84 or GRS80 spheroid.	
Longitude Second Amount: Decimal seconds of longitude West of the Prime (Greenwich) Meridian based on the WGS84 or GRS80 spheroid.	

c) *Collecting Other X-Y Coordinates*

DNR programs often collect feature locations in coordinate systems other than WTM91 and LL to support specific business needs. A complete list of these coordinate systems is presented in the *Referencing System Codes* list (***Appendix B.2***). Standards for collecting *x-y* coordinates in some of the more common of these systems are described below. Regardless of the coordinate systems used, a DNR program must collect *x-y* coordinates to the appropriate accuracy level, based on its specific business needs and the capabilities of the data collection method or tool.

Universal Transverse Mercator (UTM) Coordinates: UTM eastings (*x-axis*) and northings (*y-axis*) are always expressed in meters. Wisconsin is divided roughly in half by two UTM zones – "western" zone 15 and "eastern" zone 16. Each zone has its own coordinate grid, which results in unsigned, positive coordinate numbers**.** A DNR program intending to collect UTM coordinates should reference them to one of the following datums (*in order of preference*): (1) NAD91/HGPN – the *UTM91* referencing system or (2) NAD83 - the *UTM83* referencing system. Valid Wisconsin UTM91 coordinate ranges are:

	MIN. NORTHING	MAX. NORTHING	MIN. EASTING	MAX. EASTING
UTM91 Zone 15	4,707,000.00	5,223,000.00	500,000.00	757,000.00
UTM91 Zone 16	4,691,000.00	5,141,000.00	243,000.00	520,000.00

UTM91 northings may have up to nine digits, with two digits to the right of the decimal point (e.g., 4712345.12), and eastings may have up to eight digits, with two to the right of the decimal point (e.g., 510654.12). However, the data collection method, and not the number of "significant digits" in coordinates, should be used to assess the accuracy of feature locations in a data set!

State Plane (SP) Coordinates: SP eastings (*x-axis*) and northings (*y-axis*) may be expressed in feet or meters, depending on the datum. Wisconsin is divided into three SP zones – north, central and south. Each zone has its own coordinate grid, which results in unsigned, positive coordinate numbers. SP coordinates are commonly used by county or local agencies, and for survey-level data collection activities. A DNR program intending to collect SP coordinates should reference them to one of the following datums (*in order of preference*): (1) NAD91/ HGPN – the *SP91* referencing system or (2) NAD83 – the *SP83* referencing system. Valid Wisconsin SP91 coordinate ranges are:

	MIN. NORTHING	MAX. NORTHING	MIN. EASTING	MAX. EASTING
SP91 North Zone	22,860.00	218,237.00	365,304.00	854,813.00
SP91 Central Zone	4,572.00	244,450.00	365,304.00	855,118.00
SP91 South Zone	41,758.00	281,026.00	410,414.00	800,254.00

Both SP91 eastings and northings may have up to eight digits, with two digits to the right of the decimal point (e.g., 471234.12).). However, the data collection method, and not the number of "significant digits" in coordinates, should be used to assess the accuracy of feature locations in a data set!

County/Local Coordinate Systems: A unified set of coordinate systems for Wisconsin counties has been developed. This Wisconsin County Coordinate System (CCS) is designed so that each county (or group of neighboring counties) has its own coordinate system referenced to NAD91/HPGN. In addition, a county or local entity may create a customized coordinate system to meet specific business needs. Please refer to the *Wisconsin Coordinate Systems* (Wisconsin State Cartographer's Office. 1995) for more information about county/local coordinate systems.

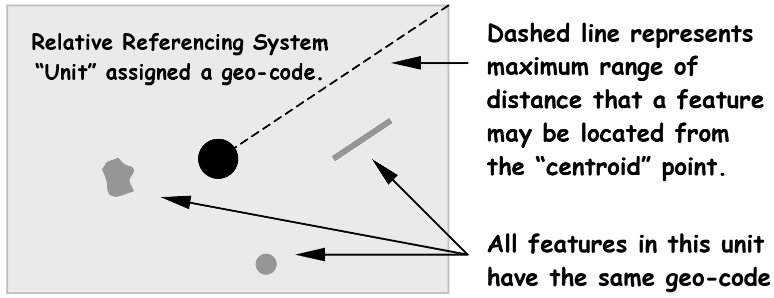
Other Coordinate Systems: The *Referencing System Codes* list (***Appendix B.2***) contains common referencing systems used by DNR staff and external partners. Requests to add new referencing systems to this list can be emailed via **DNR's Locational Data Standards** homepage: http://www.dnr.state.wi.us/org/at/et/geo/location/loc_stds.html. BEITA's Enterprise Data Management Section also intends to add the *parameters* of each coordinate system to a future version of this list. These parameters will describe characteristics (e.g., spheroid, datum, origins, offsets) of these referencing systems to help DNR programs complete the metadata for their data sets (see ***Section IX***). These parameters will also facilitate "on-the-fly" projection functions available in new ArcGIS products.

3. COLLECTING "RELATIVE REFERENCING SYSTEM" LOCATIONS

Refer to the companion document, *Location Matters: Locational Data Basics*, (expected completion in Spring, 2001) for more detailed explanations of relative referencing systems and related topics, including the Public Land Survey System, parcel descriptions, and street addresses!

As described in ***Section IV.1.b***, relative referencing systems assign a unique geo-code to specify the horizontal location of a feature. The location of the feature is considered "relative" because the same geo-code references *all* of the features within a "unit" of the specified referencing system. In addition, the coordinates of the centroid point representing the unit can be assigned to the features in that unit (i.e., features that can be represented by a point). DNR programs and external partners commonly collect the locations of features in the following relative referencing systems:

- **Public Land Survey System (PLSS)**
- **Parcel Description**
- **Street Address**



a) Collecting Public Land Survey System (PLSS) Descriptions

The Public Land Survey System (PLSS) consists of a series of semi-regular grids, defined by state statute and administrative codes, which cover most of Wisconsin. Some parts of Wisconsin are not included in the PLSS! Townships (*y-axis*) and Ranges (*x-axis*) form the highest PLSS grid level. Townships increase from south to north, while Ranges increase to the west (for western Wisconsin) or to the east (for eastern Wisconsin) of a line centered on the 4th Principal Meridian. Valid ranges for Wisconsin's Township/Range grid cells are:

Township North (N)	Range West (W)	Range East (E)
1 – 53 N	1 – 20 W	1 – 30 E

Each Township/Range grid cell is divided into 36 sections, nominally 1 mile on a side. Sections are quartered to create a ¼-section grid, ¼-sections are quartered to create a ¼-¼-section grid, and so on. No PLSS grid cell, at any level, is a perfect square! A DNR program must collect PLSS descriptions to the appropriate accuracy level (i.e., ¼-section level or smaller), based on its business needs and the capabilities of the collection method or tool.

PLSS Quarter Codes: The following *PLSS Quarter Codes* must be captured and used in all DNR database systems and applications in which quarters of PLSS sections and smaller grid cells are described. Storage of numeric PLSS quarter codes is required – equivalent character codes may be stored *only in addition to* numeric codes.

Numeric Codes	Character Codes	Section/Quarter Description
0	UN	Unknown or Undefined Quarter
1	NE	Northeast Quarter of Section/Quarter
2	NW	Northwest Quarter of Section/Quarter
3	SW	Southwest Quarter of Section/Quarter
4	SE	Southeast Quarter of Section/Quarter
5	N2	North Half of Section/Quarter (NE + NW Quarters)
6	W2	West Half of Section/Quarter (NW + SW Quarters)
7	S2	South Half of Section/Quarter (SE + SW Quarters)
8	E2	East Half of Section/Quarter (NE + SE Quarters)
9	AQ	All Quarters of Section/Quarter (NE + NW + SE + SW Quarters)

Attachment 3 to MNRD Non-Local Beings Report

PLSS Precision & Accuracy Considerations:

The following table shows the approximate acreage, maximum distance from the centroid point, and dimensions of idealized PLSS grid cell units. DNR programs can use this information to assess which grid cell level best supports their specific business needs.

PLSS Grid Cell	Approximate Acres	Approximate Maximum Distance from Centroid	Approximate Dimensions	
			meters	***feet***
Township/Range	23,040	6,828 meters	9,656 x 9656	31,680 x 31,680
Section	640	1,138 meters	1,609 x 1,609	5,280 x 5,280
¼ Section	160	569 meters	804 x 804	2,640 x 2,640
¼ ¼ Section	40	284 meters	402 x 402	1,320 x 1,320
¼ ¼ ¼ Section	10	141 meters	201 x 201	660 x 660
¼ ¼ ¼ ¼ Section	2.5	71 meters	100 x 100	330 x 330

Special Tracts NOT included in the PLSS: The following table describes non-standard survey areas (or "tracts") in Wisconsin that are not included in the PLSS. The Wisconsin Land Information Association (WLIA) and other state agencies have also adopted these codes. When a feature is located in one of these tracts, the value 0 must be captured for the *PLSS Section Number* and *PLSS Quarter-Section Number* data elements.

PLSS TRACT TYPE CODE	TRACT TYPE DESCRIPTION
05	Government Lot
06	Native American Claim (e.g., former reservations east of Lake Winnebago)
07	Mining Claim
08	Private Claim (e.g., lots north of Kaukauna, except those in Brown County)
09	Military Reserve (e.g., reserve in Green Bay)
10	Named grant or tract (e.g., "Williams Grant")
11	Farm Lot (e.g., in Prairie du Chien)
12	Upper Village Lot (e.g., in Prairie du Chien)
13	Half Range (e.g., resurvey area between Marinette and Oconto Counties)
14	Island
15	Main Village Lot (e.g., in Prairie du Chien)
16	Outagamie-Fox Elongated PLSS (along Fox River in Outagamie County)
28	Private Claim northwest of Fox River in Brown County
38	Private Claim southeast of Fox River in Brown County

Features Located in Multiple PLSS Grid Cells: Some features lie partially or wholly within multiple PLSS sections, ¼-sections, etc. How the PLSS descriptions for these features are collected depends on the business needs of the program, and the data model upon which the database system or application is built. One method is to collect multiple PLSS descriptions for one feature and store them as multiple records in a database system or application. Another technique involves using the following precedence rules to capture one PLSS description for the feature:

1) If appropriate, use the *PLSS Quarter Codes* above to describe the ½-section or ½-quarter in which the feature is located.
2) If the feature is located in more than one ½-section or ½-quarter, use the PLSS codes of the area within which the majority of the feature lies.
3) If relatively equal portions of the feature lie within several sections/quarters, use the codes of the easternmost area.
4) If there are multiple eastern areas of relatively equal portions, use the codes of the southernmost of these eastern areas.

If a DNR program intends to capture PLSS descriptions, the following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

PUBLIC LAND SURVEY SYSTEM (PLSS) DATA ELEMENTS

DATA ELEMENT DESCRIPTION	COLLECTION REQUIREMENT
A program intending to collect PLSS descriptions is required to capture the following 8 data elements (shaded), in addition to all other required "originally collected" data elements.	
PLSS Range Direction Numeric Code: Numeric code for the PLSS Range direction East or West of the 4th Principal Meridian.	**Required for all PLSS descriptions**
PLSS Township Identifier: PLSS Township (number) identifier.	
PLSS Range Identifier: PLSS Range (number) identifier.	
PLSS Section Identifier: PLSS Section (number) identifier. Capture "0" when feature is located in a non-standard PLSS tract.	
PLSS Quarter-Section Numeric Code: Numeric PLSS quarter-section code. See *PLSS Quarter Codes* above. Capture "0" when feature is located in a non-standard PLSS tract.	
PLSS Tract Type: Code representing the type of non-standard PLSS tract. See *Special Tracts NOT Included in the PLSS* above for domain.	**Required for all non-standard PLSS descriptions**
PLSS Entity Code: Code of the non-standard PLSS tract.	
A program intending to collect PLSS descriptions is recommended to capture the following 3 data elements, in addition to all other required PLSS and "originally collected" data elements.	
PLSS Quarter-Quarter-Section Numeric Code: Numeric PLSS quarter-quarter-section code. See *PLSS Quarter Codes* above. Capture "0" when feature is located in a non-standard PLSS tract.	**Recommended for all PLSS descriptions**
DNR County Code: DNR code for the county in which the feature is located. See ***Appendix B.6***.	
PLSS DTRSQQ Code: Geo-code for PLSS description. Created by concatenating the contents of the following data elements (and adding leading zeros where appropriate): *PLSS Range Direction Numeric Code* (1st digit); *PLSS Township Number* (2nd & 3rd digits); *PLSS Range Number* (4th & 5th digits); *PLSS Section Number* (6th & 7th digits); *PLSS Quarter-Section Numeric Code* (8th digit); and *PLSS Quarter-Quarter-Section Numeric Code* (9th digit). Example: 412230523.	**Recommended for all PLSS descriptions of features represented by the centroid point (i.e., not the area) of the PLSS unit**

The following 7 data elements are <u>optional</u> for programs intending to collect PLSS descriptions.

PLSS Quarter-Quarter-Quarter-Section Numeric Code: Numeric PLSS quarter-quarter-quarter-section code. See *PLSS Quarter Codes* above. Capture "0" when feature is located in a non-standard PLSS tract. Must be equivalent to *PLSS Quarter-Quarter-Quarter-Section Character Code* value.	**Optional**
PLSS Quarter-Quarter-Quarter-Quarter-Section Numeric Code: Numeric PLSS quarter-quarter-quarter-quarter-section code. See *PLSS Quarter Codes* above. Capture "0" when feature is located in a non-standard PLSS tract. Must be equivalent to *PLSS Quarter-Quarter-Quarter-Quarter-Section Character Code.*	
PLSS Range Direction Character Code: Character code for the PLSS Range direction East or West of the 4th Principal Meridian. Must be equivalent to *PLSS Range Direction Numeric Code*.	
PLSS Quarter-Section Character Code: Character PLSS quarter-section code. See *PLSS Quarter Codes* above. Capture "UN" when feature is located in a non-standard PLSS tract. Must be equivalent to *PLSS Quarter-Section Numeric Code* value.	
PLSS Quarter-Quarter-Section Character Code: Character PLSS quarter-quarter-section code. See *PLSS Quarter Codes* above. Capture "UN" when feature is located in a non-standard PLSS tract. Must be equivalent to *PLSS Quarter-Quarter-Section Numeric Code*.	
PLSS Quarter-Quarter-Quarter-Section Character Code: Character PLSS quarter-quarter-quarter-section code. See *PLSS Quarter Codes* above. Capture "UN" when feature is located in a non-standard PLSS tract. Must be equivalent to *PLSS Quarter-Quarter-Quarter-Section Numeric Code*.	
PLSS Quarter-Quarter-Quarter-Quarter-Section Character Code: Character PLSS quarter-quarter-quarter-quarter-section code. See *PLSS Quarter Codes* above. Capture "UN" when feature is located in a non-standard PLSS tract. Must be equivalent to *PLSS Quarter-Quarter-Quarter-Quarter-Section Numeric Code*.	

b) Collecting Parcel Descriptions

These standards define a "parcel" as an <u>area of real property that can be defined by its geographic extent (i.e., location, shape, boundaries) and its legally recognized ownership</u>. Parcel boundaries are usually described in narrative format on deeds. DNR's standard parcel data elements are compatible with the data exchange standards adopted by the Wisconsin Land Information Program (WLIP), WLIA and the "Uniform Parcel Number" format developed by the Wisconsin DOR and the Real Property Listers Association.

The terms "parcel identifier" and "parcel number" have specific meanings for the purposes of these standards. A <u>parcel identifier</u> is created by concatenating (or "stringing together") the following data elements, usually in the stated order: (1) *DOR County Code*, (2) *Municipality Type Code*, (3) *Minor Civil Division Code*, (4) *PLSS Range Direction Numeric Code*, (5) *PLSS Township Identifier*, (6) *PLSS Range Identifier*, (7) *PLSS Section Identifier*, (8) *PLSS Quarter-Section Numeric Code* and *PLSS Quarter-Quarter-Section Numeric Code* **OR** *PLSS Tract Type* and *PLSS Entity Code* (for non-standard tracts), and (9) *Parcel Number*.

The <u>parcel number</u> is just one component of the entire parcel identifier. Standard parcel numbers have 4 digits and are usually unique within a ¼-section or non-standard PLSS tract (see ***Section V.3.a***). Some counties, however, assign non-standard (i.e., 5+ digits) parcel numbers.

Assigning Parcel Identifiers: DNR does not assign parcel numbers or any other parcel identifier component! County/local Real Property Listers assign and maintain parcel identifiers for their jurisdictions. DNR receives parcel identifiers in one of two formats: (1) broken (or "parsed") into its individual components or (2) concatenated as one number, with or without dashes separating its individual components. Whenever possible, the individual components of the parcel identifier should be captured and stored in their respective data fields. If a DNR program is unable to distinguish or separate these components, it should ask the appropriate county/local agency to identify them – and also store the concatenated parcel identifier in the [PARCEL_NO] data field.

If a DNR program intends to capture parcel descriptions, the following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

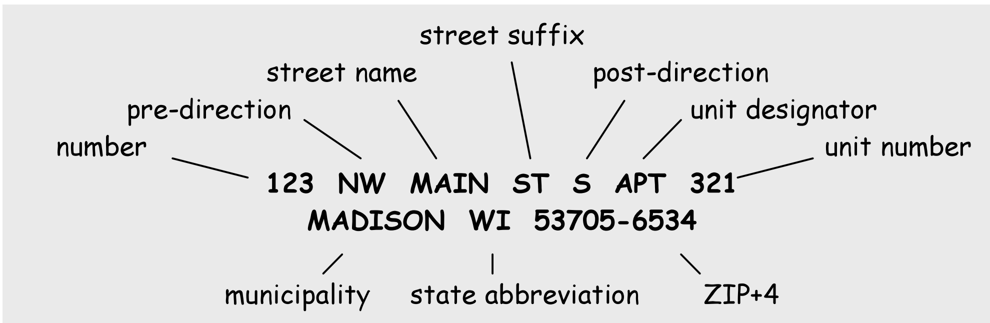
PARCEL DESCRIPTION DATA ELEMENTS

DATA ELEMENT DESCRIPTION	COLLECTION REQUIREMENT
A program intending to collect parcel descriptions is required to capture the following 12 data elements (shaded), in addition to all other required "originally collected" data elements.	
DOR County Code: Wisconsin Department of Revenue code for the county in which the feature is located. See ***Appendix B.6***.	**Required for all parcel descriptions**
Municipality Type Code: Numeric code representing the type of municipality in which the parcel is located. See ***DW_MCD*** table via the *DAMenu* application (***Section III.8***).	
Minor Civil Division Code: Numeric code representing the specific minor civil division in which the parcel is located. See ***DW_MCD*** table via the *DAMenu* application (***Section III.8***).	
PLSS Range Direction Numeric Code (See ***Section V.3.a*** for definition)	
PLSS Township Identifier (See ***Section V.3.a*** for definition)	
PLSS Range Identifier (See ***Section V.3.a*** for definition)	
PLSS Section Identifier (See ***Section V.3.a*** for definition)	
PLSS Quarter-Section Numeric Code (See ***Section V.3.a*** for definition)	
PLSS Quarter-Quarter-Section Numeric Code (See ***Section V.3.a*** for definition)	
PLSS Tract Type (See ***Section V.3.a*** for definition)	
PLSS Entity Code (See ***Section V.3.a*** for definition)	
Parcel Number: Standard or non-standard parcel number assigned by county/local "Real Property" Lister. May include dashes.	
The following 1 data element is optional for programs intending to collect parcel descriptions.	
Federal Information Processing System (FIPS) Code: Numeric FIPS code. See ***DW_MCD*** table via the *DAMenu* application (***Section III.8***). Created by concatenating: *DOR County Code* (1st & 2nd digits); *Municipal Type Code* (3rd digit); and *Minor Civil Division Code* (4th & 5th digits).	**Optional**

c) Collecting Street Addresses

The street address of a feature is the address at which that feature is physically located. The street address of a feature ***may or may not be the same*** as the mailing address, contact address, shipping address, or other addresses for that feature. For example, the mail for a facility may be sent to a Post Office (PO) Box or to the corporate headquarters (e.g., in another building, city, state, or country) of a company operating at a facility.

U.S. Postal Service Addressing Standards: The U.S. Postal Service (USPS) has adopted the following standard format for mailing addresses (U.S. Postal Service, 1999). USPS has also implemented capitalization, abbreviation, punctuation, and other standards. For example, address elements must appear in the prescribed order, all letters must be capitalized, and no punctuation, except for a dash in the zip code, is used.



DNR programs are required to adhere to this USPS address format when using street addresses to locate features for the following reasons:

- Standard names, abbreviations, capitalization, etc. helps users better compare and integrate street addresses from different database systems or applications.
- DNR's address geo-coding software provides more accurate coordinates for street addresses that meet USPS standards (see discussion below).
- If the street address and mailing address are the same, a standardized street address does not need to be "cleaned-up" before it can be used for mailings.

DNR programs can also save postage costs for bulk and direct mailings by conforming to USPS addressing standards! The USPS website is a good source of information about addressing standards. State, street suffix, and unit designator abbreviations can be found at: http://www.framed.usps.com/ncsc/lookups/usps_abbreviations.htm. Search engines for zip codes and city/state/zip code associations can also be accessed on the USPS website at http://www.framed.usps.com/ncsc/lookups/lookups.htm.

Features with Multiple Addresses: While it is impractical to use street addresses to locate some features (e.g., a monitoring well in the middle of a field), other features may have several different types of addresses associated with them, including PO Boxes. These standards apply only to the street address at which a feature of interest is physically located! DNR programs intending to locate a feature by its street address must (1) assess the practicality of this method for the particular feature type and "setting" of interest, and (2) develop a process to identify the address that describes the true physical location of that feature.

If a DNR program intends to capture street addresses, the following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

STREET ADDRESS DATA ELEMENTS	
DATA ELEMENT DESCRIPTION	**COLLECTION REQUIREMENT**
A program intending to collect street addresses is required to capture the following 5 data elements (shaded), in addition to all other required "originally collected" data elements.	
Street Address Line 1 Text: The first line of street address, containing the following address components: number, pre-direction, street name, street suffix, post-direction. Example: 101 S WEBSTER ST.	**Required for all street addresses**
Street Address Line 2 Text: The second line of street address, containing the following address components: unit designator and unit number. Example: STE 24.	
Street Address Municipality Name: Incorporated city, town, or village name. See ***DW_MCD*** table via the *DAMenu* application (***Section III.8***).	
Street Address State Abbreviation: The USPS U.S. state abbreviation. Example: WI.	
Street Address ZIP Code: The USPS U.S. zip code. Examples: 53717 or 537171134	
The following 5 data elements are optional for programs intending to collect street addresses.	
Street Address Number Data: The street number containing the following address components: number. Example: 101.	**Optional**
Street Address Name Text: The street name containing the following address components: pre-direction, street name, street suffix, post-direction: Example: S WEBSTER ST	
Street Address Unit Text: The street address unit containing the following address components: unit designator and unit number. Example: STE 24.	
Foreign Territory Text: The USPS foreign territory name or code.	
Foreign Postal Code: The USPS foreign territory postal code.	

4. GIS FRAMEWORK DATA LAYERS

One of DNR's strategic IT goals is to develop and maintain GIS framework data layers to reflect the most current and detailed *statewide* representations of geographical features of interest to DNR programs and external partners. Examples of these GIS framework data layers are surface water (1:24,000-scale hydrography), elevation, PLSS (1:24,000-scale Landnet), public land ownership, geographic management units (GMU), watersheds and sub-watersheds, and counties. These data sets are made available to internal DNR staff via the intranet or network, and distributed to each DNR regional office via CD. These data layers are also shared with other users via the procedures described in ***Section X***).

All GIS framework data layers are currently stored and managed in the WTM91 referencing system to simplify maintenance, minimize costs, and facilitate user access to and use of these data sets. These framework data layers can be used to derive the WTM91 coordinates for features in one of the following ways.

a) Deriving Relative Feature Locations from GIS Framework Data Layers

Each "unit" in a GIS framework data layer is assigned a unique geo-code, so the locations of features in a GIS framework unit can be represented by the WTM91 coordinates of that unit's centroid point. The geo-code can then be used to link the feature's WTM91 coordinates and attributes together for analyses, mapping, and reporting purposes. Examples of framework unit geo-codes are County Code, GMU Identifier, DNR Property Code, Watershed Code, Forest Compartment/Stand Identifier, and Water Body Identification Code.

If a DNR program intends to use a GIS framework data layer to capture feature locations, the following conditions must be true:

- An appropriate GIS framework data layer, referenced to WTM91, exists and has standard metadata.
- A unique geo-coding system exists for the "units" in the GIS framework data layer.
- The data collector uses the appropriate geo-code to associate the feature of interest with the correct GIS framework data layer unit.

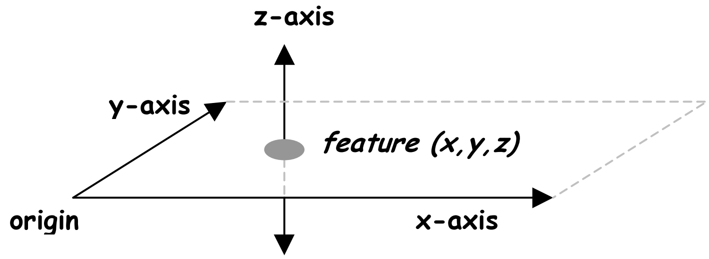
b) Deriving X-Y Coordinates from GIS Framework Data Layers

Several custom tools are also available or being developed to help programs integrate and display their data with GIS framework data layers. These tools can also facilitate data improvement and quality assurance efforts. For example, programs can use *the Surface Water Integration System (SWIS) Locator Tool* to "snap" existing program features to DNR's 1:24,000-scale surface water (or "hydrography") framework layer. The originally collected coordinates of program features may be retained, and new WTM91 coordinates are captured to indicate where a particular feature intersects the hydrography framework layer. It is **recommended** that DNR programs consider referencing appropriate feature data to a GIS framework data layer, especially as more custom tools become available.

VI. COLLECTING VERTICAL LOCATIONAL DATA

Refer to the companion document, *Location Matters: Locational Data Basics*, (expected completion in Spring, 2001) for more information about vertical data!

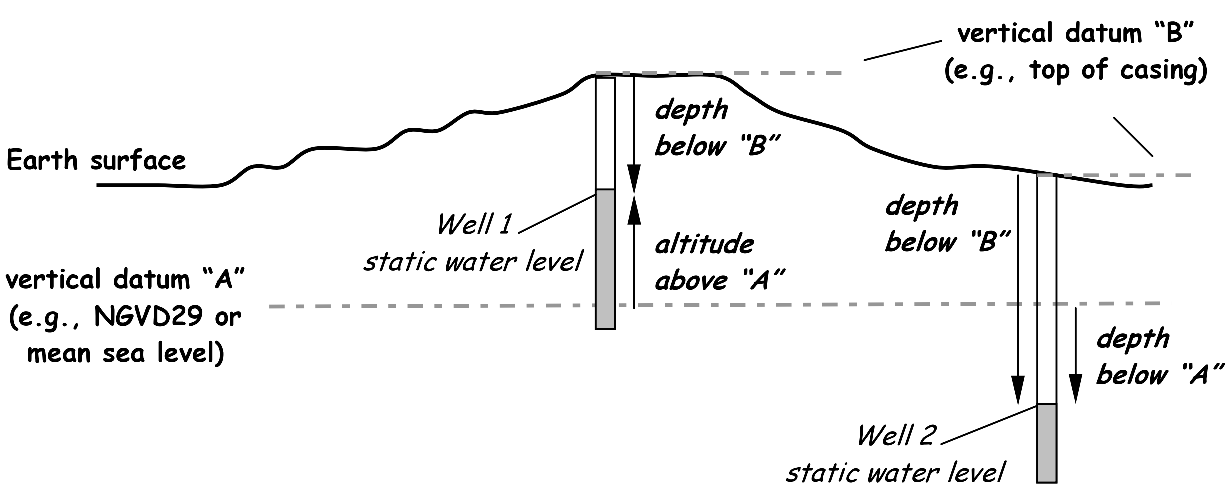
Vertical data describe the continuous surface of the Earth, or the position of a real-world feature above (*altitude*) or below (*depth*) the surface of the Earth as represented by a vertical datum. Vertical data are one-dimensional and represented by a *z-axis* value. Vertical and horizontal locational data are referenced to different datums.



It is **recommended** that a feature's altitude or depth be collected and recorded as an attribute linked to that feature's horizontal location! (The term "altitude" is used in this document instead of "elevation" to conform to Federal Geographic Data Committee standards.) It is also **recommended** that the same measurement unit be used to express the vertical and horizontal locations of a feature, whenever possible.

Vertical and horizontal locational data for a feature may be collected separately, or at the same time, depending on the collector's specific business needs and the data collection method used. For example, many GPS receivers are capable of capturing both horizontal and vertical data for a feature, although the accuracy of GPS vertical and horizontal data may differ significantly.

Deciding if a vertical measurement for a feature is an altitude or a depth value depends on the vertical datum to which it is referenced. As illustrated below, the static water level in *Well 1* may be measured as an altitude above vertical datum "A" or as a depth below vertical datum "B". The static water level in *Well 2* can be measured and expressed as a depth below vertical datum "A" or "B". Identifying the vertical referencing system and capturing appropriate altitude or depth data elements, are critical for properly assessing the quality of vertical locational data!



Attachment 3 to MNRD Non-Local Beings Report

Because horizontal and vertical locations of a feature are linked, the following horizontal locational data elements also apply to a feature's vertical data (see ***Section V.1***): *Program-defined Feature Identifier* (required data element) and *Feature Type Code* and *Program-defined Site Identifier* (recommended data elements). This section describes the required, recommended, and optional data elements associated with vertical locational data collection activities. For the purposes of these standards, ***vertical data collection activities*** involve the capture of feature locations and related data ***in the field*** (e.g., GPS or terrestrial surveying) or ***in the office*** (e.g., on-table or on-screen digitizing).

1. "ORIGINALLY COLLECTED" VERTICAL DATA ELEMENTS

Regardless of the data collection method or referencing system used, capturing data about *how* a feature's vertical location was "originally collected" is critical for assessing the quality of the data, and the quality of any other data derived from them. The following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

"ORIGINALLY COLLECTED" VERTICAL DATA ELEMENTS

DATA ELEMENT DESCRIPTION	COLLECTION REQUIREMENT
A program intending to collect vertical feature locations is required to collect, assign, know, or otherwise note the following 8 data elements (shaded) for all features.	
Program-defined Feature Identifier: (see ***Section V.1*** for definition)	**Required for all located features**
Original Vertical Collection Method Code: Code indicating the method by which the feature's vertical location was originally collected. See ***Appendix B.1***.	
Original Vertical Referencing System Code: Code indicating the referencing system in which the feature's vertical location was originally collected. See ***Appendix B.2***.	
Original Vertical Collection Date: Date on which the feature's vertical location was originally collected.	
Original Vertical Source Year: The year that the source (e.g., map, imagery, DOP), from which the feature's vertical location was originally collected, was created, updated, revised, flown, etc.	**Required for applicable data collection methods**
Original Vertical Source Denominator Amount: Scale denominator of the source (e.g., map, source photography of DOP) from which the feature's vertical location was originally collected. Example: 24000 entered for a 1:24,000 scale map.	
Original Vertical Image Resolution Amount: Pixel resolution of the raster source (e.g., satellite imagery, DOP, DRG) from which the feature's vertical location was originally collected.	
Original Vertical Image Resolution Units: Pixel resolution unit of the raster source (e.g., satellite imagery, DOP, DRG) from which the feature's vertical location was originally collected.	

A program intending to collect vertical feature locations is recommended to collect, assign, know, or otherwise note the following 5 data elements for all features.

Feature Type Code: (see ***Section V.1*** for definition)	**Recommended for all located features**
Program-defined Site Identifier: (see ***Section V.1*** for definition)	
Original Vertical Collection Method Text: Additional detail about the method by which the feature's vertical location was originally collected. See ***Appendix B.1***.	
Original Vertical Collection Tool Code: Code indicating the tool used during the original collection of the feature's vertical location. See ***Appendix B.5***.	
Original Vertical Collector Name: DNR user ID (e.g., SMITHJ) or name of the person who originally collected the feature's vertical location.	

2. COLLECTING ALTITUDE (or ELEVATION) DATA ELEMENTS

It is recommended that DNR programs collect altitude data in reference to the National Geodetic Vertical Datum of 1929 (NGVD29), whenever possible. This datum was chosen as the standard for DNR's elevation GIS framework data layer because most U.S. Geological Survey (USGS) paper maps and digital elevation products use this datum. DNR does not have the capability to project vertical data between different vertical datums at this time! A future project of the Enterprise Data Management Section will be to investigate and develop procedures for vertical data projection.

Using GPS Tools to Collection Altitude Data: Many GPS receivers can collect both vertical and horizontal locational data for a feature. In almost all cases, vertical data collected with a GPS are 2-3 times *less accurate* than the horizontal data. For example, if the horizontal data accuracy is 2-5 meters, the vertical data accuracy can be 15+ meters. The one exception is survey-grade GPS tools, which produce highly accurate horizontal and vertical data.

If a DNR program intends to capture altitude data, the following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

ALTITUDE DATA ELEMENTS	
DATA ELEMENT DESCRIPTION	**COLLECTION REQUIREMENT**

A program intending to collect feature altitude data is required to capture the following 2 data elements (shaded), in addition to all other required "originally collected" data elements.

Altitude Amount: The altitude of a feature, measured in *Altitude Units*, above the vertical datum specified in the *Original Vertical Referencing System Code* data element.	**Required for all altitude data**
Altitude Units: Units in which the altitude of a feature is measured.	

Attachment 3 to MNRD Non-Local Beings Report

3. COLLECTING DEPTH DATA ELEMENTS

As with altitude data, it is recommended that DNR programs collect depth data in reference to NGVD29, whenever possible. In practice, however, many DNR programs measure depth from a local surface or point, which ***may or may not*** be referenced to NGVD29. Each DNR program is responsible for selecting the collection method or tool that best supports its business needs for depth data. These standards simply define the depth-related data elements that must be captured.

For example, NR141 (Wis. Adm Code) requires that the top of a monitoring well casing be referenced to the nearest NGVD29 benchmark. The depth of the static water level in a monitoring well, however, is typically measured and recorded as the distance from the top of the well casing to the water table. (In this case, the static water level in a monitoring well *could* be calculated in reference to NGVD29 by using the well casing measurements.) It is especially important to note a custom or local vertical datum (i.e., not NGVD29 or NAVD88) used when collecting depth data (i.e., in the [ORIG_VRT_COLL_MTHD_TEXT] data field).

If a DNR program intends to capture depth data, the following data elements are to be collected, assigned, known, or otherwise noted during locational data collection activities. DNR programs must always collect **required** data elements (shaded) under the prescribed conditions! And, programs must make the decision to collect **recommended** and **optional** data elements, based on a thorough assessment of their business needs. Standard data field names, characteristics, and storage requirements for these data elements are defined in ***Appendix A***.

DEPTH DATA ELEMENTS	
DATA ELEMENT DESCRIPTION	**COLLECTION REQUIREMENT**
A program intending to collect feature depth data is required to capture the following 2 data elements (shaded), in addition to all other required "originally collected" data elements.	
Depth Amount: The depth of a feature, measured in *Depth Units*, below the vertical datum specified in the *Original Vertical Referencing System Code* data element.	**Required for all depth data**
Depth Units: Units in which the depth of a feature is measured.	

Attachment 3 to MNRD Non-Local Beings Report

VII. STORING LOCATIONAL DATA

After a DNR program collects or assigns the standard horizontal and vertical data elements described in the preceding sections, it must decide where and in what format to store the data. This section describes required, recommended, and optional data fields for storing horizontal and vertical data elements in DNR's database systems and applications. For the purposes of this document, ***locational data storage activities*** involve the storage and maintenance of locational data ***at the record level*** (i.e., in defined, standard data fields). Appropriate documentation of standard locational data elements *at the metadata level* is described in ***Section IX***.

DNR programs currently store their locational data in a variety of GIS, database, spreadsheet, statistical, and modeling software formats. This approach is flexible, but can hinder the ability of users to access and integrate locational data from multiple sources within the agency. The locational data storage standards defined in this document are intended to help users:

- efficiently integrate data from multiple DNR sources to meet specific business needs.
- better understand and assess the content and quality of DNR's locational data.
- eliminate redundant storage of locational data within DNR.

Data producers must consider several factors when deciding where and in what format to store the locational data they have collected:

➢ Some data fields are required in database systems and applications, while others are recommended or optional.

➢ How *x-y* coordinates are stored differs for tabular database and GIS applications and systems.

➢ Storing data elements at the record level versus the metadata level depends on the homogeneity of the locational data in a data set.

1. REQUIRED, RECOMMENDED, AND OPTIONAL LOCATIONAL DATA FIELDS

Appendix A lists standard data field names, characteristics, and storage requirements associated with the "collected" locational data elements described in ***Sections V*** and ***VI*** above. DNR programs must always build **required** data fields into applications and systems that contain locational data! In addition, the data in these required data fields must always be stored and documented at the record level. Programs must make the decision to build **recommended** and **optional** data fields into these applications and systems, based on a thorough assessment of their business needs.

VIII. USING LOCATIONAL DATA

The agency's GIS framework data layers are referenced to WTM91 for the reasons described in ***Section V.4***. A DNR program intending to use (e.g., map, display, analyze) its data internally, in conjunction with one or more GIS framework layers, should collect or derive WTM91 coordinates for its data, or otherwise make its data available in the WTM91 referencing system. This recommendation applies to data stored in tabular and GIS applications and systems. Please note that this recommendation does not preclude a DNR program from collecting, storing or using locational data in another referencing system when necessary to support its unique business needs.

For example, both the PLSS descriptions and WTM91 coordinates for private drinking water wells are collected, stored and used for specific purposes. The PLSS description is used to query customized database systems and applications, while the WTM91 coordinates are used to display wells in reference to other framework data layers in GIS applications. The Latitude/Longitude coordinates for these wells are also derived for specific EPA reporting requirements.

See ***Appendix A*** for WTM91 data field specifications. Recommendations on deriving WTM91 coordinates from other coordinate and relative referencing systems are described below.

1. DERIVING WTM91 COORDINATES FROM OTHER COORDINATES

DNR's "Projection Service" (http://intranet.dnr.state.wi.us/int/at/et/GEO/prj_srvc.htm) can help DNR programs project WTM91 coordinates from feature locations originally collected in other coordinate systems (e.g., WTM27, Latitude/Longitude, UTM, SP). This service can project horizontal data in tabular and GIS applications and systems.

2. DERIVING WTM91 COORDINATES FROM PLSS DESCRIPTIONS

DNR has developed a PLSS centroid look-up table (named *DTRSQQ_LUT*) to help programs derive WTM91 (or Latitude/Longitude) coordinates for features that can be represented by the "centroid" point of a PLSS Township/Range, section, ¼-section, or ¼-¼-section grid cell. This table contains data from DNR's 1:24,000-scale Landnet GIS framework data layer, and resides in ArcSDE/Oracle. Users can access this table through ArcSDE or from a client to *production* Oracle via a database link pointing to the ArcSDE/Oracle instance. A future project of the Enterprise Data Management Section will be to investigate and develop a PLSS centroid service. Questions about this look-up table can be emailed via the **PLSS Centroid Table** homepage: http://intranet.dnr.state.wi.us/int/at/et/geo/location/plss_centroid_tbl.html.

The [PLSS_DTRSQQ_CODE] data field defined in this document holds the geo-code used to link WTM91 coordinates to each applicable PLSS grid cell. The PLSS "centroid" table can be used to derive WTM91 coordinates even when feature locations within the same data set are described to different PLSS grid cell levels. Non-standard PLSS tracts, half sections, and half quarters, however, are not included in the current 1:24,000-scale Landnet data layer. As a result, the geo-codes for these tracts are not included in the PLSS "centroid" look-up table, and the WTM91 coordinates for features in these tracts must be collected using other methods! WTM91 coordinates that describe (i.e., bound) *area* features located by PLSS descriptions must also be derived through other methods, such as digitizing or projection.

3. DERIVING WTM91 COODINRATES FROM PARCEL DESCRIPTIONS

WTM91 coordinates for features represented by parcel "centroid" points can be derived using the same process that is used to derive WTM91 coordinates from PLSS descriptions. This same process works because parcel identifiers contain the components necessary to derive the PLSS geo-codes contained in the [PLSS_DTRSQQ_CODE] data field, and used in the PLSS centroid look-up table. When a feature is best represented as an *area*, another method must be used to derive its WTM91 coordinates. For example, DNR has digitized a GIS framework data layer of DNR managed lands (i.e., parcels) which is referenced to WTM91.

4. DERIVING WTM91 COORDINATES FROM STREET ADDRESSES

The process of converting street addresses into WTM91 (or other) coordinates is called address geo-coding. A street address is used to derive a point that represents one or more features located at that address. As with all relative referencing systems, a feature located by street address can be located anywhere within the property designated by that address, and can be within a range of distance from the point representing that address.

DNR has acquired *Centrus Desktop™* address standardization and geo-coding software, and provides consulting services to help programs with their address geo-coding, standardization, and related activities. (For more information, see DNR's **Address Standardization and Geo-Coding** web page: http://intranet.dnr.state.wi.us/int/at/et/geo/location/addressmatch.html.) ArcView GIS software has an extension that uses *Dynamap 2000* data for address geo-coding. However, *Centrus Desktop™* is recommended for address standardization and geo-coding activities within DNR for the following reasons:

- address data are updated every two months
- several sources of address data are used (i.e., GDT, USPS)
- "match codes" allow users to assess how addresses have been standardized
- "location codes" allow users to assess the accuracy of derived coordinates

5. DERIVING WTM91 COORDINATES FROM GIS FRAMEWORK DATA LAYERS

Because DNR's GIS framework data layers are stored and managed in WTM91 coordinates, features located using the geo-code for a framework "unit" can be assigned the WTM91 coordinates of that unit's "centroid" point. In addition, WTM91 coordinates are also generated for features "snapped" to one of these GIS framework data layers.

IX. METADATA – DOCUMENTING LOCATIONAL DATA SETS

Standard metadata must be developed and made available for each DNR tabular and GIS data set that contains locational data. DNR has adopted the Federal Geographic Data Committee's (FGDC) metadata standards for its GIS framework data layers, with additional elements added to support specific program needs (e.g., Aquatic and Terrestrial Resource Inventory Internet application). FGDC metadata elements are considered mandatory, mandatory-if-applicable, or optional.

When a data set containing locational data is considered "homogeneous" (see ***Section II.4.g***), some of the collected data elements may be documented solely in that data set's metadata, and not also stored in standard data fields within that data set. The following FGDC metadata elements are related to the locational data in a data set. The quoted FGDC definition of each metadata element comes directly from the FGDC standards document, *Content Standard for Digital Geospatial Metadata* (United States Geological Survey, 1998). Please refer to the FGDC standards for the domains of the following metadata elements.

1. IDENTIFICATION INFORMATION

a) Spatial Domain

"The geographic areal domain of the data set." The spatial domain is defined as (1) a text description or (2) by its bounding horizontal coordinates (western-, eastern-, northern-, and southern-most limits of area covered by the data set), boundary outline, excluded interior area boundaries, and minimum and maximum altitude values. The values for the horizontal spatial domain elements must be entered as Latitude/Longitude decimal degrees (see ***Section V.2.b***).

2. DATA QUALITY INFORMATION

a) Positional Accuracy

"An assessment of the accuracy of the positions of spatial objects" in the data set. Positional accuracy is described separately for horizontal and vertical locations in the data set. Positional accuracy may be estimated or formally tested. In some cases, a specific number or number range can describe the accuracy of the data (e.g., a formal statistical test has been conducted). In other cases, the accuracy of positional data may be difficult or impossible to represent numerically, and must be described verbally. The informal or formal method used to determine accuracy must also be described. The ***Location Matters: Data Accuracy Basics***, (expected in Spring, 2001) contains more detailed information about data accuracy issues.

3. SPATIAL DATA ORGANIZATION INFORMATION

a) Indirect Spatial Reference

"Name of types of geographic features, addressing schemes, or other means through which locations are referenced in the data set." This element refers to *relative referencing systems* used to locate features. FGDC relative referencing system descriptions (shaded column) for the following *Original Horizontal Collection Method Code* (stored in the [ORIG_HRZ_COLL_MTHD_CODE] data field are used to fill this element:

[ORIG_HRZ_COLL_MTHD_CODE]	FGDC Relative Referencing System Description
GCD001 - GCD004	Public Land Survey System Description
GCD005 – GCD013	Street Address
GCD014	Parcel Description

b) Direct Spatial Reference Method

"The system of objects used to represent space in the data set." FGDC sets the domain of this element as point, vector, or raster. More detailed characteristics about the point/vector or raster objects comprising the data set can also be entered into optional metadata fields. The ***Location Matters: Locational Data Basics*** document (expected completion in Spring, 2001) contains more information about vector and raster data. FGDC direct spatial referencing methods (shaded column) are listed for the following data set characteristics.

Data Set Characteristics	FGDC Direct Spatial Reference Method
• X-Y coordinates in a tabular database system or application • GIS data layers containing point feature • All geo-coded data sets	**Point**
• GIS data layers containing lines, areas (polygons), routes or regions (using *x-y* coordinates)	**Vector**
• Scanned maps, photos, etc. • Digital orthophotos (DOPs) • Digital raster graphics (DRGs) • Satellite imagery • Continuous surfaces (e.g., elevation) • Categorical surfaces (e.g., Wisconsin land cover)	**Raster**

4. SPATIAL REFERENCE INFORMATION

a) Horizontal Coordinate System Definition

"The reference frame or system from which linear or angular quantities are measured and assigned to the position that a point occupies." The value in the [ORIG_HRZ_REF_SYS_CODE] data field can be used to fill in these metadata elements. Different elements are mandatory for geographic coordinates (latitude/longitude), planar coordinates (WTM91, State Plane, UTM), and local coordinates. The required metadata parameters for horizontal referencing systems commonly used in Wisconsin will ultimately be listed in an updated version of ***Appendix B.2***.

b) Vertical Coordinate System Definition

"The reference frame or system from which vertical distances (altitudes or depths) are measured." The value in the [ORIG_HRZ_REF_SYS_CODE] data field can be used to fill in these metadata elements. The required metadata parameters for horizontal referencing systems commonly used in Wisconsin will ultimately be listed in an updated version of ***Appendix B.2***.

5. ENTITY ATTRIBUTE INFORMATION

FGDC metadata standards allow two options for describing the data entities (e.g., data fields) in a data set. A detailed description for each entity can be provided, or an overview description can refer the user to another document that describes the entities in the data set.

a) Detailed Description

"Description of entities, attributes, attribute values, and related characteristics encoded in the data set." The data field names, definitions and domain values defined in this document can be used to provide detailed descriptions of the locational data entities in a data set.

b) Overview Description

"Summary of, and citation to detailed description of, the information content of the data set." The overview description can refer users to this document for information about the locational data elements in a data set.

X. DISTRIBUTING LOCATIONAL DATA

DNR shares (i.e., provides and receives) data with many local, state and federal agencies, private organizations, and others. Some of these data sharing arrangements are formalized as part of a contract or agreement, while others are more informal. In addition, to support specific business requirements (e.g., reporting to EPA) data may be reported in a format different from that in which they were collected.

DNR also provides GIS framework data layers and customized applications, such as DNRView, to internal users via the intranet, network, or CD. Please refer to the companion document, *Wisconsin DNR GIS Datasharing Policy*, for DNR's current locational data sharing approaches and standards (http://www.dnr.state.wi.us/org/at/et/geo/datasharing/index.htm.) The Enterprise Data Management Section intends to update this data sharing document in the near future, adding and/or expanding its discussions about:

- issues and considerations associated with the sharing of locational data (e.g., accuracy, confidentiality, fees, file sizes and types, consulting services)
- new procedures and tools
- example language for formal data sharing contracts/agreements

XI. GLOSSARY OF TERMS

Accuracy: The closeness of results of observations, computations or estimates to the true values or the values accepted as being true. (U.S. Geological Survey, 1998).

Altitude: The perpendicular distance of a feature above a vertical reference datum, as defined in Federal Information Processing Standard 70-1. (modified from U.S. Geological Survey, 1998). The term “altitude” is used instead of elevation to conform to Federal Geographic Data Committee (FGDC) standards.

Area: A generic term for a bounded, continuous, two-dimensional object that may or may not include its boundary. (U.S. Geological Survey, 1998).

Attribute: A defined characteristic of an entity type. (U.S. Geological Survey, 1998).

Attribute Value: A specific quality or quantity assigned to an attribute. (U.S. Geological Survey, 1998).

Coordinates: Pairs of numbers expressing horizontal distances along orthogonal axes. (U.S. Geological Survey, 1998).

Data Element: A logically primitive item of data. (U.S. Geological Survey, 1998).

Data Record: A row of data in a database table.

Data Set: A collection of related data. (U.S. Geological Survey, 1998).

Datum: A mathematically defined reference surface used to represent the size and shape of the Earth. A horizontal datum is defined by its ellipsoid, latitude and longitude orientation, and a physical origin. (Wisconsin State Cartographer’s Office, 1995)

Depth: Perpendicular distance of an interior point from the surface of an object (U.S. Geological Survey, 1998). Also, the perpendicular distance of a feature below a vertical reference datum.

Digital Image: A two-dimensional array of regularly spaced picture elements (pixels) constituting a picture. (U.S. Geological Survey, 1998).

Domain: Valid values for a data element. (U.S. Geological Survey, 1998).

Elevation: see Altitude.

Ellipsoid: A mathematical surface (an ellipse rotated around the Earth’s polar axis) which provides a convenient model of the size and shape of the Earth. The ellipsoid is chosen to best meet the needs of a particular geodetic datum system design. (Wisconsin State Cartographer’s Office, 1995).

False Easting / False Northing: A numerical constant used to eliminate negative coordinates in a system, or to change the coordinates to more convenient values. The false easting and/or northing values are assigned to the true origin of the projection system. (Wisconsin State Cartographer's Office, 1995).

False Northing: see **False Easting / False Northing**.

Geographic Coordinate System: The network of curved lines (latitude and longitude) representing the Earth's spherical surface. These coordinates are measured in angular values of degrees, minutes, and seconds, and are based on the equator and an arbitrary location of a prime meridian as the origin location. (Wisconsin State Cartographer's Office, 1995).

Geoid: An undulating surface represented by extending the Earth's mean sea level through the land areas. The geoid is a theoretical surface perpendicular at every point to the direction of gravity. (Wisconsin State Cartographer's Office, 1995).

Geospatial Data: see **Locational Data**

Grid: A two-dimensional set of grid cells forming a regular, or nearly regular, surface. A set of points arrayed in a pattern that forms a regular, or nearly regular, surface. (modified from U.S. Geological Survey, 1998).

Grid Cell: A two-dimensional object that represents the smallest non-divisible element of a grid. (U.S. Geological Survey, 1998).

Horizontal: Tangent to the geoid or parallel to a plane that is tangent to the geoid. (U.S. Geological Survey, 1998).

Latitude: Angular distance measured on a meridian north or south of the equator. (U.S. Geological Survey, 1998).

Locational Data: Information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the Earth. (modified from U.S. Geological Survey, 1998).

Longitude: Angular distance between the plane of a meridian east or west from the plane of the meridian of Greenwich, England. (U.S. Geological Survey, 1998).

Map: A spatial representation, usually graphic on a flat surface, of spatial phenomena. (U.S. Geological Survey, 1998).

Media: The physical devices used to record, store, and (or) transmit data.

Meridian: A great circle on the Earth that passes through the geographic poles. (U.S. Geological Survey, 1998).

Metadata: Data about the content, quality, condition, and other characteristics of data. (U.S. Geological Survey, 1998).

Origin: The true geodetic zero point of a coordinate system. The actual origin may be assigned arbitrary coordinate values (using false eastings and/or northings) to eliminate negative coordinates in the system. (Wisconsin State Cartographer's Office, 1995).

Pixel: Two-dimensional picture element that is the smallest nondivisible element of a digital image. (U.S. Geological Survey, 1998).

Precision: A statistical measure of repeatability, usually expressed as a variance or standard deviation (root mean square, RMS) of repeated measurements. (Robinson, A.H., R.D. Sale, J.L. Morrison, and P.C. Muehrcke, 1984).

Projection: The method used to transform and portray the curved surface of the Earth as a flat (map) surface. Although there are theoretically an infinite number of possible projections, a relatively small number are commonly used. Different projection systems have differing amounts and patterns of distortion. (Wisconsin State Cartographer's Office, 1995)

Rectangular Coordinate System: A network of two sets of straight parallel lines intersecting at right angles and superimposed on a map projection. The origin (zero point) is located based upon the area covered on the Earth. Coordinate values are usually expressed in feet or meters.

Resolution: The minimum difference between two independently measured or computed values which can be distinguished by the measurement or analytical method being considered or used. (U.S. Geological Survey, 1998).

Spatial Data: see **Locational Data**.

Spheroid: An ellipsoid that approximates a sphere is commonly referred to as a spheroid. see **Ellipsoid**.

Topology: The way in which geographical elements are linked together (Burrough, P.A., 1986)

Vertical: At right angles to the horizontal; vertical data includes altitude and depth. (U.S. Geological Survey, 1998).

XII. BIBLIOGRAPY

Brinker, R.C. and P.R. Wolf. 1984. *Elemental surveying*. Seventh Edition. New York: Harper and Row, Publishers, Inc.

Burrough, P.A. 1986. *Principles of geographical information systems for land resources assessment*. New York: Oxford University Press.

Minnesota Land Management Information Center. 1999. *Positional accuracy handbook*. St. Paul, Minnesota. available at website http://www.mnplan.state.mn.us/press/accurate.html

Robinson, A.H., R.D. Sale, J.L. Morrison, and P.C. Muehrcke. 1984. *Elements of cartography*. Fifth Edition. New York: John Wiley & Sons.

United States Geological Survey. 1998. *Content standard for digital geospatial metadata*. Reston, VA: Federal Geographic Data Committee. available at website http://www.fgdc.gov/standards/status/textstatus.html

United States Geological Survey. 1993. *Digital elevation models: data users guide 5 (Retired)*. Reston, VA.

United States Postal Service. 1997. *Publication 28: Postal addressing standards*. Washington, D.C. available at website http://pe.usps.gov/cpim/ftp/pubs/Pub28/pub28.pdf

Wisconsin Department of Natural Resources. 1996. *24K Landnet Spatial Database Technical Documentation*.

Wisconsin Department of Natural Resources. 1993. *Wisconsin DNR GIS database users guide*. Madison, WI.

Wisconsin Department of Natural Resources. 1993. *Wisconsin DNR GIS datasharing policy*. Madison, WI. available at website http://www.dnr.state.wi.us/org/at/et/geo/datasharing/index.htm

Wisconsin Land Information Association. 1999 (adopted). *Digital Parcel Mapping Data Content Standards*. Wildrose, WI. available at website http://www.wlia.org/standards.html

Wisconsin Land Information Association. 1995. *Parcel Geo-Locator Standard*. Wildrose, WI. available at website http://www.wlia.org/standards.html

Wisconsin State Cartographer's Office. 1995. *Wisconsin coordinate systems*. Madison, Wisconsin: Board of Regents of the University of Wisconsin System.

APPENDIX A: LOCATIONAL DATA FIELD DEFINITIONS

“ORIGINALLY COLLECTED” HORIZONTAL DATA FIELDS				
DATA FIELD NAME (30 and 10* character lengths)	**DATA FIELD (& ELEMENT) DEFINITION / DOMAIN**	**DATA FIELD TYPE, LENGTH, & DECIMAL PLACES**	**HOMOGENEOUS DATA SET STORAGE REQUIREMENTS**	**HETEROGENEOUS DATA SET STORAGE REQUIREMENTS**
{Program-defined Feature Identifier}	**Program-defined Feature Identifier:** Program-defined unique character or numeric identifier assigned to the feature being located. Example: WI Unique Well Number.	**Type:** {Prog-def} **Length:** {Prog-def} **Dec. Places:** 0 **Format:** {Prog-def}	Required record-level storage for all features, and metadata documentation for data set.	
ORIG_HRZ_COLL_MTHD_CODE ***OH_COL_MTH**	**Original Horizontal Collection Method Code:** Code indicating the method by which the feature’s horizontal location was originally collected. **Domain:** See COLL_MTHD_ CODE in *Data Collection Method Codes* (***Appendix B.1***).	**Data Type:** Character **Length:** 6 **Dec. Places:** 0 **Format:** AAA###; All capitalized	Required record-level storage for all features, and metadata documentation for data set.	
ORIG_HRZ_REF_SYS_CODE ***OH_REF_SYS**	**Original Horizontal Referencing System Code:** Code indicating the referencing system in which the feature’s horizontal location was originally collected. **Domain:** See REF_ SYS_CODE in *Referencing System Codes* (***Appendix B.2***).	**Type:** Character **Length:** 5 **Dec. Places:** 0 **Format:** AA###; All capitalized	Required metadata documentation for data set. Required record-level storage for x-y coords in non-GIS systems and applications. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
ORIG_HRZ_X_COORD_AMT ***OH_X_COORD**	**Original Horizontal X-Axis Coordinate Amount:** Originally collected *x-axis* coordinate for point features in a tabular database system or application. Includes Eastings and Longitudes.	**Type:** Numeric **Length:** Variable **Dec. Places:** Variable **Format**:	Required record-level storage for x coordinates in non-GIS system/applications.	
ORIG_HRZ_Y_COORD_AMT ***OH_Y_COORD**	**Original Horizontal Y-Axis Coordinate Amount:** Originally collected *y-axis* coordinate for point features in a tabular database system or application. Includes Northings and Latitudes.	**Type:** Numeric **Length:** Variable **Dec. Places:** Variable **Format:**	Required record-level storage for y coordinates in non-GIS systems/applications.	

Attachment 3 to MNRD Non-Local Beings Report

"ORIGINALLY COLLECTED" HORIZONTAL DATA FIELDS				
DATA FIELD NAME	**DATA FIELD (& ELEMENT) DEFINITION / DOMAIN**	**DATA FIELD TYPE, LENGTH, & DECIMAL PLACES**	**HOMOGENEOUS DATA SET STORAGE REQUIREMENTS**	**HETEROGENEOUS DATA SET STORAGE REQUIREMENTS**
ORIG_HRZ_COLL_DATE ***OH_COL_DAT**	**Original Horizontal Collection Date:** Beginning date on which the feature's horizontal location was originally collected.	**Type:** Date **Length:** 8 **Dec. Places:** 0 **Format:** MMDDYYYY	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
ORIG_HRZ_SRC_YEAR **** OH_SRC_YR*** **NOTE: Data field only applicable for some data collection methods!**	**Original Horizontal Source Year:** Year that the source (e.g., map, imagery, DOP), from which the feature's horizontal location was originally collected, was created, published, updated, revised, flown, etc.	**Type:** Numeric **Length:** 4 **Dec. Places:** 0 **Format:** YYYY	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
ORIG_HRZ_SRC_DNOM_AMT ***OH_SRC_DNM** **NOTE: Data field only applicable for some data collection methods!**	**Original Horizontal Source Denominator Amount:** Scale denominator of the source (e.g., map, DOP photo base) from which the feature's horizontal location was originally collected. Example: 24000 for 1:24,000 scale.	**Type:** Numeric **Length:** 10 **Dec. Places:** 0 **Format:**	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
ORIG_HRZ_IMG_RSLN_AMT ***OH_IMG_RSL** **NOTE: Data field only applicable for some data collection methods!**	**Original Horizontal Image Resolution Amount:** Pixel resolution of the raster source (e.g., satellite imagery, DOP, DRG) from which the feature's horizontal location was originally collected.	**Type:** Numeric **Length:** 10 **Dec. Places:** 0 **Format:**	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
ORIG_HRZ_IMG_RSLN_UNITS ***OH_RSL_UNT** **NOTE: Data field only applicable for some data collection methods!**	**Original Horizontal Image Resolution Units:** Pixel resolution unit of the raster source (e.g., satellite imagery, DOP, DRG) from which the feature's horizontal location was originally collected. ***Domain:*** MT = meters; FT = feet; KM = kilometers; MI = miles.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.

"ORIGINALLY COLLECTED" HORIZONTAL DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
FEAT_TYPE_CODE ***FEAT_TYPE**	**Feature Type Code:** Code indicating the type of feature being located. See discussion of *Feature Type Codes* in ***Appendix B.3***.	**Type:** Character **Length:** 6 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for some EPA reporting. Required metadata documentation for data set. Recommended record-level storage for all features.	
{Program-defined Site Identifier} ***{Program-defined}**	**Program-defined Site Identifier:** Program-defined unique character or numeric identifier assigned to the site (e.g., facility, property, area) at which the feature is being located. Examples: FID, DNR Property Code.	**Type:** {Prog-def} **Length:** {Prog-def} **Dec. Places:** 0 **Format:** {Prog-def}	Required record-level storage for some EPA reporting. Required metadata documentation for data set. Recommended record-level storage for all features.	
FEAT_GEOM_REP_CODE ***FEAT_GEOM**	**Feature Geometric Representation Code:** Code indicating how the feature being located is geometrically represented. **Domain:** See FEAT_GEOM_REP_CODE in *Feature Geometric Representation Codes* (***Appendix B.4***).	**Type:** Character **Length:** 6 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for some EPA reporting. Required metadata documentation for data set. Recommended record-level storage for all features.	
ORIG_HRZ_COLL_MTHD_TEXT ***OH_MTH_TXT**	**Original Horizontal Collection Method Text:** Additional detail about the method by which the feature's horizontal location was originally collected. See *Data Collection Method Codes* discussion (***Appendix B.1***).	**Type:** Character **Length:** 255 **Dec. Places:** 0 **Format:** All capitalized	Recommended record-level storage for applicable features and data collection method.	
ORIG_HRZ_COLL_TOOL_CODE ***OH_COLTOOL**	**Original Horizontal Collection Tool Code:** Code indicating the tool used during the original collection of the feature's horizontal location. **Domain:** See COLL_TOOL_CODE in *Data Collection Tool Codes* (***Appendix B.5***).	**Type:** Character **Length:** 8 **Dec. Places:** 0 **Format:** All capitalized	Recommended record-level storage for applicable features and data collection method.	
ORIG_HRZ_COLL_NAME ***OH_COL_NAM**	**Original Horizontal Collector Name:** DNR user ID (e.g., SMITHJ) or name of the person who originally collected the feature's horizontal location.	**Type:** Character **Length:** 30 **Dec. Places:** 0 **Format:** All capitalized	Recommended record-level storage for applicable features and data collection method.	

Attachment 3 to MNRD Non-Local Beings Report

WISCONSIN TRANSVERSE MERCATOR (WTM) DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
WTM91_X_AMT ***WTM91_X***	**WTM91 Easting (X) Amount:** An unsigned, positive 8-digit number representing meters East of the WTM coordinate system y-axis based on the 1991 adjustment of the North American Datum of 1983 – GRS80 spheroid. Example: 652342.12.	**Type:** Numeric **Length:** 8 **Dec. Places:** 2 **Format:**	Required record-level storage for WTM91 Eastings in non-GIS systems and applications.	
WTM91_Y_AMT ***WTM91_Y***	**WTM91 Northing (Y) Amount:** An unsigned, positive 8-digit number representing meters North of the WTM coordinate system x-axis based on the 1991 adjustment of the North American Datum of 1983 – GRS80 spheroid. Example: 652342.12.	**Type:** Numeric **Length:** 8 **Dec. Places:** 2 **Format:**	Required record-level storage for WTM91 Northings in non-GIS systems and applications.	

LATITUDE/LONGITUDE (LL) DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
LL_LAT_DD_AMT ***LL_LAT_DD***	**Latitude Decimal Degree Amount:** Unsigned, positive number representing the decimal degrees of latitude North of the equator based on the WGS84 or GRS80 spheroid. Example: 42.1234567.	**Type:** Numeric **Length:** 9 **Dec. Places:** 7 **Format:**	Required record-level storage for Latitude (referenced to WGS84 or GRS80) in non-GIS systems/applications.	
LL_LONG_DD_AMT ***LL_LONG_DD***	**Longitude Decimal Degree Amount:** Signed, negative number representing the decimal degrees of longitude West of the Prime (Greenwich) Meridian based on the WGS84 or GRS80 spheroid. Example: -93.1234567.	**Type:** Numeric **Length:** 10 **Dec. Places:** 7 **Format:**	Required record-level storage for Longitude (referenced to WGS84 or GRS80) in non-GIS systems/applications.	

LATITUDE/LONGITUDE (LL) DATA FIELDS				
DATA FIELD NAME	**DATA FIELD (& ELEMENT) DEFINITION / DOMAIN**	**DATA FIELD TYPE, LENGTH, & DECIMAL PLACES**	**HOMOGENEOUS DATA SET STORAGE REQUIREMENTS**	**HETEROGENEOUS DATA SET STORAGE REQUIREMENTS**
LL_LAT_DEG_AMT ***LL_LAT_DEG**	**Latitude Degree Amount:** Unsigned, positive number representing degrees of latitude north of the equator based on the WGS84 or GRS80 spheroid. **WI Domain:** 42 through 47.	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format:**	Optional	
LL_LAT_MIN_AMT ***LL_LAT_MIN**	**Latitude Minute Amount:** Unsigned, positive number representing minutes of latitude north of the equator based on the WGS84 or GRS80 spheroid. **Domain:** 00 through 59.	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format:**	Optional	
LL_LAT_SCND_AMT ***LL_LAT_SCN**	**Latitude Second Amount:** Unsigned, positive number representing the decimal seconds of latitude north of the equator based on the WGS84 or GRS80 spheroid. **Domain:** 00.0000 through 59.9999.	**Type:** Numeric **Length:** 6 **Dec. Places:** 4 **Format:**	Optional	
LL_LONG_DEG_AMT ***LL_LON_DEG**	**Longitude Degree Amount:** Signed, negative number representing the degrees of longitude West of the Prime (Greenwich) Meridian based on the WGS84 or GRS80 spheroid. **Wisconsin domain:** -86 through –93.	**Type:** Numeric **Length:** 3 **Dec. Places:** 0 **Format:**	Optional	
LL_LONG_MIN_AMT ***LL_LON_MIN**	**Longitude Minute Amount:** Unsigned, positive number representing the minutes of longitude West of the Prime (Greenwich) Meridian based on the WGS84 or GRS80 spheroid. **Domain:** 00 through 59.	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format:**	Optional	
LL_LONG_SCND_AMT ***LL_LON_SCN**	**Longitude Second Amount:** Unsigned, positive number representing the decimal seconds of longitude West of the Prime (Greenwich) Meridian based on the WGS84 or GRS80 spheroid. **Domain:** 00.0000 through 59.9999.	**Type:** Numeric **Length:** 6 **Dec. Places:** 4 **Format:**	Optional	

PUBLIC LAND SURVEY SYSTEM (PLSS) DATA FIELDS				
DATA FIELD NAME	**DATA FIELD (& ELEMENT) DEFINITION / DOMAIN**	**DATA FIELD TYPE, LENGTH, & DECIMAL PLACES**	**HOMOGENEOUS DATA SET STORAGE REQUIREMENTS**	**HETEROGENEOUS DATA SET STORAGE REQUIREMENTS**
PLSS_RNG_DIR_NUM_CODE ***RNG_DIR_NO**	**PLSS Range Direction Numeric Code:** Numeric code for PLSS Range direction East or West of the 4th Principal Meridian. **Domain:** 2 = West, 4 = East.	**Type:** Numeric **Length:** 1 **Dec. Places:** 0 **Format:**	Required record-level storage for all PLSS descriptions in tabular and GIS systems and applications.	
PLSS_TWN_ID ***TWN_ID**	**PLSS Township Identifier:** PLSS Township (number) identifier. **Domain:** 1 through 53.	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format:**	Required record-level storage for all PLSS descriptions in tabular and GIS systems and applications.	
PLSS_RNG_ID ***RNG_ID**	**PLSS Range Identifier:** PLSS Range (number) identifier. **Domain:** 1 through 20 (West); 1 through 30 (East).	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format:**	Required record-level storage for all PLSS descriptions in tabular and GIS systems and applications.	
PLSS_SCTN_ID ***SCTN_ID**	**PLSS Section Identifier:** PLSS section (number) identifier. Store "0" when feature is located in a non-standard PLSS tract. **Domain:** 0 through 36	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format:**	Required record-level storage for all PLSS descriptions in tabular and GIS systems and applications.	
PLSS_Q1_SCTN_NUM_CODE ***Q1_SCTN_NO**	**PLSS Quarter-Section Numeric Code:** Numeric PLSS quarter-section code. Store "0" when feature is located in a non-standard PLSS tract. **Domain:** 0-9 (see *PLSS Quarter Codes* in ***Section V.3.a*** above).	**Type:** Numeric **Length:** 1 **Dec. Places:** 0 **Format:**	Required record-level storage for all PLSS descriptions in tabular and GIS systems and applications.	
PLSS_TRACT_TYPE ***PLS_TRACT**	**PLSS Tract Type:** Code representing the type of non-standard PLSS tract. Leading zero required. **Domain:** See *Special Tracts NOT Included in the PLSS* in ***Section V.3.a*** above.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for applicable PLSS descriptions in tabular and GIS systems and applications.	
PLSS_ENTITY_CODE ***PLS_ENTITY**	**PLSS Entity Code**: Code of the non-standard PLSS tract. Leading zero required. **Domain:** 000-999.	**Type:** Character **Length:** 3 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for applicable PLSS descriptions in tabular and GIS systems and applications.	

PUBLIC LAND SURVEY SYSTEM (PLSS) DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
PLSS_Q2_SCTN_NUM_CODE ***Q2_SCTN_NO**	**PLSS Quarter-Quarter-Section Numeric Code:** Numeric PLSS quarter-quarter-section code. Store "0" when feature is located in a non-standard PLSS tract. **Domain:** 0-9 (see *PLSS Quarter Codes* in ***Section V.3.a*** above).	**Type:** Numeric **Length:** 1 **Dec. Places:** 0 **Format:**	Recommended record-level storage for applicable PLSS descriptions in tabular and GIS systems and applications.	
DNR_CNTY_CODE ***DNR_CTY_CD**	**DNR County Code:** Numeric DNR code for the county in which the feature is located. **Domain:** See DNR_CNTY_CODE in the *County Codes* (***Appendix B.6***).	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format:**	Recommended record-level storage for applicable PLSS descriptions in tabular and GIS systems and applications.	
PLSS_DTRSQQ_CODE ***DTRSQQ**	**PLSS DTRSQQ Code:** Geo-code for PLSS description. Created by concatenating the contents of the following data fields (and adding leading zeros where appropriate): [PLSS_RNG_DIR_NUM_CODE] (1st digit); [PLSS_ TWN_ID] (2nd & 3rd digits); [PLSS_ RNG_ID] (4th & 5th digits); [PLSS_SCTN_ID] (6th & 7th digits); [PLSS_Q1_SCTN_NUM_CODE] (8th digit); [PLSS_Q2_SCTN_NUM_CODE] (9th digit). Example: 412230523.	**Type:** Numeric **Length:** 9 **Dec. Places:** 0 **Format:**	Recommended record-level storage for applicable PLSS descriptions in tabular and GIS systems and applications. Must be used when PLSS "centroid" look-up table geo-codes feature locations from PLSS descriptions.	
PLSS_Q3_SCTN_NUM_CODE ***Q3_SCTN_NO**	**PLSS Quarter-Quarter-Quarter-Section Numeric Code:** Numeric PLSS quarter-quarter-quarter-section code. Store "0" when feature is located in a non-standard PLSS tract. Must be equivalent to [PLSS_Q3_SCTN_ CHAR_CODE] value. **Domain:** 0-9 (see *PLSS Quarter Codes* in ***Section V.3.a*** above).	**Type:** Numeric **Length:** 1 **Dec. Places:** 0 **Format:**	Optional	
PLSS_Q4_SCTN_NUM_CODE ***Q4_SCTN_NO**	**PLSS Quarter-Quarter-Quarter-Quarter-Section Numeric Code:** Numeric PLSS quarter-quarter-quarter-quarter-section code. Store "0" when feature is located in a non-standard PLSS tract. Must be equivalent to [PLSS_Q4_SCTN_ CHAR_CODE] value. **Domain:** 0-9 (see *PLSS Quarter Codes* in ***Section V.3.a*** above).	**Type:** Numeric **Length:** 1 **Dec. Places:** 0 **Format:**	Optional	

Attachment 3 to MNRD Non-Local Beings Report

PUBLIC LAND SURVEY SYSTEM (PLSS) DESCRIPTION DATA FIELDS				
DATA FIELD NAME	**DATA FIELD (& ELEMENT) DEFINITION / DOMAIN**	**DATA FIELD TYPE, LENGTH, & DECIMAL PLACES**	**HOMOGENEOUS DATA SET STORAGE REQUIREMENTS**	**HETEROGENEOUS DATA SET STORAGE REQUIREMENTS**
PLSS_RNG_DIR_CHAR_CODE ***RNG_DIR_CH**	**PLSS Range Direction Character Code:** Character code for the PLSS Range direction East or West of the 4th Principal Meridian. Must be equivalent to [PLSS_RNG_DIR_ NUM_CODE]. **Domain:** W = West; E = East.	**Type:** Character **Length:** 1 **Dec. Places:** 0 **Format:** All capitalized	Optional	
PLSS_Q1_SCTN_CHAR_CODE ***Q1_SCTN_CH**	**PLSS Quarter-Section Character Code:** Character PLSS quarter-section code. Must be equivalent to [PLSS_Q1_SCTN_NUM _CODE] value. **Domain:** See *PLSS Quarter Codes* in ***Section V.3.a*** above.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Optional	
PLSS_Q2_SCTN_CHAR_CODE ***Q2_SCTN_CH**	**PLSS Quarter-Quarter-Section Character Code:** Character PLSS quarter-quarter-section code. Must be equivalent to [PLSS_Q2_ SCTN_NUM _CODE] value. **Domain:** See *PLSS Quarter Codes* in ***Section V.3.a*** above.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Optional	
PLSS_Q3_SCTN_CHAR_CODE ***Q3_SCTN_CH**	**PLSS Quarter-Quarter-Quarter-Section Character Code:** Character PLSS quarter-quarter-quarter-section code. Must be equivalent to [PLSS_Q3_SCTN_NUM _CODE] value. **Domain:** See *PLSS Quarter Codes* in ***Section V.3.a*** above.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Optional	
PLSS_Q4_SCTN_CHAR_CODE ***Q4_SCTN_CH**	**PLSS Quarter-Quarter-Quarter-Quarter-Section Character Code:** Character PLSS quarter-quarter-quarter-quarter-section code. Must be equivalent to [PLSS_Q4_SCTN_ NUM _CODE] value. **Domain:** See *PLSS Quarter Codes* in ***Section V.3.a*** above.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Optional	

PARCEL DESCRIPTION DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
DOR_CNTY_CODE ***DOR_CTY_CD**	**DOR County Code:** Wisconsin Department of Revenue (DOR) code for the county in which the feature is located**. Domain:** See DOR_ CNTY_CODE values in *County Codes* (***Appendix B.6***).	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format:**	Required record-level storage for all parcel descriptions in tabular and GIS systems and applications.	
MUNI_TYPE_CODE ***MUNI_TYPE**	**Municipality Type Code:** Numeric code representing the type of municipality in which the parcel is located. **Domain:** 0 = Civil Town; 1 = Village; 2 = City. See ***DW_MCD*** table via the *DAMenu* application (***Section III.8***).	**Type:** Numeric **Length:** 1 **Dec. Places:** 0 **Format:**	Required record-level storage for all parcel descriptions in tabular and GIS systems and applications.	
MCD_CODE ***MCD_CODE**	**Minor Civil Division Code:** Numeric code representing the minor civil division in which the parcel is located. **Domain:** See ***DW_MCD*** table via the *DAMenu* application (***Section III.8***).	**Type:** Numeric **Length:** 2 **Dec. Places:** 0 **Format**	Required record-level storage for all parcel descriptions in tabular and GIS systems and applications.	
PLSS_RNG_DIR_NUM_CODE	**PLSS Range Direction Numeric Code**	See characteristics in *Public Land Survey System (PLSS) Data Fields* table above.	Required record-level storage for all parcel descriptions in tabular and GIS systems and applications.	
PLSS_TWN_ID	**PLSS Township Identifier**			
PLSS_RNG_ID	**PLSS Range Identifier**			
PLSS_SCTN_ID	**PLSS Section Identifier**			
PLSS_Q1_SCTN_NUM_CODE	**PLSS Quarter-Section Numeric Code**			
PLSS_Q2_SCTN_NUM_CODE	**PLSS Quarter-Quarter-Section Numeric Code**			
PLSS_TRACT_TYPE	**PLSS Tract Type**		Required record-level storage for applicable parcel descriptions in tabular and GIS systems and applications	
PLSS_ENTITY_CODE	**PLSS Entity Code**			
PARCEL_NO ***PARCEL_NO**	**Parcel Number:** Standard or non-standard parcel number assigned by county/local "Real Property" Lister. May include dashes.	**Type:** Character **Length:** 50 **Dec. Places:** 0 **Format:** Various	Required record-level storage for all parcel descriptions in tabular and GIS systems and applications.	

Attachment 3 to MNRD Non-Local Beings Report

PARCEL DESCRIPTION DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
FIPS_CODE ***FIPS_CODE**	**Federal Information Processing System (FIPS) Code:** Numeric FIPS code. Created by concatenating the following data fields (and adding leading zeros where appropriate): [DOR_CNTY_CODE] (1st & 2nd digits); [MUNI_TYPE_CODE] (3rd digit); [MCD_ CODE] (4th & 5th digits). **Domain:** See ***DW_MCD*** table via the *DAMenu* application (***Section III.8***).	**Type:** Numeric **Length:** 5 **Dec. Places:** 0 **Format:**	Optional	

STREET ADDRESS DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
STREET_ADDR_1_TEXT ***ADDR_1_TXT**	**Street Address Line 1 Text:** The first line of street address, containing the following address components: number, pre-direction, street name, street suffix, post-direction. Example: 101 S WEBSTER ST.	**Type:** Character **Length:** 60 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for all street addresses in tabular and GIS systems and applications.	
STREET_ADDR_2_TEXT ***ADDR_2_TXT**	**Street Address Line 2 Text:** The second line of street address, containing the following address components: unit designator and unit number. Example: STE 24.	**Type:** Character **Length:** 30 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for applicable street addresses in tabular and GIS systems and applications.	
STREET_ADDR_MUNI_NAME ***ADDR_MUNI**	**Street Address Municipality Name:** Incorporated city, town, or village name. **Domain:** See ***DW_MCD*** table via the *DAMenu* application (***Section III.8***).	**Type:** Character **Length:** 20 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for all street addresses in tabular and GIS systems and applications.	
STREET_ADDR_STATE_ABBR ***ADDR_STATE**	**Street Address State Abbreviation:** The USPS U.S. state abbreviation. Example: WI.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for all street addresses in tabular and GIS systems and applications.	

STREET ADDRESS DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
STREET_ADDR_ZIP_CODE ***ADDR_ZIP**	**Street Address ZIP Code:** The USPS U.S. zip code. Examples: 53717 or 537171134.	**Type:** Numeric **Length:** 9 **Dec. Places:** 0 **Format:**	Required record-level storage for all street addresses in tabular and GIS systems and applications.	
STREET_ADDR_NO_DATA ***STREET_NUM**	**Street Address Number Data:** The street number containing the following address components: number. Example: 101	**Type:** Numeric **Length:** Variable **Dec. Places:** 0 **Format:**	Optional.	
STREET_ADDR_NAME_TEXT ***STREET_NAM**	**Street Address Name Text:** The street name, containing the following address components: pre-direction, street name, street suffix, post-direction: Example: S WEBSTER ST	**Type:** Character **Length:** 60 **Dec. Places:** 0 **Format:** All capitalized	Optional	
STREET_ADDR_UNIT_TEXT ***STREET_UNT**	**Street Unit Text:** The street address unit, containing the following address components: unit designator and unit number. Example: STE 24.	**Type:** Character **Length:** 30 **Dec. Places:** 0 **Format:** All capitalized	Optional	
STREET_FRGN_TERR_TEXT ***FRGN_TERR**	**Foreign Territory:** The USPS foreign territory name or code.	**Type:** Character **Length:** 20 **Dec. Places:** 0 **Format:** All capitalized	Optional	
STREET_FRGN_POST_CODE ***FRGN_PO_CD**	**Foreign Postal Code:** The USPS foreign territory postal code.	**Type:** Character **Length:** 20 **Dec. Places:** 0 **Format:** All capitalized	Optional	

"ORIGINALLY COLLECTED" VERTICAL DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
{Program-defined Feature Identifier}	**Program-defined Feature Identifier**	See characteristics in *"Originally Collected" Horizontal Data Fields* table above.	Required record-level storage for all features, and metadata documentation for data set.	
ORIG_VRT_COLL_MTHD_CODE ***OV_COL_MTH**	**Original Vertical Collection Method Code:** Code indicating the method by which the feature's vertical location was originally collected. **Domain:** See COLL_MTHD_ CODE in *Data Collection Method Codes* (***Appendix B.1***).	**Data Type:** Character **Length:** 6 **Dec. Places:** 0 **Format:** AAA###; All capitalized	Required record-level storage for all features, and metadata documentation for data set.	
ORIG_VRT_REF_SYS_CODE ***OV_REF_SYS**	**Original Vertical Referencing System Code:** Code indicating the referencing system in which the feature's vertical location was originally collected. **Domain:** See REF_ SYS_CODE in *Referencing System Codes* (***Appendix B.2***).	**Type:** Character **Length:** 5 **Dec. Places:** 0 **Format:** AA###; All capitalized	Required record-level storage for all features and metadata documentation for data set.	
ORIG_VRT_COLL_DATE ***OV_COL_DAT**	**Original Vertical Collection Date:** Beginning date on which the feature's vertical location was originally collected.	**Type:** Date **Length:** 8 **Dec. Places:** 0 **Format:** MMDDYYYY	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
ORIG_VRT_SRC_YEAR ***OV_SRC_YR** **NOTE: Data field only applicable for some data collection methods!**	**Original Vertical Source Year:** Year that the source (e.g., map, imagery, DOP), from which the feature's vertical location was originally collected, was created, published, updated, revised, flown, etc.	**Type:** Numeric **Length:** 4 **Dec. Places:** 0 **Format:** YYYY	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
ORIG_VRT_SRC_DNOM_AMT ***OV_SRC_DNM** **NOTE: Data field only applicable for some data collection methods!**	**Original Vertical Source Denominator Amount:** Scale denominator of the source (e.g., map, DOP photo base) from which the feature's vertical location was originally collected. Example: 24000 for 1:24,000 scale.	**Type:** Numeric **Length:** 10 **Dec. Places:** 0 **Format:**	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.

"ORIGINALLY COLLECTED" VERTICAL DATA FIELDS				
DATA FIELD NAME	**DATA FIELD (& ELEMENT) DEFINITION / DOMAIN**	**DATA FIELD TYPE, LENGTH, & DECIMAL PLACES**	**HOMOGENEOUS DATA SET STORAGE REQUIREMENTS**	**HETEROGENEOUS DATA SET STORAGE REQUIREMENTS**
ORIG_VRT_IMG_RSLN_AMT ***OV_IMG_RSL** **NOTE: Data field only applicable for some data collection methods!**	**Original Vertical Image Resolution Amount:** Pixel resolution of the raster source (e.g., satellite imagery, DOP, DRG) from which the feature's vertical location was originally collected.	**Type:** Numeric **Length:** 10 **Dec. Places:** 0 **Format:**	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
ORIG_VRT_IMG_RSLN_UNITS ***OV_RSL_UNT** **NOTE: Data field only applicable for some data collection methods!**	**Original Vertical Image Resolution Units:** Pixel resolution unit of the raster source (e.g., satellite imagery, DOP, DRG) from which the feature's vertical location was originally collected. ***Domain:*** MT = meters; FT = feet; KM = kilometers; MI = miles.	**Type:** Numeric **Length:** Variable **Dec. Places:** 0 **Format:**	Required metadata documentation for data set. Recommended record-level storage for all features.	Required record-level storage for all features and metadata documentation for data set.
FEAT_TYPE_CODE	**Feature Type Code**	See characteristics in *"Originally Collected" Horizontal Data Fields* table above.	Required record-level storage for some EPA reporting.	
{Program-defined Site Identifier}	**Program-defined Site Identifier**		Required metadata documentation for data set. Recommended record-level storage for all features.	
ORIG_VRT_COLL_MTHD_TEXT ***OV_MTH_TXT**	**Original Vertical Collection Method Text:** Additional detail about the method by which the feature's vertical location was originally collected. See *Data Collection Method Codes* discussion (***Appendix B.1***).	**Type:** Character **Length:** 255 **Dec. Places:** 0 **Format:** All capitalized	Recommended record-level storage for applicable features and data collection method.	
ORIG_VRT_COLL_TOOL_CODE ***OV_COLTOOL**	**Original Vertical Collection Tool Code:** Code indicating the tool used during the original collection of the feature's vertical location. **Domain:** See COLL_TOOL_CODE in *Data Collection Tool Codes* (***Appendix B.5***).	**Type:** Character **Length:** 8 **Dec. Places:** 0 **Format:** All capitalized	Recommended record-level storage for applicable features and data collection method.	
ORIG_VRT_COLL_NAME ***OV_COL_NAM**	**Original Vertical Collector Name:** DNR user ID (e.g., SMITHJ) or name of the person who originally collected the feature's vertical location.	**Type:** Character **Length:** 30 **Dec. Places:** 0 **Format:** All capitalized	Recommended record-level storage for applicable features and data collection method.	

Attachment 3 to MNRD Non-Local Beings Report

ALTITUDE DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
ALTITUDE_AMT ***ALTD_AMT**	**Altitude Amount:** The altitude of a feature, measured in [ALTITUDE_UNITS], above the vertical datum specified in the [ORIG_VRT_ REF_SYS_CODE] data field.	**Type:** Numeric **Length:** Floating **Dec. Places:** Floating **Format:**	Required record-level storage for altitude data in tabular and GIS systems and applications.	
ALTITUDE_UNITS ***ALTD_UNITS**	**Altitude Units:** Units in which the altitude of a feature is measured. **Domain**: MT = meters; FT = feet; and KM = kilometers; MI = miles.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for altitude data in tabular and GIS systems and applications.	

DEPTH DATA FIELDS

DATA FIELD NAME	DATA FIELD (& ELEMENT) DEFINITION / DOMAIN	DATA FIELD TYPE, LENGTH, & DECIMAL PLACES	HOMOGENEOUS DATA SET STORAGE REQUIREMENTS	HETEROGENEOUS DATA SET STORAGE REQUIREMENTS
DEPTH_AMT ***DEPTH_AMT**	**Depth Amount:** The depth of a feature, measured in [DEPTH_UNITS], below the vertical datum specified in the [ORIG_VRT_ REF_SYS_CODE] data field.	**Type:** Numeric **Length:** Floating **Dec. Places:** Floating **Format:**	Required record-level storage for altitude data in tabular and GIS systems and applications.	
DEPTH_UNITS ***DEPTH_UNIT**	**Depth Units:** Units in which the depth of a feature is measured. **Domain**: MT = meters; FT = feet; and KM = kilometers; MI = miles.	**Type:** Character **Length:** 2 **Dec. Places:** 0 **Format:** All capitalized	Required record-level storage for altitude data in tabular and GIS systems and applications.	

APPENDIX B: CODE "LOOKUP" TABLE LISTS

1. DATA COLLECTION METHOD CODES

This table lists standard horizontal and vertical locational data collection method codes. It also contains equivalent EPA codes where appropriate, and suggested domain values for <u>recommended</u> or <u>optional</u> "originally collected" horizontal [ORIG_HRZ_...] and vertical [ORIG_VRT_...] data fields are also listed. For example, values in the COLL_MTHD_TEXT column below are stored in the [ORIG_HRZ_ COLL_MTHD_ TEXT] or [ORIG_VRT_COLL_ MTHD_TEXT] data field. "**No**" means the data element is not collected/stored for that method.

Collection Method Code COLL_MTHD_CODE	Collection Method Description COLL_MTHD_DESC	EPA Vert. Collection Method Code	EPA Horiz. Collection Method Code	Collection Method Text COLL_MTHD_TEXT	Collection Tool Code COLL_TOOL_CODE	Source Year SRC_YEAR	Source Denominator Amount SRC_DNOM_AMT	Image Resolution Amount IMG_RSLN_AMT and Units IMG_RSLN_UNITS
CNV001	Data provided to DNR in digital format from known source, and converted for DNR use (refer to metadata).	---	---	No				
GCD001	Geo-coded by Public Land Survey System (PLSS) quarter-quarter-section centroid.	--	035	Enter "geoflag" code from protraction.	PROTRACT or CENTROID or OTH_GCD	No		
GCD002	Geo-coded by Public Land Survey System (PLSS) quarter-section centroid.	--	023					
GCD003	Geo-coded by Public Land Survey System (PLSS) section centroid.	--	024					
GCD004	Geo-coded by Public Land Survey System (PLSS) township/range centroid.	--	---					
GCD005	Geo-coded by street address.	---	001	Enter Centrus "location" code.	CENTRUS or DYNAMAP or OTH_GCD	No		
GCD006	Geo-coded by nearest street intersection.	---	004					
GCD007	Geo-coded by census block group centroid.	---	009					
GCD008	Geo-coded by census block tract centroid.	---	010					
GCD009	Geo-coded by 9-digit zip code (zip+4) centroid.	---	037					
GCD010	Geo-coded by 7-digit zip code (zip+2) centroid.	---	038					
GCD011	Geo-coded by 5-digit zip code centroid.	---	026					

Collection Method Code COLL_MTHD_CODE	Collection Method Description COLL_MTHD_DESC	EPA Vert. Collection Method Code	EPA Horiz. Collection Method Code	Collection Method Text COLL_MTHD_TEXT	Collection Tool Code COLL_TOOL_CODE	Source Year SRC_YEAR	Source Denominator Amount SRC_DNOM_AMT	Image Resolution Amount IMG_RSLN_AMT and Units IMG_RSLN_UNITS
GCD012	Geo-coded by landmark name.		007	Describe as needed	No			
GCD013	Geo-coded by Wisconsin Department of Revenue (DOR) or other parcel centroid.	--	---					
GCD014	Geo-coded by minor civil division (MCD) centroid.	--	007					
GCD015	Geo-coded by other centroid.	--	---					
GCD016	Geo-coded by unknown centroid.	--	027	No				
GPS001	Global positioning system (GPS): Survey grade receiver stationary during data collection (i.e., carrier phase static relative position).	G1	012	Enter PDOP and spheroid (if other than WSG84 or GRS80)	TRIM_G2 or TRIM_G3 or TRIM_G3C or TRIM_TS or TRIM_XR or GARMIN or OTH_GPS	No		
GPS002	Global positioning system (GPS): Survey grade receiver moves during data collection (carrier phase kinematic relative position).	G2	013					
GPS003	Global positioning system (GPS): Mapping grade receiver with real-time differential correction using beacon receiver (pseudo range differential GPS or "DGPS").	G3	014					
GPS004	Global positioning system (GPS): Mapping grade receiver with post-processing differential correction.	G3	014					
GPS005	Global positioning system (GPS): Recreational grade receiver with real-time differential correction using beacon receiver (pseudo range differential GPS or "DGPS").	G3	014					
GPS006	Global positioning system (GPS): Mapping or recreational grade receiver with no differential correction and selective availability off (pseudo range standard position).	G5	016					
GPS007	Global positioning system (GPS): Mapping or recreational grade receiver with no differential correction and selective availability on (pseudo range standard position).	G6	017					

Collection Method Code COLL_MTHD_CODE	Collection Method Description COLL_MTHD_DESC	EPA Vert. Collection Method Code	EPA Horiz. Collection Method Code	Collection Method Text COLL_MTHD_TEXT	Collection Tool Code COLL_TOOL_CODE	Source Year SRC_YEAR	Source Denominator Amount SRC_DNOM_AMT	Image Resolution Amount IMG_RSLN_AMT and Units IMG_RSLN_UNITS
GPS008	Global positioning system (GPS): Receiver grade and/or differential correction procedures unknown.	--	028	No				
GPS009	Global positioning system (GPS): Mapping grade receiver used to collect data with offset (assumes GPS data are differentially corrected).	G3	014	Enter PDOP and spheroid (if other than WSG84 or GRS80)	TRIM_G2; TRIM_G3; TRIM_GC3; TRIM_TS; TRIM_XR; GARMIN; or OTH_GPS	No		
GPS010	Global positioning system (GPS): Recreational grade receiver in real-time mode used to collect data with offset.	G3	014					
GPS011	Global positioning system (GPS): Recreational grade receiver without real-time differential correction used to collect data with offset.	G5	016					
LOR001	Loran C radio receiver.	--	022	No				
MLT001	Multiple locational data collection methods or sources used for one feature.	--	---	Describe as needed in these data fields or in metadata.				
MLT002	Points composed of point data from different source(s) or collected using multiple methods.	---	---					
MLT003	Arcs composed of segments from different source(s) or collected using multiple methods.	---	---					
MLT004	Polygons composed of arcs from different source(s) or collected using multiple methods.	---	---					
MLT005	Route/Region feature composed of arcs/polygons from different source(s) or collected using multiple methods.	---	---					
OTH001	Other locational data collection method.	OT	---	Describe as needed in these data fields or in metadata.				
PAR001	Interpreted from parcel description (verbal description, metes & bounds, survey notes).	--	---	Describe as needed in these fields or metadata.	No			
SCN001	Scanning or vectorizing techniques.	--	---	Describe as needed in these data fields or in metadata.				

<table>
<tr><th>Collection Method Code
COLL_MTHD_CODE</th><th>Collection Method Description
COLL_MTHD_DESC</th><th>EPA Vert. Collection Method Code</th><th>EPA Horiz. Collection Method Code</th><th>Collection Method Text
COLL_MTHD_TEXT</th><th>Collection Tool Code
COLL_TOOL_CODE</th><th>Source Year
SRC_YEAR</th><th>Source Denominator Amount
SRC_DNOM_AMT</th><th>Image Resolution Amount IMG_RSLN_AMT and Units IMG_RSLN_UNITS</th></tr>
<tr><td>SCR001</td><td>Digitized on screen: feature published/ visible on digital orthophoto (DOP).</td><td>--</td><td>019</td><td rowspan="14">Describe zoom scale, snap tolerance, and other conditions as needed.</td><td rowspan="14">ARCVIEW
or
ARCINFO
or
ERDAS
or
OTH_SCR
or
SWIS1.5</td><td rowspan="14">Yes</td><td rowspan="6">Yes</td><td rowspan="4">Yes</td></tr>
<tr><td>SCR002</td><td>Digitized on screen: feature interpreted from digital orthophoto (DOP).</td><td>--</td><td>019</td></tr>
<tr><td>SCR003</td><td>Digitized on screen: feature published/visible on USGS 7.5-minute digital raster graphic (DRG).</td><td>--</td><td>018</td></tr>
<tr><td>SCR004</td><td>Digitized on screen: feature interpreted from USGS 7.5-minute digital raster graphic (DRG).</td><td>--</td><td>018</td></tr>
<tr><td>SCR005</td><td>Digitized on screen: feature published/visible on digital vector data (e.g., hydrography, landnet).</td><td>--</td><td>021</td><td rowspan="2">No</td></tr>
<tr><td>SCR006</td><td>Digitized on screen: feature interpreted from digital vector data (e.g., hydrography, landnet).</td><td>--</td><td>021</td></tr>
<tr><td>SCR007</td><td>Digitized on screen: feature published/visible on Landsat Thematic Mapper ™ satellite imagery.</td><td>--</td><td>033</td><td rowspan="4">No</td><td rowspan="8">Yes</td></tr>
<tr><td>SCR008</td><td>Digitized on screen: feature interpreted from Landsat Thematic Mapper ™ satellite imagery.</td><td>--</td><td>033</td></tr>
<tr><td>SCR009</td><td>Digitized on screen: feature published/visible on SPOT satellite imagery.</td><td>--</td><td>031</td></tr>
<tr><td>SCR010</td><td>Digitized on screen: feature interpreted from SPOT satellite imagery.</td><td>--</td><td>031</td></tr>
<tr><td>SCR011</td><td>Digitized on screen: feature published/visible on scanned rectified aerial photograph.</td><td>--</td><td>019</td><td rowspan="4">Yes</td></tr>
<tr><td>SCR012</td><td>Digitized on screen: feature interpreted from scanned rectified aerial photograph.</td><td>--</td><td>019</td></tr>
<tr><td>SCR013</td><td>Digitized on screen: feature published/visible on scanned unrectified aerial photograph.</td><td>--</td><td>019</td></tr>
<tr><td>SCR014</td><td>Digitized on screen: feature interpreted from scanned unrectified aerial photograph.</td><td>--</td><td>019</td></tr>
</table>

Collection Method Code COLL_MTHD_CODE	Collection Method Description COLL_MTHD_DESC	EPA Vert. Collection Method Code	EPA Horiz. Collection Method Code	Collection Method Text COLL_MTHD_TEXT	Collection Tool Code COLL_TOOL_CODE	Source Year SRC_YEAR	Source Denominator Amount SRC_DNOM_AMT	Image Resolution Amount IMG_RSLN_AMT and Units IMG_RSLN_UNITS
SCR015	Digitized on screen: feature published/visible on other satellite imagery.	--	020	Describe zoom scale, snap tolerance, and other conditions as needed.	ARCVIEW or ARCINFO or ERDAS or OTH_SCR or SWIS1.5	Yes	No	Yes
SCR016	Digitized on screen: feature interpreted from other satellite imagery.	--	020	Describe zoom scale, snap tolerance, and other conditions as needed.	ARCVIEW or ARCINFO or ERDAS or OTH_SCR or SWIS1.5	Yes	No	Yes
SCR017	Digitized on screen: feature published/visible on other scanned or raster source.	--	021	Describe zoom scale, snap tolerance, and other conditions as needed.	ARCVIEW or ARCINFO or ERDAS or OTH_SCR or SWIS1.5	Yes	Yes	Yes
SCR018	Digitized on screen: feature interpreted from other scanned or raster source.	--	021	Describe zoom scale, snap tolerance, and other conditions as needed.	ARCVIEW or ARCINFO or ERDAS or OTH_SCR or SWIS1.5	Yes	Yes	Yes
SRV001	Classical terrestrial surveying techniques.	S1	025	Describe as needed	EDM or LSR_RNG or GEOD_TS or THEODLT	No	No	No
SRV002	Calculated from COGO measurements.	--	025	Describe as needed	EDM or LSR_RNG or GEOD_TS or THEODLT	No	No	No
TAB001	Digitized on table: feature published/visible on map sheet (e.g., paper, mylar).	--	018	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No
TAB002	Digitized on table: feature interpreted from map sheet (e.g., paper, mylar).	--	018	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No
TAB003	Digitized on table: feature published/visible on rectified aerial photograph (e.g., paper, film).	--	019	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No
TAB004	Digitized on table: feature interpreted from rectified aerial photograph (e.g., paper, film).	--	019	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No
TAB005	Digitized on table: feature published/visible on unrectified aerial photograph (e.g., paper, film).	--	019	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No
TAB006	Digitized on table: feature interpreted from unrectified aerial photograph (e.g., paper, film).	--	019	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No
TAB007	Digitized on table: feature published/visible on CAD diagram, blueprint, or construction plan sheet (e.g., paper, mylar).	--	021	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No
TAB008	Digitized on table: feature interpreted from CAD diagram, blueprint, or construction plan sheet (e.g., paper, mylar).	--	021	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No

Collection Method Code COLL_MTHD_CODE	Collection Method Description COLL_MTHD_DESC	EPA Vert. Collection Method Code	EPA Horiz. Collection Method Code	Collection Method Text COLL_MTHD_TEXT	Collection Tool Code COLL_TOOL_CODE	Source Year SRC_YEAR	Source Denominator Amount SRC_DNOM_AMT	Image Resolution Amount IMG_RSLN_AMT and Units IMG_RSLN_UNITS
TAB009	Digitized on table: feature published/visible on other paper, mylar or film source.	--	021	Describe as needed	ARCVIEW or ARCINFO or CAD or OTH_TAB	Yes	Yes	No
TAB010	Digitized on table: feature interpreted from other paper, mylar or film source.	--	021					
UNK001	Unknown/guess	--	027	No				
VRT001	Topographic map interpolation: feature altitude or depth published/visible on source map.	T1	---	Describe as needed	No	Yes	Yes	No
VRT002	Topographic map interpolation: feature altitude or depth interpreted from source map.	T1	---					
VRT003	Measured using precise leveling techniques with benchmark control points.	L1	---			No		
VRT004	Measured using leveling techniques with non-benchmark control points.	L2	---					
VRT005	Measured using trigonometric leveling techniques.	L3	---					
VRT006	Interpreted from digital elevation model (DEM).	--	---			Yes	Yes	Yes
VRT007	Photogrammetric techniques.	P1	---			No		
VRT008	Interpreted from digital terrain model (DTM).	--				Yes	No	Yes

2. REFERENCING SYSTEM CODES

Referencing System Code REF_SYS_CODE	Referencing System Name REF_SYS_NAME	Referencing System Description REF_SYS_DESC	Referencing System Type H = Horizontal V = Vertical
CC001	ADAMS_CCS_FEET	Adams County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC002	ADAMS_OTHR	Adams County other coordinate system (must provide parameter documentation).	H
CC003	ASHLND_CCS_FEET	Ashland County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC004	ASHLND_OTHR	Ashland County other coordinate system (must provide parameter documentation).	H
CC005	BARRON_CCS_FEET	Barron County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC006	BARRON_OTHR	Barron County other coordinate system (must provide parameter documentation).	H
CC007	BAYFLD_CCS_FEET	Bayfield County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC008	BAYFLD_OTHR	Bayfield County other coordinate system (must provide parameter documentation).	H
CC009	BROWN_CCS_FEET	Brown County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC010	BROWN_OTHR	Brown County other coordinate system (must provide parameter documentation).	H
CC011	BUFFAL_CCS_FEET	Buffalo County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC012	BUFFAL_OTHR	Buffalo County other coordinate system (must provide parameter documentation).	H
CC013	BURNET_CCS_FEET	Burnett County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC014	BURNET_OTHR	Burnett County other coordinate system (must provide parameter documentation).	H
CC015	CALUME_CCS_FEET	Calumet County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC016	CALUME_OTHR	Calumet County other coordinate system (must provide parameter documentation).	H
CC017	CHIPPE_CCS_FEET	Chippewa County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC018	CHIPPE_OTHR	Chippewa County other coordinate system (must provide parameter documentation).	H
CC019	CLARK_CCS_FEET	Clark County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC020	CLARK_OTHR	Clark County other coordinate system (must provide parameter documentation).	H
CC021	COLUMB_CCS_FEET	Columbia County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC022	COLUMB_OTHR	Columbia County other coordinate system (must provide parameter documentation).	H
CC023	CRAWFD_CCS_FEET	Crawford County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC024	CRAWFD_OTHR	Crawford County other coordinate system (must provide parameter documentation).	H
CC025	DANE_CCS_FEET	Dane County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC026	DANE_OTHR	Dane County other coordinate system (must provide parameter documentation).	H
CC027	DODGE_CCS_FEET	Dodge County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC028	DODGE_OTHR	Dodge County other coordinate system (must provide parameter documentation).	H
CC029	DOOR_CCS_FEET	Door County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC030	DOOR_OTHR	Door County other coordinate system (must provide parameter documentation).	H
CC031	DOUGLA_CCS_FEET	Douglas County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC032	DOUGLA_OTHR	Douglas County other coordinate system (must provide parameter documentation).	H
CC033	DUNN_CCS_FEET	Dunn County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC034	DUNN_OTHR	Dunn County other coordinate system (must provide parameter documentation).	H
CC035	EAUCLR_CCS_FEET	Eau Claire County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC036	EAUCLR_OTHR	Eau Claire County other coordinate system (must provide parameter documentation).	H

Referencing System Code REF_SYS_CODE	Referencing System Name REF_SYS_NAME	Referencing System Description REF_SYS_DESC	Referencing System Type H = Horizontal V = Vertical
CC037	FLOREN_CCS_FEET	Florence County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC038	FLOREN_OTHR	Florence other coordinate system (must provide parameter documentation).	H
CC039	FONDUL_CCS_FEET	Fond du Lac County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC040	FONDUL_OTHR	Fond du Lac County other coordinate system (must provide parameter documentation).	H
CC041	FOREST_CCS_FEET	Forest County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC042	FOREST_OTHR	Forest County other coordinate system (must provide parameter documentation).	H
CC043	GRANT_CCS_FEET	Grant County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC044	GRANT_OTHR	Grant County other coordinate system (must provide parameter documentation).	H
CC045	GREEN_CCS_FEET	Green County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC046	GREEN_OTHR	Green County other coordinate system (must provide parameter documentation).	H
CC047	GRNLAK_CCS_FEET	Green Lake County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC048	GRNLAK_OTHR	Green Lake County other coordinate system (must provide parameter documentation).	H
CC049	IOWA_CCS_FEET	Iowa County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC050	IOWA_OTHR	Iowa County other coordinate system (must provide parameter documentation).	H
CC051	IRON_CCS_FEET	Iron County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC052	IRON_OTHR	Iron County other coordinate system (must provide parameter documentation).	H
CC053	JACKSN_CCS_FEET	Jackson County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC054	JACKSN_OTHR	Jackson County other coordinate system (must provide parameter documentation).	H
CC055	JEFFER_CCS_FEET	Jefferson County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC056	JEFFER_OTHR	Jefferson County other coordinate system (must provide parameter documentation).	H
CC057	JUNEAU_CCS_FEET	Juneau County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC058	JUNEAU_OTHR	Juneau County other coordinate system (must provide parameter documentation).	H
CC059	KENOSH_CCS_FEET	Kenosha County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC060	KENOSH_OTHR	Kenosha County other coordinate system (must provide parameter documentation).	H
CC061	KEWAUN_CCS_FEET	Kewaunee County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC062	KEWAUN_OTHR	Kewaunee County other coordinate system (must provide parameter documentation).	H
CC063	LACROS_CCS_FEET	LaCrosse County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC064	LACROS_OTHR	LaCrosse County other coordinate system (must provide parameter documentation).	H
CC065	LAFAYT_CCS_FEET	Lafayette County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC066	LAFAYT_OTHR	Lafayette County other coordinate system (must provide parameter documentation).	H
CC067	LANGLD_CCS_FEET	Langlade County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC068	LANGLD_OTHR	Langlade County other coordinate system (must provide parameter documentation).	H
CC069	LINCLN_CCS_FEET	Lincoln County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC070	LINCLN_OTHR	Lincoln County other coordinate system (must provide parameter documentation).	H
CC071	MANITO_CCS_FEET	Manitowoc County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC072	MANITO_OTHR	Manitowoc County other coordinate system (must provide parameter documentation).	H
CC073	MARATH_CCS_FEET	Marathon County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC074	MARATH_OTHR	Marathon County other coordinate system (must provide parameter documentation).	H

Referencing System Code REF_SYS_CODE	Referencing System Name REF_SYS_NAME	Referencing System Description REF_SYS_DESC	Referencing System Type H = Horizontal V = Vertical
CC075	MARINT_CCS_FEET	Marinette County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC076	MARINT_OTHR	Marinette County other coordinate system (must provide parameter documentation).	H
CC077	MARQUE_CCS_FEET	Marquette County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC078	MARQUE_OTHR	Marquette County other coordinate system (must provide parameter documentation).	H
CC079	MENOMI_CCS_FEET	Menominee County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC080	MENOMI_OTHR	Menominee County other coordinate system (must provide parameter documentation).	H
CC081	MILWAU_CCS_FEET	Milwaukee County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC082	MILWAU_OTHR	Milwaukee County other coordinate system (must provide parameter documentation).	H
CC083	MONROE_CCS_FEET	Monroe County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC084	MONROE_OTHR	Monroe County other coordinate system (must provide parameter documentation).	H
CC085	OCONTO_CCS_FEET	Oconto County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC086	OCONTO_OTHR	Oconto County other coordinate system (must provide parameter documentation).	H
CC087	ONEIDA_CCS_FEET	Oneida County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC088	ONEIDA_OTHR	Oneida County other coordinate system (must provide parameter documentation).	H
CC089	OUTAGM_CCS_FEET	Outagamie County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC090	OUTAGM_OTHR	Outagamie County other coordinate system (must provide parameter documentation).	H
CC091	OZAUKE_CCS_FEET	Ozaukee County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC092	OZAUKE_OTHR	Ozaukee County other coordinate system (must provide parameter documentation).	H
CC093	PEPIN_CCS_FEET	Pepin County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC094	PEPIN_OTHR	Pepin County other coordinate system (must provide parameter documentation).	H
CC095	PIERCE_CCS_FEET	Pierce County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC096	PIERCE_OTHR	Pierce County other coordinate system (must provide parameter documentation).	H
CC097	POLK_CCS_FEET	Polk County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC098	POLK_OTHR	Polk County other coordinate system (must provide parameter documentation).	H
CC099	PORTAG_CCS_FEET	Portage County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC100	PORTAG_OTHR	Portage County other coordinate system (must provide parameter documentation).	H
CC101	PRICE_CCS_FEET	Price County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC102	PRICE_OTHR	Price County other coordinate system (must provide parameter documentation).	H
CC103	RACINE_CCS_FEET	Racine County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC104	RACINE_OTHR	Racine County other coordinate system (must provide parameter documentation).	H
CC105	RICHLD_CCS_FEET	Richland County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC106	RICHLD_OTHR	Richland County other coordinate system (must provide parameter documentation).	H
CC107	ROCK_CCS_FEET	Rock County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC108	ROCK_OTHR	Rock County other coordinate system (must provide parameter documentation).	H
CC109	RUSK_CCS_FEET	Rusk County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC110	RUSK_OTHR	Rusk County other coordinate system (must provide parameter documentation).	H
CC111	STCROI_CCS_FEET	Saint Croix County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H

Referencing System Code REF_SYS_CODE	Referencing System Name REF_SYS_NAME	Referencing System Description REF_SYS_DESC	Referencing System Type H = Horizontal V = Vertical
CC112	STCROI_OTHR	Saint Croix County other coordinate system (must provide parameter documentation).	H
CC113	SAUK_CCS_FEET	Sauk County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC114	SAUK_OTHR	Sauk County other coordinate system (must provide parameter documentation).	H
CC115	SAWYER_CCS_FEET	Sawyer County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC116	SAWYER_OTHR	Sawyer County other coordinate system (must provide parameter documentation).	H
CC117	SHAWAN_CCS_FEET	Shawano County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC118	SHAWAN_OTHR	Shawano County other coordinate system (must provide parameter documentation).	H
CC119	SHEBOY_CCS_FEET	Sheboygan County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC120	SHEBOY_OTHR	Sheboygan County other coordinate system (must provide parameter documentation).	H
CC121	TAYLOR_CCS_FEET	Taylor County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC122	TAYLOR_OTHR	Taylor County other coordinate system (must provide parameter documentation).	H
CC123	TREMPE_CCS_FEET	Trempealeau County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC124	TREMPE_OTHR	Trempealeau County other coordinate system (must provide parameter documentation).	H
CC125	VERNON_CCS_FEET	Vernon County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC126	VERNON_OTHR	Vernon County other coordinate system (must provide parameter documentation).	H
CC127	VILAS_CCS_FEET	Vilas County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC128	VILAS_OTHR	Vilas County other coordinate system (must provide parameter documentation).	H
CC129	WALWTH_CCS_FEET	Walworth County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC130	WALWTH_OTHR	Walworth County other coordinate system (must provide parameter documentation).	H
CC131	WASHBN_CCS_FEET	Washburn County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC132	WASHBN_OTHR	Washburn County other coordinate system (must provide parameter documentation).	H
CC133	WAUKES_CCS_FEET	Waukesha County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC134	WAUKES_OTHR	Waukesha County other coordinate system (must provide parameter documentation).	H
CC135	WAUPAC_CCS_FEET	Waupaca County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC136	WAUPAC_OTHR	Waupaca County other coordinate system (must provide parameter documentation).	H
CC137	WAUSHA_CCS_FEET	Waushara County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC138	WAUSHA_OTHR	Waushara County other coordinate system (must provide parameter documentation).	H
CC139	WASHIN_CCS_FEET	Washington County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC140	WASHIN_OTHR	Washington County other coordinate system (must provide parameter documentation).	H
CC141	WINNEB_CCS_FEET	Winnebago County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC142	WINNEB_OTHR	Winnebago County other coordinate system (must provide parameter documentation).	H
CC143	WOOD_CCS_FEET	Wood County Coordinate System (Wisconsin State Cartographer's Office, 1995).	H
CC144	WOOD_OTHR	Wood County other coordinate system (must provide parameter documentation).	H
GC001	PLSS_DESC	Public Land Survey System (PLSS) description.	H
GC002	STREET_ADDR	Street address.	H
GC003	PARCEL_DESC	Parcel description.	H
HZ001	HRZ_OTHR	Other horizontal referencing system. Must describe in the [ORIG_HRZ_ COLL_MTHD_TEXT] data field.	H
HZ002	HRZ_UNKNOWN	Unknown horizontal referencing system.	H
LL001	LL_DD	Latitude/longitude (LL) in decimal degrees (DD): WGS84 or GRS80 spheroid*.	H

Referencing System Code REF_SYS_CODE	Referencing System Name REF_SYS_NAME	Referencing System Description REF_SYS_DESC	Referencing System Type H = Horizontal V = Vertical
LL002	LL_OTHR_DD	Latitude/longitude (LL) in decimal degrees (DD): other spheroid (not WGS84 or GRS80).	H
LL003	LL_DMS	Latitude/longitude (LL) in degrees/minutes/seconds (DMS): WGS84 or GRS80 spheroid*.	H
LL004	LL_OTHR_DMS	Latitude/longitude (LL) in degrees/minutes/seconds (DMS): other spheroid (not WGS84 or GRS80).	H
LL005	LL_OTHR	Latitude/longitude (LL) in other notation (i.e., not DD or DMS). Must describe notation and/or non-standard spheroid in [ORIG_HRZ_COLL_MTHD_ TEXT] data field.	
ML001	MULTIPLE	Multiple referencing systems used for one feature	H
SP001	SP91_ZON_NORTH_METER	State Plane (SP) North zone: 1991 adjustment of North American Datum of 1983 - GRS80 spheroid. Expressed in meters.	H
SP002	SP91_ZON_CTRL_METER	State Plane (SP) Central zone: 1991 adjustment of North American Datum of 1983 - GRS80 spheroid. Expressed in meters.	H
SP003	SP91_ZON_SOUTH_METER	State Plane (SP) South zone: 1991 adjustment of North American Datum of 1983 - GRS80 spheroid. Expressed in meters.	H
SP004	SP83_ZON_NORTH_METER	State Plane (SP) North zone: North American Datum of 1983 - GRS80 spheroid. Expressed in meters.	H
SP005	SP83_ZON_CTRL_METER	State Plane (SP) Central zone: North American Datum of 1983 - GRS80 spheroid. Expressed in meters.	H
SP006	SP83_ZON_SOUTH_METER	State Plane (SP) South zone: North American Datum of 1983 - GRS80 spheroid. Expressed in meters.	H
SP007	SP83_ZON_NORTH_FEET	State Plane (SP) North zone: North American Datum of 1983 - GRS80 spheroid. Expressed in feet.	H
SP008	SP83_ZON_CTRL_FEET	State Plane (SP) Central zone: North American Datum of 1983 - GRS80 spheroid. Expressed in feet.	H
SP009	SP83_ZON_SOUTH_FEET	State Plane (SP) South zone: North American Datum of 1983 - GRS80 spheroid. Expressed in feet.	H
SP010	SP27_ZON_NORTH_FEET	State Plane (SP) North zone: North American Datum of 1927 - Clarke's spheroid of 1866. Expressed in feet.	H
SP011	SP27_ZON_CTRL_FEET	State Plane (SP) Central zone: North American Datum of 1927 - Clarke's spheroid of 1866. Expressed in feet.	H
SP012	SP27_ZON_SOUTH_FEET	State Plane (SP) South zone: North American Datum of 1927 - Clarke's spheroid of 1866. Expressed in feet.	H
UT001	UTM91_ZON_15_METER	Universal Transverse Mercator (UTM) zone 15: 1991 adjustment of North American Datum of 1983 - GRS80 spheroid.	H
UT002	UTM91_ZON_16_METER	Universal Transverse Mercator (UTM) zone 16: 1991 adjustment of North American Datum of 1983 - GRS80 spheroid.	H
UT003	UTM83_ZON_15_METER	Universal Transverse Mercator (UTM) zone 15: North American Datum of 1983 - GRS80 spheroid.	H
UT004	UTM83_ZON_16_METER	Universal Transverse Mercator (UTM) zone 16: North American Datum of 1983 - GRS80 spheroid.	H
UT005	UTM27_ZON_15_METER	Universal Transverse Mercator (UTM) zone 15: North American Datum of 1927 - Clarke's spheroid of 1866.	H
UT006	UTM27_ZON_16_METER	Universal Transverse Mercator (UTM) zone 16: North American Datum of 1927 - Clarke's spheroid of 1866.	H
UT007	UTM_UNKNOWN	Universal Transverse Mercator (UTM) zone unknown.	H
VR001	NAVD88_METER	North American Vertical Datum (NAVD) of 1988.	V
VR002	NGVD29_METER	National Geodetic Vertical Datum (NGVD) of 1929.	V
VR003	MSL_FEET	Mean sea level (MSL) vertical datum.	V
VR004	LTD_FEET	Local tidal datum (LTD).	V
VR005	ALTITUDE _OTHR	Other altitude referencing system (describe in [ORIG_HRZ_COLL_MTHD_TEXT] data field).	V
VR006	DEPTH_OTHR	Other depth referencing system (describe in [ORIG_HRZ_COLL_MTHD_TEXT] data field).	V
VR007	VRT_UNKNOWN	Unknown vertical referencing system.	V

Referencing System Code REF_SYS_CODE	**Referencing System Name REF_SYS_NAME**	**Referencing System Description REF_SYS_DESC**	**Referencing System Type H = Horizontal V = Vertical**
WT001	WTM91_METER	Wisconsin Transverse Mercator: 1991 adjustment of North American Datum of 1983 - GRS80 spheroid.	H
WT002	WTM83_METER	Wisconsin Transverse Mercator: North American Datum of 1983 - GRS80 spheroid.	H
WT003	WTM27_METER	Wisconsin Transverse Mercator: North American Datum of 1927 - Clarke's spheroid of 1866.	H

3. FEATURE TYPE CODES

Feature type codes describe the type of feature being located. Many DNR programs have developed lists of feature type codes to meet their specific business needs. A comprehensive, department-wide list, however, does not exist, and may be the focus of a future DNR strategic IT initiative. In some cases, EPA also requires that feature types be reported using specific EPA *Reference Point Codes*.

This standard defines the [FEAT_TYPE_CODE] data field for storing these codes. It also proposes that *Feature Type Codes* have the following format: 3 characters representing the general feature class (e.g., AGR – for agriculture related features, FOR – for waste related features) followed by a 3 digit (sequential) number for that feature class. Examples are listed below.

Developing an enterprise feature type list would help DNR programs consistently identify the types of real-world features being located, and help users better integrate data from multiple DNR sources. It will also facilitate object-oriented data modeling, and the development of standard symbol sets for presenting data to the public via the Internet.

Feature Type Code FEAT_TYPE_CODE	Feature Type Description FEAT_TYPE_DESC	EPA Reference Point Code
AGR001	animal feedlot / combined animal feed operations	040
AGR002	agricultural farming / farm field	---
AGR003	irrigation system	---
AGR004	manure storage (lined & unlined storage facilities)	---
AIR001	air release stack	006
AIR002	air release vent	007
AIR003	air monitoring station	029
AIR004	atmospheric emissions treatment unit	012
FOR001	forest (general)	---
FOR002	forest (demonstration)	---
FOR003	forest (experimental)	---
FOR004	fire tower	---

4. FEATURE GEOMETRIC REPRESENTATION CODES

Feature Geometric Representation Code FEAT_GEOM_REP_CODE	Feature Geometric Representation Code Description FEAT_GEOM_REP_DESC	EPA Geometric Type Code EPA_GEOM_TYPE_CODE
AREA	Area (Polygon)	003
DYNLIN	Dynamic Segmentation Linear Feature	005
DYNPT	Dynamic Segmentation Point Feature	---
LINE	Line	002
LINEAR	Linear Event	005
MULTPT	Multiple Point	001
NETWRK	Network	005
POINT	Point	001
POLLIN	Polygon/Line	004
REGION	Region	004
RASTER	Raster	---
ROUTE	Route	005

5. DATA COLLECTION TOOL CODES

Data Collection Tool Code COLL_TOOL_CODE	Data Collection Tool Description
ARCVIEW	ESRI ArcView tool.
ARCINFO	ESRI ArcInfo tool.
CAD	Computer Assisted Drafting tool.
CENTROID	*DTRSQQ_LUT* “centroid” look-up table for Public Land Survey System (PLSS): based on 1:24,000-scale Landnet data.
CENTRUS	Centrus Desktop™ for address standardization and geo-coding.
DYNAMAP	Dynamap2000/ArcView for address geo-coding.
EDM	Electronic distance measurer for classical terrestrial surveying.
ERDAS	ERDAS Professional™ image processing tool.
GARMIN	Garmin recreational grade GPS receiver.
GEOD_TS	Geodetic total station for classical terrestrial surveying.
LSR_RNG	Laser ranging for classical terrestrial surveying.
MULTIPLE	Multiple tools used to collect locational data for a feature.
OTH_GCD	Other geo-coding data collection tool.
OTH_GPS	Other global positioning sytsem (GPS) data collection tool.
OTH_IMG	Other raster image processing tool used on satellite imagery.
OTH_SCR	Other on-screen digitizing tool.
OTH_TAB	Other on-table digitizing tool.
PROJECT	DNR projections service.
PROTRACT	Protraction program from Public Land Survey System (PLSS): based on 1:100,000-scale Landnet data.
SWIS1.5	SWIS locator tool – version 1.5.
THEODLIT	Theodolite for classical terrestrial surveying.
TRIM_G2	Trimble GeoExplorer 2 - mapping grade GPS receiver.
TRIM_G3	Trimble GeoExplorer 3 - mapping grade GPS receiver with "beacon-on-a-belt" real-time receiver.
TRIM_G3C	Trimble GeoExplorer 3C - mapping grade GPS receiver.
TRIM_TS	Trimble "Total Station" 48000 - survey grade GPS receiver.
TRIM_XR	Trimble PathFinder Pro XR - mapping grade GPS receiver.

6. COUNTY CODES

County codes can also be found in the DW_COUNTY look-up table, accessed through the *DAMenu* application (💻 http://intranet.dnr.state.wi.us/int/at/et/) as described in ***Section III.8***.

DNR County Code DNR_CNTY_CODE	County Code Name CNTY_NAME	DOR County Code DOR_CNTY_CODE	FIPS County Code FIPS_CNTY_CODE
1	ADAMS	1	001
2	ASHLAND	2	003
3	BARRON	3	005
4	BAYFIELD	4	007
5	BROWN	5	009
6	BUFFALO	6	011
7	BURNETT	7	013
8	CALUMET	8	015
9	CHIPPEWA	9	017
10	CLARK	10	019
11	COLUMBIA	11	021
12	CRAWFORD	12	023
13	DANE	13	025
14	DODGE	14	027
15	DOOR	15	029
16	DOUGLAS	16	031
17	DUNN	17	033
18	EAU CLAIRE	18	035
19	FLORENCE	19	037
20	FOND DU LAC	20	039
21	FOREST	21	041
22	GRANT	22	043
23	GREEN	23	045
24	GREEN LAKE	24	047
25	IOWA	25	049
26	IRON	26	051
27	JACKSON	27	053
28	JEFFERSON	28	055
29	JUNEAU	29	057
30	KENOSHA	30	059
31	KEWAUNEE	31	061
32	LACROSSE	32	063
33	LAFAYETTE	33	065
34	LANGLADE	34	067
35	LINCOLN	35	069
36	MANITOWOC	36	071
37	MARATHON	37	073
38	MARINETTE	38	075
39	MARQUETTE	39	077
40	MENOMINEE	72	078
41	MILWAUKEE	40	079
42	MONROE	41	081
43	OCONTO	42	083
44	ONEIDA	43	085
45	OUTAGAMIE	44	087
46	OZAUKEE	45	089
47	PEPIN	46	091
48	PIERCE	47	093

DNR County Code DNR_CNTY_CODE	County Code Name CNTY_NAME	DOR County Code DOR_CNTY_CODE	FIPS County Code FIPS_CNTY_CODE
49	POLK	48	095
50	PORTAGE	49	097
51	PRICE	50	099
52	RACINE	51	101
53	RICHLAND	52	103
54	ROCK	53	105
55	RUSK	54	107
56	SAINT CROIX	55	109
57	SAUK	56	111
58	SAWYER	57	113
59	SHAWANO	58	115
60	SHEBOYGAN	59	117
61	TAYLOR	60	119
62	TREMPEALEAU	61	121
63	VERNON	62	123
64	VILAS	63	125
65	WALWORTH	64	127
66	WASHBURN	65	129
67	WASHINGTON	66	131
68	WAUKESHA	67	133
69	WAUPACA	68	135
70	WAUSHARA	69	137
71	WINNEBAGO	70	139
72	WOOD	71	141
99	NON-WISC	99	999

APPENDIX C: DATA CONVERSION "CROSS-WALK" TABLES

1. METHOD CODES CROSSWALK TABLE

This crosswalk tables must be used in conjunction with program-developed "data conversion rules" to help ensure that all converted data and data fields continue to support that program's business needs. In some cases, there is not a one-to-one correlation between an "old" method code and a new one. For example, the scale has been removed from the old method descriptions, and is now stored in the [ORIG_HRZ_SRC_DNOM_AMT] data field.

Old Method Code	Old Method Code Description	New Original Horizontal Collection Method Code ORIG_HRZ_ COLL_MTHD_CODE	New Original Horizontal Source Denomin. Amount ORIG_HRZ_ SRC_DNOM_AMT
01	digitized from a map @ 1:2 million scale	TAB001	2,000,000
02	digitized from a map @ 1:1 million scale	TAB001	1,000,000
03	digitized from a map @ 1:500,000 scale	TAB001	500,000
04	digitized from a map @ 1:250,000 scale	TAB001	250,000
05	digitized from a map @ 1:126,720 scale	TAB001	126,720
06	digitized from a map @ 1:100,000 scale	TAB001	100,000
07	digitized from a map @ 1:63,360 scale	TAB001	63,360
08	digitized from a map @ 1:62,500 scale	TAB001	62,500
09	digitized from a map @ 1:24,000 scale	TAB001	24,000
10	digitized from a map @ larger than 1:24,000 scale	TAB001	<24,000
11	interpolated from a map @ 1:2 million scale	TAB002	2,000,000
12	interpolated from a map @ 1:1 million scale	TAB002	1,000,000
13	interpolated from a map @ 1:500,000 scale	TAB002	500,000
14	interpolated from a map @ 1:250,000 scale	TAB002	250,000
15	interpolated from a map @ 1:126,720 scale	TAB002	126,720
16	interpolated from a map @ 1:100,000 scale	TAB002	100,000
17	interpolated from a map @ 1:63,360 scale	TAB002	63,360
18	interpolated from a map @ 1:62,500 scale	TAB002	62,500
19	interpolated from a map @ 1:24,000 scale	TAB002	24,000
20	interpolated from a map @ larger than 1:24,000 scale	TAB002	<24,000
21	digitized from an aerial photo @ smaller than 1:60,000 scale	TAB003; TAB005	>60,000
22	digitized from an aerial photo @ 1:58,000 scale	TAB003; TAB005	58,000
23	digitized from an aerial photo @ 1:40,000 scale	TAB003; TAB005	40,000
24	digitized from an aerial photo @ 1:24,000 scale	TAB003; TAB005	24,000
25	digitized from an aerial photo @ 1:20,000 scale	TAB003; TAB005	20,000
26	digitized from an aerial photo @ 1:15,840 scale	TAB003; TAB005	15,840
27	digitized from an aerial photo @ larger than 1:15,000 scale	TAB003; TAB005	<15,000
28	interpolated from an aerial photo @ smaller than 1:60,000 scale	TAB004; TAB006	>60,000
29	interpolated from an aerial photo @ 1:58,000 scale	TAB004; TAB006	58,000
30	interpolated from an aerial photo @ 1:40,000 scale	TAB004; TAB006	40,000
31	interpolated from an aerial photo @ 1:24,000 scale	TAB004; TAB006	24,000
32	interpolated from an aerial photo @ 1:20,000 scale	TAB004; TAB006	20,000
33	interpolated from an aerial photo @ 1:15,840 scale	TAB004; TAB006	15,840
34	interpolated from an aerial photo @ larger than 1:15,000 scale	TAB004; TAB006	<15,000
35	determined from remote sensing imagery - unspecified type	UNK001	---
37	loran c radio receiver	LOR001	---
38	terrestrial surveying methods	SRV001; SRV002	---
39	global positioning system (GPS) survey methods - unspecified gps method	GPS008	---

Old Method Code	Old Method Code Description	New Original Horizontal Collection Method Code ORIG_HRZ_ COLL_MTHD_CODE	New Original Horizontal Source Denomin. Amount ORIG_HRZ_ SRC_DNOM_AMT
40	converted from a public land survey system (PLSS) description - unspecified plss units	UNK001	---
43	converted to plss quarter-quarter section from coordinate system (i.e., transverse mercator, state plane or geographic coordinates)	store appropriate “originally collected” data elements for “from” source.	---
44	from owner or propery description	PAR001	---
45	derived from local grid origin + offset coordinate	UNK001 contact source for “originally collected” data elements.	---
46	local grid origin assigned without local grid coordinates		
47	provided by local government agency	CNV001	---
50	GPS carrier phase static relative positioning technique	GPS001	---
51	GPS carrier phase kinematic relative positioning technique	GPS002	---
52	GPS code measurements (pseudo range) differential (DGPS)	GPS003; GPS005	---
53	GPS code measurements (pseudo range) precise positioning service	GPS004	---
54	GPS code measurements (pseudo range) standard positioning service - SA off	GPS006	---
55	GPS code measurements (pseudo range) standard positioning service - SA on	GPS007	---
60	geo-coded by street address	GCD005	---
61	geo-coded by landmark name	GCD012	---
62	geo-coded by nearest street intersection	GCD006	---
70	geo-coded by census block centroid	GCD007	---
71	geo-coded by census block group centroid	GCD007	---
72	geo-coded by census tract centroid	GCD008	---
73	geo-coded by minor civil division centroid	GCD014	---
74	geo-coded by zip code (5-digit)	GCD011	---
75	geo-coded by zip code (9-digit)	GCD009	---
76	geo-coded by (Department of Revenue) parcel centroid	GCD013	---
78	geo-coded by other government unit centroid	GCD015	---
80	geo-coded by centroid of PLSS township	GCD004	---
81	geo-coded by centroid of PLSS section	GCD003	---
82	geo-coded by centroid of PLSS quarter-section	GCD002	---
83	geo-coded by centroid of PLSS quarter-quarter-section	GCD001	---
90	digitized on-screen from digital orthophoto (DOP)	SCR001; SCR002	---
91	digitized on-screen from other rectified aerial photography or high-resolution satellite imagery	SCR007; SCR008; SCR009; SCR010; SCR011; SCR012	---
92	digitized on-screen from 7.5-minute digital raster graphics (DRG)	SCR003; SCR004	---
93	digitized on-screen from 1:24,000-scale digital vector data	SCR005; SCR006	24,000
94	digitized on-screen from digital vector or image data at source scales between 1:24,000 and 1:100,000	SCR005; SCR006	>24,000 - 100,000
95	digitized on-screen from digital vector or image data at source scales of1:100,000 or smaller	SCR005; SCR006	>100,000
98	best guess	UNK001	---
99	unknown	UNK001	---

2. DATA FIELDS CROSSWALK TABLE

This crosswalk tables must be used in conjunction with program-developed “data conversion rules” to help ensure that all converted data and data fields continue to support that program’s business needs. In some cases, there is not a one-to-one correlation between an “old” data field and a “new” one. For example, accuracy is no longer captured in explicit data fields for each coordinate system, but, rather, is assessed based on the “new” data collection method codes or specific accuracy testing.

OLD DATA FIELD	HOW TO CONVERT…	NOTES
Survey_Range_Ndir	Redefine data field as **PLSS_RNG_DIR_NUM_CODE**	If feature locations originally collected in or derived from PLSS or parcel description, **ORIG_ HRZ_REF_SYS_ CODE** = GC001 (PLSS_DESC) or GC003 (PARCEL_DESC). Leading zeros will disappear from data in the following “new” fields: **PLSS_TWN_ID**, **PLSS_ RNG_ID**, **PLSS_SCTN_ ID**, **DNR_CNTY_CODE**, and **DOR_ CNTY_CODE**.
Survey_Township	Redefine data field as **PLSS_TWN_ID**	
Survey_Range	Redefine data field as **PLSS_RNG_ID**	
Survey_Section	Redefine data field as **PLSS_SCTN_ID**	
Q_NSection	Redefine data field as **PLSS_Q1_SCTN_NUM_CODE**	
QQ_NSection	Redefine data field as **PLSS_Q2_SCTN_NUM_CODE**	
Parcel_No	Redefine data field as **PARCEL_NO**	
Nonstandard_Parcel_No	Move data to **PARCEL_NO**	
County_Code	Redefine data field as **DNR_CNTY_CODE** or **DOR_CNTY_CODE**. Verify what county codes were actually used and move data to appropriate data field.	
Muni_Type_Code	Redefine data field as **MUNI_TYPE_CODE**.	
MCD_Code	Redefine data field as **MCD_CODE**.	
PLSS_Method_Code	1. If feature originally located/derived using PLSS or parcel description, convert code and move data to **ORIG_HRZ_COLL_ MTHD_CODE**. Enter appropriate codes into **ORIG_HRZ_COLL_ TOOL_CODE** and **ORIG_HRZ_COLL_ MTHD_TEXT**, as recommended. 2. If features NOT originally located/derived using PLSS or parcel description, use code to track originally collected data.	

OLD DATA FIELD	HOW TO CONVERT…	NOTES
WTM_Northing	1. If WTM coordinates referenced to NAD91/HPGN (see “old” WTM_ Datum), redefine data field as **WTM91_Y_AMT**. These coordinates may also be stored in **ORIG_HRZ_Y_COORD_ AMT** as needed. 2. If features originally located by WTM83 or WTM27 (see “old” WTM_ Datum), move data to **ORIG_HRZ_Y_COORD_AMT**. 3. If coordinates NOT originally WTM83 or WTM27, project to WTM91 and store in **WTM91_Y_AMT**.	If feature locations originally collected in WTM coordinates, **ORIG_HRZ_ REF_SYS_ CODE** = WT001, WT002, or WT003.
WTM_Easting	1. If WTM coordinates referenced to NAD91/HPGN (see “old” WTM_ Datum), redefine data field as **WTM91_X_AMT**. These coordinates may also be stored in **ORIG_HRZ_X_COORD_ AMT** as needed. 2. If features originally located by WTM83 or WTM27 (see “old” WTM_ Datum), move data to **ORIG_HRZ_X_COORD_AMT**. 3. If coordinates NOT originally WTM83 or WTM27, project to WTM91 and store in **WTM91_X_AMT**.	

WTM_Datum	Incorporated into "new" **ORIG_HRZ_REF_SYS_CODE**, **WTM91_X_ AMT** and **WTM91_Y_AMT** data fields.	
WTM_Method_Code	1. If features originally located by WTM coordinates, convert code and move data to **ORIG_HRZ_COLL_ MTHD_CODE**. Enter appropriate codes into **ORIG_HRZ_COLL_ TOOL_CODE** and **ORIG_HRZ_ COLL_MTHD_TEXT** as recommended. 2. If features NOT originally located by WTM coordinates, use code to track originally collected data.	
WTM_Accuracy	Accuracy based on new **ORIG_HRZ_COLL_MTHD_ CODE** or specific accuracy testing results.	

OLD DATA FIELD	**HOW TO CONVERT…**	**NOTES**
N_Lat_DD	1. If LL coordinates referenced to WGS84 or GRS80 spheroid, redefine data field as **LL_LAT_DD_AMT**. These coordinates may also be stored in **ORIG_HRZ_X_COORD_ AMT** as needed. 2. If LL coordinates originally collected in reference to another spheroid, move data to **ORIG_HRZ_X_COORD_AMT** and note spheroid in **ORIG_HRZ_ COLL_MTHD_TEXT**.	If feature locations originally collected in LL coordinates, **ORIG_HRZ_ REF_SYS_ CODE** = LL001, LL002, LL003, LL004, or LL005. If LL coordinates are referenced to a datum (see "old" Lat_Long_ Datum), rather than a spheroid, assume that the NAD91 or NAD83 datum = GRS80 spheroid. All other datums and non-WGS84 or GRS80 spheroids should be entered in **ORIG_HRZ_ COLL_MTHD_ TEXT**.
W_Lon_DD	1. If LL coordinates referenced to WGS84 or GRS80 spheroid, redefine data field as **LL_LONG_DD_AMT**. These coordinates may also be stored in **ORIG_HRZ_Y_COORD_ AMT** as needed. 2. If LL coordinates originally collected in reference to another spheroid, move data to **ORIG_HRZ_Y_COORD_AMT** and note spheroid in **ORIG_HRZ_ COLL_MTHD_TEXT**.	
Lat_Degree	Redefine data field as **LL_LAT_DEG_AMT**	
Lat_Minute	Redefine data field as **LL_LAT_MIN_AMT**	
Lat_Second	Redefine data field as **LL_LAT_SCND_AMT**	
Long_Degree	Redefine data field as **LL_LONG_DEG_AMT**	
Long_Minute	Redefine data field as **LL_LONG_MIN_AMT**	
Long_Second	Redefine data field as **LL_LONG_SCND_AMT**	
Lat_Long_Datum	Incorporated into "new" **ORIG_HRZ_REF_SYS_CODE**.	
Lat_Long_Method_Code	1. If features originally located by LL coordinates, convert code and move data to **ORIG_HRZ_COLL_ MTHD_CODE**. Enter appropriate codes into **ORIG_HRZ_COLL_ TOOL_CODE** and **ORIG_HRZ_ COLL_MTHD_TEXT** as recommended. 2. If features NOT originally located by LL coordinates, use code to track originally collected data.	
Lat_Long_Accuracy	Accuracy based on new **ORIG_HRZ_COLL_MTHD_ CODE** or specific accuracy testing results.	

OLD DATA FIELD	**HOW TO CONVERT…**	**NOTES**
TM_Northing	1. If features originally located by UTM, move data to **ORIG_HRZ_ Y_COORD_AMT**. 2. If features NOT originally located by UTM coordinates, use code to track originally collected data, or project to WTM91 and store in **WTM91_Y_AMT**.	If feature locations originally collected in UTM coordinates, **ORIG_HRZ_ REF_SYS_ CODE** = UT001, UT002, UT003, UT004, UT005, or UT006, depending on TM_Datum and TM_Zone values.
TM_Easting	1. If features originally located by UTM, move data to **ORIG_HRZ_ X_COORD_AMT**. 2. If features NOT originally located by UTM coordinates, use code to track originally collected data, or project to WTM91 and store in **WTM91_X_AMT**.	
TM_Zone	Incorporated into "new" **ORIG_HRZ_REF_SYS_CODE**.	
TM_Datum	Incorporated into "new" **ORIG_HRZ_REF_SYS_CODE**.	

TM_Method_Code	1. If features originally located by UTM coordinates, convert code and move data to **ORIG_HRZ_COLL_ MTHD_CODE**. Enter appropriate codes into **ORIG_HRZ_COLL_ TOOL_CODE** and **ORIG_HRZ_ COLL_MTHD_TEXT** as recommended. 2. If features NOT originally located by WTM coordinates, use code to track originally collected data.	
TM_Accuracy	Accuracy based on new **ORIG_HRZ_COLL_MTHD_ CODE** or specific accuracy testing results.	
OLD DATA FIELD	**HOW TO CONVERT…**	**NOTES**
SP_Northing	1. If features originally located by SP, move data to **ORIG_HRZ_ Y_COORD_AMT**. 2. If features NOT originally located by SP coordinates, use code to track originally collected data, or project to WTM91 and store in **WTM91_Y_AMT**.	If feature locations originally collected in SP coordinates, **ORIG_HRZ_ REF_SYS_ CODE** = SP001, SP002, SP003, SP004, SP005, SP006, SP007, SP008, or SP009, depending on SP_Datum and SP_Zone values.
SP_Easting	1. If features originally located by UTM, move data to **ORIG_HRZ_ X_COORD_AMT**. 2. If features NOT originally located by UTM coordinates, use code to track originally collected data, or project to WTM91 and store in **WTM91_X_AMT**.	
SP_Zone	Incorporated into "new" **ORIG_HRZ_REF_SYS_CODE**.	
SP_Datum	Incorporated into "new" **ORIG_HRZ_REF_SYS_CODE**.	
SP_Method_Code	1. If features originally located by SP coordinates, convert code and move data to **ORIG_HRZ_COLL_ MTHD_CODE**. Enter appropriate codes into **ORIG_HRZ_COLL_ TOOL_CODE** and **ORIG_HRZ_ COLL_MTHD_TEXT** as recommended. 2. If features NOT originally located by WTM coordinates, use code to track originally collected data.	
SP_Accuracy	Accuracy based on new **ORIG_HRZ_COLL_MTHD_ CODE** or specific accuracy testing results.	

APPENDIX D: USAGE NOTES

1. CHECK FOR UPDATES ON DNR WEB PAGE PERIODICALLY!

This ***Locational Data Standards*** document is used throughout the DNR. Occasionally, users find typos or other errors in this document. In other cases, new standards are developed or existing standards are updated to support program business needs. These additions and updates are periodically incorporated into DNR's Locational Data Standards document, which is then re-released as a new version. Please check the **DNR's Locational Data Standards** web page (http://www.dnr.state.wi.us/org/at/et/geo/location/loc_stds.html) periodically to ensure that you are referring to the most current version of these standards! This web site also provides a list of pages that have been updated in the current version of the document, and a brief description of the changes that were made on those pages.

2. 30-CHARACTER VERSUS 10-CHARACTER DATA FIELD NAMES

Each standard data field defined in ***Appendix A*** of this document has two names. The first (longer) name is intended for use in Oracle and Access database tables. This name meets DNR database naming standards, including Oracle's 30-character data field name length limitation. The second name, noted by an asterisk (*), is 10-characters or less in length. This data field name is intended for use in ArcView applications that store attribute data in D:Base tables. D:Base, the native ArcView database, limits data field names to a maximum of 10 characters.

3. DEFINING THE LENGTH OF NUMERIC DATA FIELDS

The lengths of numeric data fields defined in ***Appendix A*** of this document are intended for use in Oracle and Access database tables. These database management systems do not require the user to define a space for the decimal point or the numeric sign (i.e., + or -). Arcview users storing attribute data in D:Base tables, however, must increase the length of each numeric field to accommodate storage of the decimal point (add one to the length) and, if necessary, the sign (add one to the length).

> **Example:** The length of WTM91_X_AMT is defined as 8, with 2 digits right of the decimal point (e.g., 652342.12). In ArcView, the user must define this numeric data field with a length of 9 to accommodate the six digits left of the decimal point + the decimal point + the two digits right of the decimal point.

MNRD NON-LOCAL BEINGS REPORT

ATTACHMENT 4

Cumulative Impact

The terms "cumulative" and "cumulative effects" are becoming more widely used in environmental impact assessment. The popularity of the concept is understandable as our culture comes to recognize that solitary insults to the environment considered in isolation cannot capture the full effect of the problems now before us. But what exactly do we mean by the term "cumulative"?

"Cumulative" means growing by successive additions. This could mean additions over time, additional pollutants, additional sources of pollution, or additional routes of impact. The term could also be used to describe an individual's integrated exposure to pollutants as he or she engages in daily activities and moves through successive microenvironments. This daily activity scenario incorporates all of the above accumulations as well as an integration over the space defined by the individual's movements. In popular and even in technical usage, cumulative has been applied to each of these alone, to all of them together, and to combinations. Often the meaning is clear from the context, but this is not always the case.

U.S. Environmental Protection Agency (EPA) documents (*1,2*) define the term "aggregate risk" as the risk from all routes of exposure to a single substance, and the term "cumulative risk" as the risk from all routes of exposure to a group of substances. They are silent on the issue of multiple sources (*1,2*). The EPA also developed a "Cumulative Exposure Project" that incorporated multiple pollutants, multiple sources, and multiple pathways, but did not directly address time (*3–5*). However, the EPA has recently backed away from this project and apparently will no longer carry forward the facets involving exposure through media other than inhalation of ambient air.

In Minnesota, the Environmental Quality Board has developed state rules for conducting environmental review (*6*). These rules address the issue of cumulative impacts. Specifically, they discuss multiple sources but are silent on the issue of multiple pollutants and multiple pathways. They allude to the issue of time. The courts in Minnesota have recently held that an environmental review should account for the possibility of combined impacts from multiple sources (*7*). The rulings have been less direct in addressing multiple pollutants, and they have not explicitly considered multiple media and multiple routes of exposure.

The Minnesota Rules, Part 4410.200, Subpart 11, on cumulative impact (*6*) state the following:

> "Cumulative impact" means the impact on the environment that results from incremental effects of the project in addition to other past, present, and reasonably foreseeable future projects regardless of what person undertakes the other projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.

To effectively address the "cumulative" issue, we need to define the terms of the discussion so that we may communicate clearly. Environmental impacts may manifest themselves in a cumulative manner in the following ways:

- Incremental impact of a single source, pollutant, and pathway
- Combined impact of multiple sources of a single pollutant via one pathway
- Combined impact of multiple pollutants from a single source via one pathway
- Combined impact via multiple pathways of a single pollutant from a single source
- Combined impact of multiple pollutants from multiple sources via a single pathway
- Combined impact of multiple sources via multiple pathways of a single pollutant
- Combined impact of multiple pollutants via multiple pathways from a single source
- Combined impact of multiple pollutants from multiple sources via multiple pathways.

These are some of the categories of most immediate importance in my area of expertise, although this list does not include time. Other categories that might be included are invasions by alien species, physical disruptions by human development, climate change, and additions or subtractions of nutrients.

The combined impacts of multiple insults can take on one of three magnitudes: additive, more than additive (synergistic), or less than additive (negative synergy). I hope that my comments prove useful in furthering this discussion.

Gregory C. Pratt
Minnesota Pollution Control Agency
St. Paul, Minnesota
E-mail: gregory.pratt@pca.state.mn.us

References

1. U.S. EPA, Office of Pesticide Programs. U.S. EPA Scientific Advisory Panel (SAP): Guidance for Performing Aggregate Exposure and Risk Assessments. Draft Document. Last updated 1 February 1999. Available: http://www.epa.gov/oscpmont/sap/1999/february/guidance.pdf [cited 9 February 2000].
2. U.S. EPA. Pesticides; Science Policy Issues Related to the Food Quality Protection Act. Available: http://www.epa.gov/fedrgstr/EPA-PEST/1999/February/Day-05/p2781.htm [cited 9 February 2000].
3. Woodruff TJ, Axelrad DA, Caldwell J, Morello-Frosch R, Rosenbaum A. Public health implications of 1990 air toxics concentrations across the United States. Environ Health Perspect 106:245–251 (1998).
4. Caldwell JC, Woodruff TJ, Morello-Frosch R, Axelrad DA. Application of health information to hazardous air pollutants modeled in EPA's Cumulative Exposure Project. Toxicol Ind Health 14:429–454 (1998).
5. Rosenbaum AS, Axelrad DA, Woodruff TJ, Wei YH, Ligocki MP, Cohen JP. National estimates of outdoor air toxics concentrations. J Air Waste Manag Assoc 49(10):1138:1152 (1999).
6. Minnesota Rules Chapter 4410. Available: http://www.revisor.leg.state.mn.us/arule/4410/ [cited 14 February 2000].
7. Pope County Mothers *v.* Minnesota Pollution Control Agency. Docket No. CX-98-2308. Available: http://www.courts.state.mn.us/library/archive/ctappub/9905/cx982308.htm [cited 14 February 2000].

Attachment 4 to MNRD Non-Local Beings Report

MNRD Non-Local Beings Report

Attachment 5

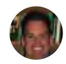
Remembering Makes Evidence Compelling: Retrieval From Memory Can Give Rise to the Illusion of Truth

Article *in* Journal of Experimental Psychology Learning Memory and Cognition · November 2010

DOI: 10.1037/a0021323 · Source: PubMed

2 authors:

Jason Ozubko
Baycrest



Jonathan A Fugelsang
University of Waterloo

Attachment 5 to MNRD Non-Local Beings Report

Journal of Experimental Psychology: Learning, Memory, and Cognition

Remembering Makes Evidence Compelling: Retrieval From Memory Can Give Rise to the Illusion of Truth

Jason D. Ozubko, and Jonathan Fugelsang

Online First Publication, November 8, 2010. doi: 10.1037/a0021323

Journal of Experimental Psychology:
Learning, Memory, and Cognition

0278-7393/10/$12.00 DOI: 10.1037/a0021323

Remembering Makes Evidence Compelling: Retrieval From Memory Can Give Rise to the Illusion of Truth

Jason D. Ozubko and Jonathan Fugelsang
University of Waterloo

The *illusion of truth* is traditionally described as the increase in perceived validity of statements when they are repeated (Hasher, Goldstein, & Toppino, 1977). However, subsequent work has demonstrated that the effect can arise due to the increased familiarity or fluency afforded by repetition and not necessarily to repetition per se. We examine the case of information retrieved from memory. Recently experienced information is expected to be subsequently reexperienced as more fluent and familiar than novel information (Jacoby, 1983; Jacoby & Dallas, 1981). Therefore, the possibility exists that information retrieved from memory, because it is subjectively reexperienced at retrieval, would be more fluent or familiar than when it was first learned and would thus lead to an increase in perceived validity. Using a method to indirectly poll the perceived truth of factual statements, our experiment demonstrated that information retrieved from memory does indeed give rise to an illusion of truth. The effect was larger than when statements were explicitly repeated twice and was of comparable size to when statements were repeated 4 times. We conclude that memory retrieval is a powerful method for increasing the perceived validity of statements (and subsequent illusion of truth) and that the illusion of truth is a robust effect that can be observed even without directly polling the factual statements in question.

Keywords: memory retrieval, familiarity, fluency, repetition, inferences

> There is nothing so absurd that it cannot be believed as truth if repeated often enough.
>
> —William James

Repetition has long been known to have persistent effects on human cognition. For example, repetition of stimuli can lead to increased subjective ratings of liking (Harrison, 1977; Zajonc, 1968) and increased attitude change in response to repeated persuasive messages (Cacioppo & Petty, 1979; Weiss, 1971). One specific case of cognitive change in the face of repetition is known as the *illusion of truth*. The illusion of truth is the finding that repetition of factual statements increases the perceived validity of those statements (Arkes, Hackett, & Boehm, 1989; Bacon, 1979; Hasher, Goldstein, & Toppino, 1977). Although the illusion of truth is usually characterized as arising due to repetition, follow-up research has demonstrated that explicit repetition is not a necessary condition for the effect.

Some of the earliest work to scrutinize the repetition assumption was that of Bacon (1979). Bacon examined the impact of subjectively judged repetition. In Bacon's studies, participants both rated the believability of statements and judged whether statements were repetitions. Bacon found that whether statements were actually repeated was irrelevant; the effect emerged whenever participants subjectively judged statements to be repetitions. From this work, researchers have suggested that the illusion of truth is driven more by the familiarity of statements than by repetition per se. Further support for this assumption comes from Begg, Armour, and Kerr (1985), who found that participants were more likely to endorse facts that were of a familiar topic than an unfamiliar topic. Conversely, Arkes et al. (1989) found that no illusion of truth effect occurred in domains of which participants claimed not to be knowledgeable. Together, these studies suggest that familiarity may be an important factor modulating the illusion of truth.

Reber and Schwarz (1999) came to similar conclusions regarding familiarity via manipulations of the perceptual fluency of statements. Perceptual fluency work (e.g., Jacoby & Whitehouse, 1989; Whittlesea, 1993; Whittlesea, Jacoby, & Girard, 1990) has demonstrated that stimuli that are easier to perceive (e.g., blue or red text on a white background) can elicit greater feelings of familiarity than stimuli that are more difficult to perceive (e.g., yellow or light blue text on a white background). Using this perceptual fluency manipulation, Reber and Schwarz demonstrated that an illusion of truth-like effect arose when statements gave rise to a sense of familiarity (i.e., were easy to perceive). This suggests that repetition is not necessary for the illusion of truth to occur.

Although some researchers have found that repetitions can increase subjective ratings of validity independent of the increased familiarity afforded by repetitions (Begg, Anas, & Farinacci, 1992; Brown & Nix, 1996), the consensus is that so long as familiarity of the statements is enhanced, the illusion of truth can occur in the absence of explicit repetitions. Thus, enhanced familiarity with

---

Jason D. Ozubko and Jonathan Fugelsang, Department of Psychology, University of Waterloo, Waterloo, Ontario, Canada.

This research was supported by an Alexander Graham Bell Canada Graduate Scholarship and by a Discovery Grant, both from the Natural Sciences and Engineering Research Council of Canada. We thank Jason Locklin for his assistance programming the experiments and Colin M. MacLeod for his helpful discussions regarding the theoretical implications of this work.

Correspondence concerning this article should be addressed to Jason D. Ozubko, Department of Psychology, University of Waterloo, 200 University Avenue West, Waterloo, Ontario N2L 3G1, Canada. E-mail: jdozubko@uwaterloo.ca

statements, whether or not the result of explicit repetition, can increase the perceived validity of statements. This leads to an interesting prediction regarding the possible impact of memory retrieval, in the absence of repetition, on the illusion of truth. That is, to rate statements that are no longer explicitly available, participants must retrieve those statements from memory. Because those statements were recently experienced, they should be reexperienced (i.e., retrieved) as subjectively more familiar than when they were first read (Jacoby, 1983; Jacoby & Dallas, 1981). Hence, on the basis of research demonstrating that increased familiarity and fluency can lead to the illusion of truth, we would expect the illusion of truth to occur for information that is simply retrieved from memory, in the absence of explicit repetition. In other words, memory retrieval may offer a simple mechanism with which to increase the perceived validity of statements and thus produce an illusion of truth effect after only a single presentation. Presenting a statement only once to participants may lead to an illusion of truth when subjective ratings are delayed and no illusion of truth when ratings are immediate. Memory retrieval therefore may be a potentially powerful way to increase the subjective believability of information and may subsequently have a significant impact on future inferences. The present work tested this hypothesis.

Present Experiment

As noted above, past studies of the illusion of truth effect have found that repetition of statements increases explicit ratings of validity (e.g., Bacon, 1979; Hasher et al., 1977). To examine the effect of memory retrieval in the absence of explicit repetition on the illusion of truth, however, one must present participants with factual statements to learn and later cue them to rate those statements, without re-presenting the specific statements that were learned as cues. Thus, in the present experiment participants read a series of factual statements that were relatively neutral in terms of believability. We constructed inference statements, which the factual statements could either support or refute, as a proxy for the perceived validity of the factual statements. Participants were told to rate the accuracy of the inference statements, based on the factual statements that they read previously. If participants perceive repeated statements to be more truthful, the increased perceived "truthfulness" of those statements should impact future inferences (i.e., if evidence is believed to be more accurate, it should be relied on more heavily when making decisions). Thus, by examining the degree to which ratings for the inference statements change as a function of repetition or memory retrieval, we can indirectly ascertain how truthful participants perceive the factual statements to be, without explicitly repeating those statements.

The present experiment is the first instance in which the believability of factual statements was indirectly polled via its impact on inferences. Although it logically follows that statements that are viewed as more believable by participants should be more readily used to make inferences, whether this is the case is an empirical question. Hence, our first goal in the present experiment was to replicate the illusion of truth by using indirect ratings of inferences based on factual statements, rather than by directly polling participants' subjective beliefs about the factual statements.

The present experiment contained four conditions. In the control condition, the inference and factual statements were presented simultaneously, and participants rated how accurate the inference statements were, based on the factual statements. This condition provides a measure of how much the factual statements influenced the inference ratings, in the absence of repetition or memory retrieval.

The two-repetition condition was a replication of the control condition except that before the inference task, participants were preexposed to all the factual statements once. Therefore, during the inferences rating task, when the factual statements were presented to participants, it was actually the second time that those statements were viewed. The four-repetition condition was identical to the two-repetition condition except that participants were preexposed to all factual statements three times. Thus, during the inferences rating task, when the factual statements were presented to participants, it was the fourth time those statements were viewed. Thus, in the repetition conditions, all factual statements viewed during the inferences task were repetitions from the preexposure phase. On the basis of past work, we expected that participants would perceive these factual statements to be more true than would participants in the control condition. Therefore, if our paradigm is sound, inference statement ratings (based on the factual statements) should become more exaggerated in the repetition conditions than in the control condition.

Finally, the retrieval condition was a replication of the two-repetition condition, with the exception that the factual statements were omitted during the inferences task. That is, participants were preexposed to each factual statement once, but during the inference rating task no factual statements were presented. Participants were still told to make their decisions based on factual statements to which they were preexposed, but in this case, no explicit repetition of those statements was provided. Instead, participants had to retrieve the relevant factual statements from memory. As previous work suggests that recently experienced stimuli are subsequently processed more fluently and give rise to a greater sense of familiarity (Jacoby, 1983; Jacoby & Dallas, 1981) and enhanced familiarity can drive the illusion of truth in the absence of repetition (Bacon, 1979; Begg et al., 1985; Reber & Schwarz, 1999), we predicted that the retrieval condition would show an effect on inferences comparable to that of the repeated conditions. If an illusion of truth effect were found in this condition, it would be a powerful demonstration of the effect, and of memory retrieval in general, as the illusion of truth effect would have arisen with only a single presentation of each factual statement.

Method

Participants

Participants were 257 individuals from the University of Waterloo. There were 47 in the control condition, 91 in the two-repetition condition, 77 in the four-repetition condition, and 42 in the retrieval condition.

Materials

The factual and inference statements used were selected from a larger, prerated set (see Appendix). In the prerating tasks, 47 participants rated the believability of the factual statements, and 36 rated the accuracy of the inference statements in the absence of any factual statements. These 83 participants did not overlap with those who participated in the experiment.

The prerating data indicated the degree to which a factual statement was rated as believable on a 7-point Likert scale, with 7 being completely believable and 1 being completely unbelievable. The prerating data for the inference statements indicated the baseline degree to which each inference statement was endorsed as accurate on a 7-point Likert scale, with 7 being completely accurate and 1 being completely inaccurate.

We selected 24 factual statements with a mean believability rating of 3.53 ($SD = 0.55$). Each factual statement corresponded to one inference statement (i.e., a factual statement could either support or refute a single inference statement). The mean accuracy rating of the corresponding inference statements was 3.23 ($SD = 0.83$). Thus, inference statements were, on average, relatively neutral in terms of judged accuracy, allowing optimal room for inference statement ratings to move toward the extremes of the Likert scale, in the presence of factual statements.[1]

Procedure

Participants completed the experiment on the Internet. For the control condition, on each trial, participants saw a factual statement and an inference statement simultaneously in black, 12-point font against a white background. Participants' task was to read both statements and to judge how accurate the inference statement was, based on the factual statement provided. A 7-point Likert scale was presented below both statements, and participants were to use this scale to indicate the accuracy of the inference statement, with 1 indicating highly inaccurate and 7 indicating highly accurate.

For the repetition conditions, participants were first presented with a list of factual statements. Factual statements were presented individually on the screen, and participants were told to read each statement and then click on an *OK* button to proceed. Individual statements remained on the screen until participants pressed *OK*; thus, presentation duration was participant paced. In the two-repetition condition, each factual statement was presented once, in the four-repetition condition, each factual statement was presented three times, each on separate trials. Hence, in the two-repetition condition there were 24 trials of preexposure and in the four-repetition condition there were 72 trials of preexposure. The order of presentation of items in both conditions and both preexposure and inference rating phase was completely randomized.

After this study phase, participants saw each inference statement presented simultaneously with the relevant factual statement. Again, participants were to read both statements and judge how accurate the inference statements were, based on the factual statements provided. After the statement was rated, the next factual and inference statement pair was presented. Finally, the retrieval condition operated identically to the two-repetition condition except that when inference statements were being rated, factual statements were not presented. Thus, participants had to retrieve the factual statement from memory to judge the inference statement.

After the inference rating phase, participants engaged in an old/new recognition memory test. The studied factual statements were randomly intermixed with an equal number of new statements, and participants had to identify which statements were old and which were new. Participants also rated their confidence with each rating on a 7-point Likert scale, with 7 being highly confident and 1 being highly not confident. The order of the statements or statement/inference pairs in all phases was randomly determined.

Results and Discussion

An alpha level of .05 was our criterion for significance in all significance tests. Effect size estimates were computed with eta squared, partial eta squared (η_p^2), or Cohen's *d*, where appropriate. The results of the memory test in the retrieval condition can be seen in Table 1. Participants could reliably discriminate old from new factual statements, $F(1, 41) = 929.34$, mean standard error (MSE) $= 0.02$, $\eta_p^2 = .96$. Confidence for these attributions was also exceptionally high (approaching the upper limit of the 7-point scale) and did not differ between old and new items ($F < 1$). Therefore, we can be assured that very little forgetting occurred in the retrieval condition.

The primary measure of interest was participants' reliance on factual statements, as estimated by how participants' preratings changed depending on the factual statements. Recall that preratings of the inference statements were relatively neutral (i.e., near the midpoint of the 7-point scale). Factual statements should shift participants away from the midpoint of the scale (as each factual statement either supported or refuted an inference statement), and the degree to which participants move away from the midpoint of the scale should be influenced by how compelling (i.e., truthful) the factual statements are perceived to be. If factual statements are highly compelling, participants should shift farther away from the center of the scale than if the factual statements are not perceived to be very compelling.

To estimate the extremity of responses to the inference statements, we coded factual statements as either positive or negative depending on whether they supported or refuted inference statements. For each participant's rating of individual inference statements, we calculated the relative difference between those ratings and the mean prerated values, with positive values indicating a shift in the correct direction (i.e., a positive shift based on positive evidence or a negative shift based on negative evidence) and negative values indicating a shift in the incorrect direction (i.e., a positive shift based on negative evidence or a negative shift based on positive evidence). For each participant then, we obtained a mean relative inference change score, which indicated, on average, how much more extreme that participant's ratings were than the preratings (i.e., than rating in the absence of evidence). Larger positive relative inference change scores indicate that participants were more compelled in the correct direction by the factual statements.

Relative inference change scores for the four conditions are provided in Figure 1. First, one-sample *t* tests testing relative inference change scores against zero revealed a significant effect for all four conditions ($ts > 8.36$). This demonstrates that in all conditions, there was a significant positive difference in inference ratings compared to the prerating values. Thus, all evidence conditions (i.e., control, two-repetition, four-repetition, and retrieval)

[1] It should be noted that the factual statements were not necessarily true (as can be seen in the Appendix). Again, they were selected to be relatively neutral in terms of believability, rather than highly accurate.

Table 1
Means and Standard Errors for Recognition Memory and Confidence Ratings of Old and New Factual Statements From the Retrieval Condition

	p("old")		Confidence	
Value	Old	New	Old	New
M	0.93	0.02	6.49	6.49
SE	0.02	0.01	0.10	0.11

led to larger inference ratings than in the preratings, where no evidence was provided. Furthermore, because all relative inference change scores were positive, the mean increased ratings were all in the direction that the evidence supported.

In terms of between-conditions comparisons, an omnibus analysis of variance revealed a significant difference of relative inference change scores between groups, $F(1, 257) = 5.17$, $MSE = 0.40$, $\eta^2 = .06$. The two-repetition condition showed a larger numerical effect on inferences than the control condition; however, this effect was nonsignificant, $t(136) = 0.94$, $p = .35$, $d = 0.16$. Thus, a single repetition was not enough to give rise to the illusion of truth in this paradigm. However, the four-repetition condition did demonstrate the illusion of truth, showing greater inference change scores than both the control and two-repetition conditions, $t(122) = 2.80$, $d = 0.51$ and $t(166) = 2.06$, $d = 0.32$, respectively. Thus, the four-repetition condition extends past work (e.g., Bacon, 1979; Hasher et al., 1977) by showing that participants not only rate repeated statements as more truthful or valid but also rely more on those statements more when making decisions. However, this effect was significant only when statements were repeated multiple times (i.e., in this case, four times).

Most important in terms of the present investigation, the retrieval condition was also found to exaggerate inference ratings beyond both the control condition and the two-repetition condition, $t(87) = 3.45$, $d = 0.74$ and $t(131) = 2.76$, $d = 0.48$, respectively, thus demonstrating that the illusion of truth effect can occur in the absence of explicit repetition. Furthermore, although the retrieval condition had a numerically larger effect than the four-repetition condition, this effect was not statistically significant, $t(117) = 1.15$, $d = 0.22$. Although this difference was nonsignificant, it is important to remember that factual statements were presented four times in the four-repetition condition, including while inferences were being rated, but were presented only once in the retrieval condition, and not while inferences were being rated. That is, although factual statements were presented much more often and also at the most critical point (i.e., during inference ratings) in the four-repetition condition, the retrieval condition gave rise to an illusion of truth effect that was, at the least, the same size as that for the four-repetition condition. Thus, these results demonstrate the sheer power of memory retrieval in giving rise to the illusion of truth.

General Discussion

The illusion of truth is the finding that repeated statements are perceived as more truthful than statements presented only once. A more careful examination of this effect, however, has shown that it arises when participants simply perceive that statements have repeated (Bacon, 1979), when information is familiar (Begg et al., 1985), and when information is fluently processed (Reber & Schwarz, 1999). Our research adds to this body of literature by demonstrating that memory retrieval is a powerful mechanism influencing the perceived truthfulness of evidence. That is, information that is read only once can give rise to a powerful illusion of truth effect, if the validity of that information is polled after initial exposure such that one needs to rely on memory. Furthermore, this effect is at least of equivalent size to four explicit presentations of exactly the same information.

Perhaps the most central question arising from these findings is, Why does memory retrieval lead to an illusion of truth-like effect? The possibility discussed thus far is that memory retrieval may act as a sort of covert repetition, insomuch as the retrieval of information can be equated to a subjective repetition. Hence, when a statement is retrieved from memory, because it was recently experienced, it is subsequently reexperienced more fluently. This leads to an increase in subjective familiarity, which in turn leads to a greater influence on inferences. Although simple, one issue with this explanation is the fact that the effect size observed in the retrieval condition was at least equivalent to four explicit repetitions suggests that something beyond just a subjective repetition must be at play.

An alternate explanation for our findings is that information that is represented in memory is necessarily more fluent and familiar than information that is perceived. That is, it may be that memory retrieval leads to an illusion of truth-like effect, not necessarily because retrieval acts as a covert repetition but because information represented in memory is more fluently processed than information that is perceived. Researchers have shown, consistent with this idea, that information easily retrieved from memory is naturally viewed as disproportionately more important and influential to participants. For example, in a review of past work Schwarz (2004) highlighted findings that showed the ease of recall of

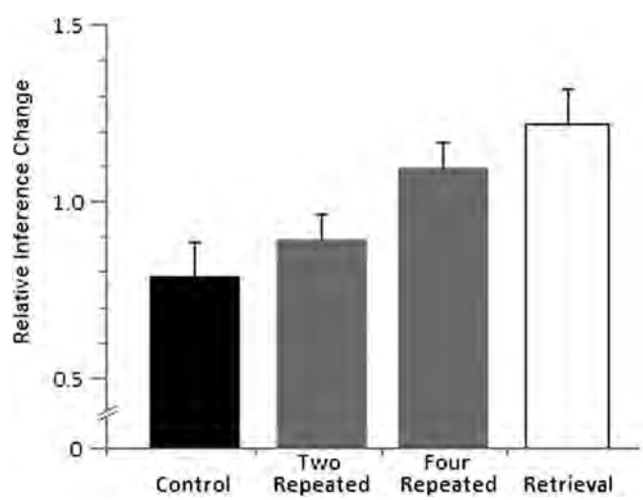


Figure 1. Mean (and standard error) of relative inference change scores by condition. Zero indicates no change from prerating values, where inferences were rated in the absence of any evidence. Positive values indicate evidence led to inference ratings that were more extreme in the direction that the evidence supported.

Attachment 5 to MNRD Non-Local Beings Report

information was positively related to the perceived importance of information. Hawkins and Hoch (1992) demonstrated directly that easily recalled statements are rated as more truthful than harder to recall statements. More recently, Labroo, Lambotte, and Zhang (2009) used the name-ease effect to demonstrate that when participants associate the ease of processing information with the memorability of that information, the perceived importance of that information increases. As a whole, this past work shows that information that is easily retrieved, or simply perceived as easy to retrieve, is also perceived to be more important and influential to participants.

If this account is correct, the current work demonstrates that information retrieved from memory can not only be viewed as relatively more important than more difficult to retrieve information but can also be viewed as more important than information that is explicitly provided. In particular, information that is retrieved from memory may actually be more fluently processed in general than information that is directly perceived. Such a suggestion is consistent with work that has demonstrated that self-generated information is more convincing (e.g., Greenwald, 1968; Miller & Wozniak, 2001) and more memorable (e.g., Slamecka & Graf, 1978) and that it may arise because information that is retrieved from memory is already represented in the very cognitive system that must interpret it. In contrast, information that is perceived must first be encoded and then decoded into the cognitive system before it can be understood and, thus, may not be processed as fluently. Although this account can better explain our results than the covert-repetition account, an important avenue for future research will be to differentiate these two possibilities.

A further implication of our work that has not yet been highlighted regards the instructions that were used during the inference rating task. Participants in all conditions, even the control condition, were instructed to treat the factual statements as true, regardless of what they actually thought, when making their inference ratings. One consequence of these instructions is that they may have made the baseline influence of evidence larger in all conditions than it would be in other studies where participants are not given specific instructions as to how to treat the evidence. It is thus possible that we might have made it particularly difficult to observe any differences between our control condition and our experimental conditions. If participants in the control condition were treating factual statements as true, we could imagine, there would be very little room left for the illusion of truth to further increase the perceived truth of statements. Indeed, this may explain why a two-repetition condition did not show a significant illusion of truth effect when compared to the control condition. Nonetheless, the fact that the illusion of truth was observed in both the four-repetition condition and the retrieval condition is a testament to the power and robustness of the effect itself, even under high task demands.

Finally, another novel aspect of our work is the demonstration that a direct polling of the believability of factual statements is not necessary to assess the illusion of truth. Recall that the illusion of truth is defined as the increase in perceived believability of repeated versus nonrepeated statements. We have demonstrated here that this effect generalizes beyond direct polling of the believability of factual statements. The current work demonstrates that participants actually rely on repeated factual statements to a greater degree when making inferences than nonrepeated, nonretrieved statements.

It should be pointed out that the paradigm presented here does share some similarities with Experiment 2 from Bacon (1979). In that experiment, Bacon presented evidence statements to participants, and statements either repeated or were replaced with contradictory statements. Bacon found that if participants noticed that new statements contradicted older statements, these new statements were rated as less accurate than if they were misidentified as repetitions of previous statements. Thus, there is some basis in the previous literature to believe that the illusion of truth extends beyond simply rating the accuracy of the evidence statements themselves and into more complex decisions such as inferences. However, our work is the first to thoroughly delineate this issue and address how multiple presentations of the same evidence and retrieval of evidence from memory can affect later decisions. Thus, the current work demonstrates the robustness of the illusion of truth and expands the paradigms with which the effect can be considered.

In conclusion, these results demonstrate that the illusion of truth can occur via memory retrieval and in the absence of explicit repetition. If the illusion of truth arises due to the familiarity and fluency of repeated factual statements, this may suggest that information retrieved from memory is naturally more familiar and fluent than information that is perceived. Finally, our study demonstrates that the illusion of truth is a robust effect: It can arise even in the face of task demands that might reduce its impact. It is not limited to direct ratings of the believability of factual statements but extends to more complicated decision-making scenarios relying on factual statements; thus, it can be polled indirectly. Retrieval from memory is a new and powerful method with which to easily give rise to the illusion of truth.

References

Arkes, H. R., Hackett, C., & Boehm, L. (1989). The generality of the relation between familiarity and judged validity. *Journal of Behavioral Decision Making, 2,* 81–94. doi:10.1002/bdm.3960020203

Bacon, E. T. (1979). Credibility of repeated statements: Memory for trivia. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 241–252. doi:10.1037/0278-7393.5.3.241

Begg, I. M., Anas, A., & Farinacci, S. (1992). Dissociation of processes in belief: Source recollection, statement familiarity, and the illusion of truth. *Journal of Experimental Psychology: General, 121,* 446–458. doi:10.1037/0096-3445.121.4.446

Begg, I. M., Armour, V., & Kerr, T. (1985). On believing what we remember. *Canadian Journal of Behavioural Science, 17,* 199–214. doi:10.1037/h0080140

Brown, A. S., & Nix, L. A. (1996). Turning lies into truths: Referential validation of falsehoods. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22,* 1088–1100. doi:10.1037/0278-7393.22.5.1088

Cacioppo, J. T., & Petty, R. E. (1979). Effects of message repetition and position on cognitive response, recall, and persuasion. *Journal of Personality and Social Psychology, 37,* 97–109. doi:10.1037/0022-3514.37.1.97

Greenwald, A. G. (1968). Cognitive learning, cognitive response to persuasion, and attitude change. In A. G. Greenwald, T. C. Brock, & T. M. Ostrom (Eds.), *Psychological foundations of attitudes* (pp. 147–170). New York, NY: Academic Press.

Harrison, A. A. (1977). Mere exposure. In L. Berkowitz (Ed.), *Advances in* *experimental social psychology* (Vol. 10, pp. 39–83). New York, NY: Academic Press. doi:10.1016/S0065-2601(08)60354-8

Hasher, L., Goldstein, D., & Toppino, T. (1977). Frequency and the conference of referential validity. *Journal of Verbal Learning and Verbal Behavior, 16,* 107–112. doi:10.1016/S0022-5371(77)80012-1

Hawkins, S. A., & Hoch, S. J. (1992). Low-involvement learning: Memory without evaluation. *Journal of Consumer Research, 19,* 212–225. doi:10.1086/209297

Jacoby, L. L. (1983). Perceptual enhancement: Persistent effects of an experience. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* 21–38. doi:10.1037/0278-7393.9.1.21

Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General, 110,* 306–340. doi:10.1037/0096-3445.110.3.306

Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General, 118,* 126–135. doi:10.1037/0096-3445.118.2.126

Labroo, A. A., Lambotte, S., & Zhang, Y. (2009). The "name-ease" effect and its dual impact on importance judgments. *Psychological Science, 20,* 1516–1522. doi:10.1111/j.1467-9280.2009.02477.x

Miller, R. L., & Wozniak, W. (2001). Counter-attitudinal advocacy: Effort vs. self-generation of arguments. *Current Research in Social Psychology, 6*(4), 46–55.

Reber, R., & Schwarz, N. (1999). Effects of perceptual fluency on judgments of truth. *Consciousness and Cognition, 8,* 338–342. doi:10.1006/ccog.1999.0386

Schwarz, N. (2004). Metacognitive experiences in consumer judgment and decision making. *Journal of Consumer Psychology, 14,* 332–348. doi:10.1207/s15327663jcp1404_2

Slamecka, N. J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. *Journal of Experimental Psychology: Human Learning and Memory, 4,* 592–604. doi:10.1037/0278-7393.4.6.592

Weiss, R. F. (1971). Role-playing and repetition effects on memory strength. *Journal of Social Psychology, 85,* 29–35.

Whittlesea, B. W. A. (1993). Illusions of familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 1235–1253. doi:10.1037/0278-7393.19.6.1235

Whittlesea, B. W., Jacoby, L. L., & Girard, K. (1990). Illusions of immediate memory: Evidence of an attributional basis for feelings of familiarity and perceptual quality. *Journal of Memory and Language, 29,* 716–732. doi:10.1016/0749-596X(90)90045-2

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology, 9*(2, Pt. 2), 1–27. doi:10.1037/h0025848

(*Appendix follows*)

Appendix

Preratings for Evidence Statements and Corresponding Inference Statements

Evidence statement	Believability rating	Inference statement	Prerating accuracy
A dime has 15 ridges around the edge	2.89	It's pretty hard to count all the ridges on a dime	4.50
A person uses 8 sheets of toilet paper each day	3.26	People use only one or two pieces of toilet paper each time they go to the washroom	2.14
A toilet has 100 times more bacteria than an office desk	3.82	Toilets are infested with more bacteria than other areas in the house or workplace	3.36
The life span of a dollar bill is 1 and 1/2 years	2.84	Paper money is usually replaced every couple of years	3.75
The average North American car contains 2,000 pounds of plastics	3.09	Most of the weight in cars nowadays is from plastics	2.83
49% of a person's income is spent on transportation	3.41	For most people, transportation costs are easily afforded	2.67
In 1991, the first Wal-Mart opened up in Rogers, Arkansas	3.23	Wal-Mart is a relatively new company	4.58
85% of kids in the USA are overweight	4.16	Being overweight is still more uncommon for children than being a healthy weight	3.75
The average person falls asleep in 12 minutes	4.36	People usually fall asleep pretty quickly when they go to bed at night	3.83
The stomach of an adult can hold 20 liters of material	2.93	One jug of pop is enough to fill up an adult's stomach	4.14
Roses need 20 minutes of sunlight per day to grow properly	4.18	Roses can grow even with very little sunlight	3.31
4% of injuries by athletes involve the wrist and hand	3.42	Common injuries for athletes involve hands and wrists	4.67
6% of Americans eat breakfast everyday	3.07	No one really eats breakfast every day	2.31
80% of households have oatmeal in their kitchen	4.13	It is incredibly rare to find a household that doesn't have oatmeal in it	3.17
A crocodile can run up to a speed of 16 kilometers per hour	4.39	Crocodiles can run at highway speeds because they're so low to the ground	2.08
95% of Americans don't know that the sun is a star	3.65	Only scientists tend to know that the sun is a star	4.08
90% of the states in the United States have severe or extreme pollution problems	4.11	Pollution still isn't a major problem for most of the states in the US	2.67
62% of the people who use personal ads for dating are already married	3.07	If you meet a person from a personal ad, chances are they are already married	2.67
99% of accidental deaths occur in the home	2.84	You're more likely to die during work, school, or in transit than at home	3.81
79% of babies are born on their actual due date	3.80	Doctors are remarkably accurate in predicting the exact day a baby will be born	3.17
92% of lottery players go back to work after winning the jackpot	4.28	Pretty much no one quits their job when they win the jackpot in a lottery	3.25
40% of people end up marrying their first love	3.84	The reason most marriages end in divorce is that most people marry their first love	2.03
In the United States, 87% of land is covered by forests	2.85	If you drive across the US, most of the drive you will be driving through forests	2.19
James Bond made his debut in the 1765 novel *Casino Royale*	3.11	The first James Bond tale was written hundreds of years ago	2.50

Received March 4, 2010
Revision received August 5, 2010
Accepted August 6, 2010 ■

Attachment 5 to MNRD Non-Local Beings Report

MNRD Non-Local Beings Report

Attachment 6

Attachment 6 to MNRD Non-Local Beings Report

Judgment under Uncertainty: Heuristics and Biases

Biases in judgments reveal some heuristics of thinking under uncertainty.

Amos Tversky and Daniel Kahneman

Many decisions are based on beliefs concerning the likelihood of uncertain events such as the outcome of an election, the guilt of a defendant, or the future value of the dollar. These beliefs are usually expressed in statements such as "I think that . . . ," "chances are . . . ," "it is unlikely that . . . ," and so forth. Occasionally, beliefs concerning uncertain events are expressed in numerical form as odds or subjective probabilities. What determines such beliefs? How do people assess the probability of an uncertain event or the value of an uncertain quantity? This article shows that people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors.

The subjective assessment of probability resembles the subjective assessment of physical quantities such as distance or size. These judgments are all based on data of limited validity, which are processed according to heuristic rules. For example, the apparent distance of an object is determined in part by its clarity. The more sharply the object is seen, the closer it appears to be. This rule has some validity, because in any given scene the more distant objects are seen less sharply than nearer objects. However, the reliance on this rule leads to systematic errors in the estimation of distance. Specifically, distances are often overestimated when visibility is poor because the contours of objects are blurred. On the other hand, distances are often underestimated when visibility is good because the objects are seen sharply. Thus, the reliance on clarity as an indication of distance leads to common biases. Such biases are also found in the intuitive judgment of probability. This article describes three heuristics that are employed to assess probabilities and to predict values. Biases to which these heuristics lead are enumerated, and the applied and theoretical implications of these observations are discussed.

The authors are members of the department of psychology at the Hebrew University, Jerusalem, Israel.

Representativeness

Many of the probabilistic questions with which people are concerned belong to one of the following types: What is the probability that object A belongs to class B? What is the probability that event A originates from process B? What is the probability that process B will generate event A? In answering such questions, people typically rely on the representativeness heuristic, in which probabilities are evaluated by the degree to which A is representative of B, that is, by the degree to which A resembles B. For example, when A is highly representative of B, the probability that A originates from B is judged to be high. On the other hand, if A is not similar to B, the probability that A originates from B is judged to be low.

For an illustration of judgment by representativeness, consider an individual who has been described by a former neighbor as follows: "Steve is very shy and withdrawn, invariably helpful, but with little interest in people, or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail." How do people assess the probability that Steve is engaged in a particular occupation from a list of possibilities (for example, farmer, salesman, airline pilot, librarian, or physician)? How do people order these occupations from most to least likely? In the representativeness heuristic, the probability that Steve is a librarian, for example, is assessed by the degree to which he is representative of, or similar to, the stereotype of a librarian. Indeed, research with problems of this type has shown that people order the occupations by probability and by similarity in exactly the same way (*1*). This approach to the judgment of probability leads to serious errors, because similarity, or representativeness, is not influenced by several factors that should affect judgments of probability.

Insensitivity to prior probability of outcomes. One of the factors that have no effect on representativeness but should have a major effect on probability is the prior probability, or base-rate frequency, of the outcomes. In the case of Steve, for example, the fact that there are many more farmers than librarians in the population should enter into any reasonable estimate of the probability that Steve is a librarian rather than a farmer. Considerations of base-rate frequency, however, do not affect the similarity of Steve to the stereotypes of librarians and farmers. If people evaluate probability by representativeness, therefore, prior probabilities will be neglected. This hypothesis was tested in an experiment where prior probabilities were manipulated (*1*). Subjects were shown brief personality descriptions of several individuals, allegedly sampled at random from a group of 100 professionals—engineers and lawyers. The subjects were asked to assess, for each description, the probability that it belonged to an engineer rather than to a lawyer. In one experimental condition, subjects were told that the group from which the descriptions had been drawn consisted of 70 engineers and 30 lawyers. In another condition, subjects were told that the group consisted of 30 engineers and 70 lawyers. The odds that any particular description belongs to an engineer rather than to a lawyer should be higher in the first condition, where there is a majority of engineers, than in the second condition, where there is a majority of lawyers. Specifically, it can be shown by applying Bayes' rule that the ratio of these odds should be $(.7/.3)^2$, or 5.44, for each description. In a sharp violation of Bayes' rule, the subjects in the two conditions produced essen-

Attachment 6 to MNRD Non-Local Beings Report

tially the same probability judgments. Apparently, subjects evaluated the likelihood that a particular description belonged to an engineer rather than to a lawyer by the degree to which this description was representative of the two stereotypes, with little or no regard for the prior probabilities of the categories.

The subjects used prior probabilities correctly when they had no other information. In the absence of a personality sketch, they judged the probability that an unknown individual is an engineer to be .7 and .3, respectively, in the two base-rate conditions. However, prior probabilities were effectively ignored when a description was introduced, even when this description was totally uninformative. The responses to the following description illustrate this phenomenon:

> Dick is a 30 year old man. He is married with no children. A man of high ability and high motivation, he promises to be quite successful in his field. He is well liked by his colleagues.

This description was intended to convey no information relevant to the question of whether Dick is an engineer or a lawyer. Consequently, the probability that Dick is an engineer should equal the proportion of engineers in the group, as if no description had been given. The subjects, however, judged the probability of Dick being an engineer to be .5 regardless of whether the stated proportion of engineers in the group was .7 or .3. Evidently, people respond differently when given no evidence and when given worthless evidence. When no specific evidence is given, prior probabilities are properly utilized; when worthless evidence is given, prior probabilities are ignored (*1*).

Insensitivity to sample size. To evaluate the probability of obtaining a particular result in a sample drawn from a specified population, people typically apply the representativeness heuristic. That is, they assess the likelihood of a sample result, for example, that the average height in a random sample of ten men will be 6 feet (180 centimeters), by the similarity of this result to the corresponding parameter (that is, to the average height in the population of men). The similarity of a sample statistic to a population parameter does not depend on the size of the sample. Consequently, if probabilities are assessed by representativeness, then the judged probability of a sample statistic will be essentially independent of sample size. Indeed, when subjects assessed the distributions of average height for samples of various sizes, they produced identical distributions. For example, the probability of obtaining an average height greater than 6 feet was assigned the same value for samples of 1000, 100, and 10 men (*2*). Moreover, subjects failed to appreciate the role of sample size even when it was emphasized in the formulation of the problem. Consider the following question:

> A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day, and in the smaller hospital about 15 babies are born each day. As you know, about 50 percent of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50 percent, sometimes lower.
>
> For a period of 1 year, each hospital recorded the days on which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?
>
> ► The larger hospital (21)
> ► The smaller hospital (21)
> ► About the same (that is, within 5 percent of each other) (53)

The values in parentheses are the number of undergraduate students who chose each answer.

Most subjects judged the probability of obtaining more than 60 percent boys to be the same in the small and in the large hospital, presumably because these events are described by the same statistic and are therefore equally representative of the general population. In contrast, sampling theory entails that the expected number of days on which more than 60 percent of the babies are boys is much greater in the small hospital than in the large one, because a large sample is less likely to stray from 50 percent. This fundamental notion of statistics is evidently not part of people's repertoire of intuitions.

A similar insensitivity to sample size has been reported in judgments of posterior probability, that is, of the probability that a sample has been drawn from one population rather than from another. Consider the following example:

> Imagine an urn filled with balls, of which ⅔ are of one color and ⅓ of another. One individual has drawn 5 balls from the urn, and found that 4 were red and 1 was white Another individual has drawn 20 balls and found that 12 were red and 8 were white. Which of the two individuals should feel more confident that the urn contains ⅔ red balls and ⅓ white balls, rather than the opposite? What odds should each individual give?

In this problem, the correct posterior odds are 8 to 1 for the 4 : 1 sample and 16 to 1 for the 12 : 8 sample, assuming equal prior probabilities. However, most people feel that the first sample provides much stronger evidence for the hypothesis that the urn is predominantly red, because the proportion of red balls is larger in the first than in the second sample. Here again, intuitive judgments are dominated by the sample proportion and are essentially unaffected by the size of the sample, which plays a crucial role in the determination of the actual posterior odds (*2*). In addition, intuitive estimates of posterior odds are far less extreme than the correct values. The underestimation of the impact of evidence has been observed repeatedly in problems of this type (*3, 4*). It has been labeled "conservatism."

Misconceptions of chance. People expect that a sequence of events generated by a random process will represent the essential characteristics of that process even when the sequence is short. In considering tosses of a coin for heads or tails, for example, people regard the sequence H-T-H-T-T-H to be more likely than the sequence H-H-H-T-T-T, which does not appear random, and also more likely than the sequence H-H-H-H-T-H, which does not represent the fairness of the coin (*2*). Thus, people expect that the essential characteristics of the process will be represented, not only globally in the entire sequence, but also locally in each of its parts. A locally representative sequence, however, deviates systematically from chance expectation: it contains too many alternations and too few runs. Another consequence of the belief in local representativeness is the well-known gambler's fallacy. After observing a long run of red on the roulette wheel. for example, most people erroneously believe that black is now due, presumably because the occurrence of black will result in a more representative sequence than the occurrence of an additional red. Chance is commonly viewed as a self-correcting process in which a deviation in one direction induces a deviation in the opposite direction to restore the equilibrium. In fact, deviations are not "corrected" as a chance process unfolds, they are merely diluted.

Misconceptions of chance are not limited to naive subjects. A study of the statistical intuitions of experienced research psychologists (*5*) revealed a lingering belief in what may be called the "law of small numbers," according to which even small samples are highly representative of the populations from which they are drawn. The responses of these investigators reflected the expectation that a valid hypothesis about a population will be represented by a statistically significant result in a sample—with little regard for its size. As a consequence, the researchers put too much faith in the results of small samples and grossly overestimated the replicability of such results. In the actual conduct of research, this bias leads to the selection of samples of inadequate size and to overinterpretation of findings.

Insensitivity to predictability. People are sometimes called upon to make such numerical predictions as the future value of a stock, the demand for a commodity, or the outcome of a football game. Such predictions are often made by representativeness. For example, suppose one is given a description of a company and is asked to predict its future profit. If the description of the company is very favorable, a very high profit will appear most representative of that description; if the description is mediocre, a mediocre performance will appear most representative. The degree to which the description is favorable is unaffected by the reliability of that description or by the degree to which it permits accurate prediction. Hence, if people predict solely in terms of the favorableness of the description, their predictions will be insensitive to the reliability of the evidence and to the expected accuracy of the prediction.

This mode of judgment violates the normative statistical theory in which the extremeness and the range of predictions are controlled by considerations of predictability. When predictability is nil, the same prediction should be made in all cases. For example, if the descriptions of companies provide no information relevant to profit, then the same value (such as average profit) should be predicted for all companies. If predictability is perfect, of course, the values predicted will match the actual values and the range of predictions will equal the range of outcomes. In general, the higher the predictability, the wider the range of predicted values.

Several studies of numerical prediction have demonstrated that intuitive predictions violate this rule, and that subjects show little or no regard for considerations of predictability (*1*). In one of these studies, subjects were presented with several paragraphs, each describing the performance of a student teacher during a particular practice lesson. Some subjects were asked to *evaluate* the quality of the lesson described in the paragraph in percentile scores, relative to a specified population. Other subjects were asked to *predict*, also in percentile scores, the standing of each student teacher 5 years after the practice lesson. The judgments made under the two conditions were identical. That is, the prediction of a remote criterion (success of a teacher after 5 years) was identical to the evaluation of the information on which the prediction was based (the quality of the practice lesson). The students who made these predictions were undoubtedly aware of the limited predictability of teaching competence on the basis of a single trial lesson 5 years earlier; nevertheless, their predictions were as extreme as their evaluations.

The illusion of validity. As we have seen, people often predict by selecting the outcome (for example, an occupation) that is most representative of the input (for example, the description of a person). The confidence they have in their prediction depends primarily on the degree of representativeness (that is, on the quality of the match between the selected outcome and the input) with little or no regard for the factors that limit predictive accuracy. Thus, people express great confidence in the prediction that a person is a librarian when given a description of his personality which matches the stereotype of librarians, even if the description is scanty, unreliable, or outdated. The unwarranted confidence which is produced by a good fit between the predicted outcome and the input information may be called the illusion of validity. This illusion persists even when the judge is aware of the factors that limit the accuracy of his predictions. It is a common observation that psychologists who conduct selection interviews often experience considerable confidence in their predictions, even when they know of the vast literature that shows selection interviews to be highly fallible. The continued reliance on the clinical interview for selection, despite repeated demonstrations of its inadequacy, amply attests to the strength of this effect.

The internal consistency of a pattern of inputs is a major determinant of one's confidence in predictions based on these inputs. For example, people express more confidence in predicting the final grade-point average of a student whose first-year record consists entirely of B's than in predicting the grade-point average of a student whose first-year record includes many A's and C's. Highly consistent patterns are most often observed when the input variables are highly redundant or correlated. Hence, people tend to have great confidence in predictions based on redundant input variables. However, an elementary result in the statistics of correlation asserts that, given input variables of stated validity, a prediction based on several such inputs can achieve higher accuracy when they are independent of each other than when they are redundant or correlated. Thus, redundancy among inputs decreases accuracy even as it increases confidence, and people are often confident in predictions that are quite likely to be off the mark (*1*).

Misconceptions of regression. Suppose a large group of children has been examined on two equivalent versions of an aptitude test. If one selects ten children from among those who did best on one of the two versions, he will usually find their performance on the second version to be somewhat disappointing. Conversely, if one selects ten children from among those who did worst on one version, they will be found, on the average, to do somewhat better on the other version. More generally, consider two variables X and Y which have the same distribution. If one selects individuals whose average X score deviates from the mean of X by k units, then the average of their Y scores will usually deviate from the mean of Y by less than k units. These observations illustrate a general phenomenon known as regression toward the mean, which was first documented by Galton more than 100 years ago.

In the normal course of life, one encounters many instances of regression toward the mean, in the comparison of the height of fathers and sons, of the intelligence of husbands and wives, or of the performance of individuals on consecutive examinations. Nevertheless, people do not develop correct intuitions about this phenomenon. First, they do not expect regression in many contexts where it is bound to occur. Second, when they recognize the occurrence of regression, they often invent spurious causal explanations for it (*1*). We suggest that the phenomenon of regression remains elusive because it is incompatible with the belief that the predicted outcome should be maximally

Attachment 6 to MNRD Non-Local Beings Report

representative of the input, and, hence, that the value of the outcome variable should be as extreme as the value of the input variable.

The failure to recognize the import of regression can have pernicious consequences, as illustrated by the following observation (*1*). In a discussion of flight training, experienced instructors noted that praise for an exceptionally smooth landing is typically followed by a poorer landing on the next try, while harsh criticism after a rough landing is usually followed by an improvement on the next try. The instructors concluded that verbal rewards are detrimental to learning, while verbal punishments are beneficial, contrary to accepted psychological doctrine. This conclusion is unwarranted because of the presence of regression toward the mean. As in other cases of repeated examination, an improvement will usually follow a poor performance and a deterioration will usually follow an outstanding performance, even if the instructor does not respond to the trainee's achievement on the first attempt. Because the instructors had praised their trainees after good landings and admonished them after poor ones, they reached the erroneous and potentially harmful conclusion that punishment is more effective than reward.

Thus, the failure to understand the effect of regression leads one to overestimate the effectiveness of punishment and to underestimate the effectiveness of reward. In social interaction, as well as in training, rewards are typically administered when performance is good, and punishments are typically administered when performance is poor. By regression alone, therefore, behavior is most likely to improve after punishment and most likely to deteriorate after reward. Consequently, the human condition is such that, by chance alone, one is most often rewarded for punishing others and most often punished for rewarding them. People are generally not aware of this contingency. In fact, the elusive role of regression in determining the apparent consequences of reward and punishment seems to have escaped the notice of students of this area.

Availability

There are situations in which people assess the frequency of a class or the probability of an event by the ease with which instances or occurrences can be brought to mind. For example, one may assess the risk of heart attack among middle-aged people by recalling such occurrences among one's acquaintances. Similarly, one may evaluate the probability that a given business venture will fail by imagining various difficulties it could encounter. This judgmental heuristic is called availability. Availability is a useful clue for assessing frequency or probability, because instances of large classes are usually recalled better and faster than instances of less frequent classes. However, availability is affected by factors other than frequency and probability. Consequently, the reliance on availability leads to predictable biases, some of which are illustrated below.

Biases due to the retrievability of instances. When the size of a class is judged by the availability of its instances, a class whose instances are easily retrieved will appear more numerous than a class of equal frequency whose instances are less retrievable. In an elementary demonstration of this effect, subjects heard a list of well-known personalities of both sexes and were subsequently asked to judge whether the list contained more names of men than of women. Different lists were presented to different groups of subjects. In some of the lists the men were relatively more famous than the women, and in others the women were relatively more famous than the men. In each of the lists, the subjects erroneously judged that the class (sex) that had the more famous personalities was the more numerous (*6*).

In addition to familiarity, there are other factors, such as salience, which affect the retrievability of instances. For example, the impact of seeing a house burning on the subjective probability of such accidents is probably greater than the impact of reading about a fire in the local paper. Furthermore, recent occurrences are likely to be relatively more available than earlier occurrences. It is a common experience that the subjective probability of traffic accidents rises temporarily when one sees a car overturned by the side of the road.

Biases due to the effectiveness of a search set. Suppose one samples a word (of three letters or more) at random from an English text. Is it more likely that the word starts with r or that r is the third letter? People approach this problem by recalling words that begin with r (road) and words that have r in the third position (car) and assess the relative frequency by the ease with which words of the two types come to mind. Because it is much easier to search for words by their first letter than by their third letter, most people judge words that begin with a given consonant to be more numerous than words in which the same consonant appears in the third position. They do so even for consonants, such as r or k, that are more frequent in the third position than in the first (*6*).

Different tasks elicit different search sets. For example, suppose you are asked to rate the frequency with which abstract words (thought, love) and concrete words (door, water) appear in written English. A natural way to answer this question is to search for contexts in which the word could appear. It seems easier to think of contexts in which an abstract concept is mentioned (love in love stories) than to think of contexts in which a concrete word (such as door) is mentioned. If the frequency of words is judged by the availability of the contexts in which they appear, abstract words will be judged as relatively more numerous than concrete words. This bias has been observed in a recent study (*7*) which showed that the judged frequency of occurrence of abstract words was much higher than that of concrete words, equated in objective frequency. Abstract words were also judged to appear in a much greater variety of contexts than concrete words.

Biases of imaginability. Sometimes one has to assess the frequency of a class whose instances are not stored in memory but can be generated according to a given rule. In such situations, one typically generates several instances and evaluates frequency or probability by the ease with which the relevant instances can be constructed. However, the ease of constructing instances does not always reflect their actual frequency, and this mode of evaluation is prone to biases. To illustrate, consider a group of 10 people who form committees of k members, $2 \leqslant k \leqslant 8$. How many different committees of k members can be formed? The correct answer to this problem is given by the binomial coefficient $\binom{10}{k}$ which reaches a maximum of 252 for $k = 5$. Clearly, the number of committees of k members equals the number of committees of $(10 - k)$ members, because any committee of k

Attachment 6 to MNRD Non-Local Beings Report

members defines a unique group of $(10 - k)$ nonmembers.

One way to answer this question without computation is to mentally construct committees of k members and to evaluate their number by the ease with which they come to mind. Committees of few members, say 2, are more available than committees of many members, say 8. The simplest scheme for the construction of committees is a partition of the group into disjoint sets. One readily sees that it is easy to construct five disjoint committees of 2 members, while it is impossible to generate even two disjoint committees of 8 members. Consequently, if frequency is assessed by imaginability, or by availability for construction, the small committees will appear more numerous than larger committees, in contrast to the correct bell-shaped function. Indeed, when naive subjects were asked to estimate the number of distinct committees of various sizes, their estimates were a decreasing monotonic function of committee size (*6*). For example, the median estimate of the number of committees of 2 members was 70, while the estimate for committees of 8 members was 20 (the correct answer is 45 in both cases).

Imaginability plays an important role in the evaluation of probabilities in real-life situations. The risk involved in an adventurous expedition, for example, is evaluated by imagining contingencies with which the expedition is not equipped to cope. If many such difficulties are vividly portrayed, the expedition can be made to appear exceedingly dangerous, although the ease with which disasters are imagined need not reflect their actual likelihood. Conversely, the risk involved in an undertaking may be grossly underestimated if some possible dangers are either difficult to conceive of, or simply do not come to mind.

Illusory correlation. Chapman and Chapman (*8*) have described an interesting bias in the judgment of the frequency with which two events co-occur. They presented naive judges with information concerning several hypothetical mental patients. The data for each patient consisted of a clinical diagnosis and a drawing of a person made by the patient. Later the judges estimated the frequency with which each diagnosis (such as paranoia or suspiciousness) had been accompanied by various features of the drawing (such as peculiar eyes). The subjects markedly overestimated the frequency of co-occurrence of natural associates, such as suspiciousness and peculiar eyes. This effect was labeled illusory correlation. In their erroneous judgments of the data to which they had been exposed, naive subjects "rediscovered" much of the common, but unfounded, clinical lore concerning the interpretation of the draw-a-person test. The illusory correlation effect was extremely resistant to contradictory data. It persisted even when the correlation between symptom and diagnosis was actually negative, and it prevented the judges from detecting relationships that were in fact present.

Availability provides a natural account for the illusory-correlation effect. The judgment of how frequently two events co-occur could be based on the strength of the associative bond between them. When the association is strong, one is likely to conclude that the events have been frequently paired. Consequently, strong associates will be judged to have occurred together frequently. According to this view, the illusory correlation between suspiciousness and peculiar drawing of the eyes, for example, is due to the fact that suspiciousness is more readily associated with the eyes than with any other part of the body.

Lifelong experience has taught us that, in general, instances of large classes are recalled better and faster than instances of less frequent classes; that likely occurrences are easier to imagine than unlikely ones; and that the associative connections between events are strengthened when the events frequently co-occur. As a result, man has at his disposal a procedure (the availability heuristic) for estimating the numerosity of a class, the likelihood of an event, or the frequency of co-occurrences, by the ease with which the relevant mental operations of retrieval, construction, or association can be performed. However, as the preceding examples have demonstrated, this valuable estimation procedure results in systematic errors.

Adjustment and Anchoring

In many situations, people make estimates by starting from an initial value that is adjusted to yield the final answer. The initial value, or starting point, may be suggested by the formulation of the problem, or it may be the result of a partial computation. In either case, adjustments are typically insufficient (*4*). That is, different starting points yield different estimates, which are biased toward the initial values. We call this phenomenon anchoring.

Insufficient adjustment. In a demonstration of the anchoring effect, subjects were asked to estimate various quantities, stated in percentages (for example, the percentage of African countries in the United Nations). For each quantity, a number between 0 and 100 was determined by spinning a wheel of fortune in the subjects' presence. The subjects were instructed to indicate first whether that number was higher or lower than the value of the quantity, and then to estimate the value of the quantity by moving upward or downward from the given number. Different groups were given different numbers for each quantity, and these arbitrary numbers had a marked effect on estimates. For example, the median estimates of the percentage of African countries in the United Nations were 25 and 45 for groups that received 10 and 65, respectively, as starting points. Payoffs for accuracy did not reduce the anchoring effect.

Anchoring occurs not only when the starting point is given to the subject, but also when the subject bases his estimate on the result of some incomplete computation. A study of intuitive numerical estimation illustrates this effect. Two groups of high school students estimated, within 5 seconds, a numerical expression that was written on the blackboard. One group estimated the product

$$8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$$

while another group estimated the product

$$1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$$

To rapidly answer such questions, people may perform a few steps of computation and estimate the product by extrapolation or adjustment. Because adjustments are typically insufficient, this procedure should lead to underestimation. Furthermore, because the result of the first few steps of multiplication (performed from left to right) is higher in the descending sequence than in the ascending sequence, the former expression should be judged larger than the latter. Both predictions were confirmed. The median estimate for the ascending sequence was 512, while the median estimate for the descending sequence was 2,250. The correct answer is 40,320.

Biases in the evaluation of conjunctive and disjunctive events. In a recent study by Bar-Hillel (*9*) subjects were given the opportunity to bet on one of two events. Three types of events were used: (i) simple events, such as drawing a red marble from a bag containing 50 percent red marbles and 50 percent white marbles; (ii) conjunctive events, such as drawing a red marble seven times in succession, with replacement, from a bag containing 90 percent red marbles and 10 percent white marbles; and (iii) disjunctive events, such as drawing a red marble at least once in seven successive tries, with replacement, from a bag containing 10 percent red marbles and 90 percent white marbles. In this problem, a significant majority of subjects preferred to bet on the conjunctive event (the probability of which is .48) rather than on the simple event (the probability of which is .50). Subjects also preferred to bet on the simple event rather than on the disjunctive event, which has a probability of .52. Thus, most subjects bet on the less likely event in both comparisons. This pattern of choices illustrates a general finding. Studies of choice among gambles and of judgments of probability indicate that people tend to overestimate the probability of conjunctive events (*10*) and to underestimate the probability of disjunctive events. These biases are readily explained as effects of anchoring. The stated probability of the elementary event (success at any one stage) provides a natural starting point for the estimation of the probabilities of both conjunctive and disjunctive events. Since adjustment from the starting point is typically insufficient, the final estimates remain too close to the probabilities of the elementary events in both cases. Note that the overall probability of a conjunctive event is lower than the probability of each elementary event, whereas the overall probability of a disjunctive event is higher than the probability of each elementary event. As a consequence of anchoring, the overall probability will be overestimated in conjunctive problems and underestimated in disjunctive problems.

Biases in the evaluation of compound events are particularly significant in the context of planning. The successful completion of an undertaking, such as the development of a new product, typically has a conjunctive character: for the undertaking to succeed, each of a series of events must occur. Even when each of these events is very likely, the overall probability of success can be quite low if the number of events is large. The general tendency to overestimate the probability of conjunctive events leads to unwarranted optimism in the evaluation of the likelihood that a plan will succeed or that a project will be completed on time. Conversely, disjunctive structures are typically encountered in the evaluation of risks. A complex system, such as a nuclear reactor or a human body, will malfunction if any of its essential components fails. Even when the likelihood of failure in each component is slight, the probability of an overall failure can be high if many components are involved. Because of anchoring, people will tend to underestimate the probabilities of failure in complex systems. Thus, the direction of the anchoring bias can sometimes be inferred from the structure of the event. The chain-like structure of conjunctions leads to overestimation, the funnel-like structure of disjunctions leads to underestimation.

Anchoring in the assessment of subjective probability distributions. In decision analysis, experts are often required to express their beliefs about a quantity, such as the value of the Dow-Jones average on a particular day, in the form of a probability distribution. Such a distribution is usually constructed by asking the person to select values of the quantity that correspond to specified percentiles of his subjective probability distribution. For example, the judge may be asked to select a number, X_{90}, such that his subjective probability that this number will be higher than the value of the Dow-Jones average is .90. That is, he should select the value X_{90} so that he is just willing to accept 9 to 1 odds that the Dow-Jones average will not exceed it. A subjective probability distribution for the value of the Dow-Jones average can be constructed from several such judgments corresponding to different percentiles.

By collecting subjective probability distributions for many different quantities, it is possible to test the judge for proper calibration. A judge is properly (or externally) calibrated in a set of problems if exactly Π percent of the true values of the assessed quantities falls below his stated values of X_{Π}. For example, the true values should fall below X_{01} for 1 percent of the quantities and above X_{99} for 1 percent of the quantities. Thus, the true values should fall in the confidence interval between X_{01} and X_{99} on 98 percent of the problems.

Several investigators (*11*) have obtained probability distributions for many quantities from a large number of judges. These distributions indicated large and systematic departures from proper calibration. In most studies, the actual values of the assessed quantities are either smaller than X_{01} or greater than X_{99} for about 30 percent of the problems. That is, the subjects state overly narrow confidence intervals which reflect more certainty than is justified by their knowledge about the assessed quantities. This bias is common to naive and to sophisticated subjects, and it is not eliminated by introducing proper scoring rules, which provide incentives for external calibration. This effect is attributable, in part at least, to anchoring.

To select X_{90} for the value of the Dow-Jones average, for example, it is natural to begin by thinking about one's best estimate of the Dow-Jones and to adjust this value upward. If this adjustment—like most others—is insufficient, then X_{90} will not be sufficiently extreme. A similar anchoring effect will occur in the selection of X_{10}, which is presumably obtained by adjusting one's best estimate downward. Consequently, the confidence interval between X_{10} and X_{90} will be too narrow, and the assessed probability distribution will be too tight. In support of this interpretation it can be shown that subjective probabilities are systematically altered by a procedure in which one's best estimate does not serve as an anchor.

Subjective probability distributions for a given quantity (the Dow-Jones average) can be obtained in two different ways: (i) by asking the subject to select values of the Dow-Jones that correspond to specified percentiles of his probability distribution and (ii) by asking the subject to assess the probabilities that the true value of the Dow-Jones will exceed some specified values. The two procedures are formally equivalent and should yield identical distributions. However, they suggest different modes of adjustment from different anchors. In procedure (i), the natural starting point is one's best estimate of the quantity. In procedure (ii), on the other hand, the subject may be anchored on the value stated in the question. Alternatively, he may be anchored on even odds, or 50-50 chances, which is a natural starting point in the estimation of likelihood. In either case, procedure (ii) should yield less extreme odds than procedure (i).

To contrast the two procedures, a set of 24 quantities (such as the air distance from New Delhi to Peking) was presented to a group of subjects who assessed either X_{10} or X_{90} for each problem. Another group of subjects received the median judgment of the first group for each of the 24 quantities. They were asked to assess the odds that each of the given values exceeded the true value of the relevant quantity. In the absence of any bias, the second group should retrieve the odds specified to the first group, that is, 9 : 1. However, if even odds or the stated value serve as anchors, the odds of the second group should be less extreme, that is, closer to 1 : 1. Indeed, the median odds stated by this group, across all problems, were 3 : 1. When the judgments of the two groups were tested for external calibration, it was found that subjects in the first group were too extreme, in accord with earlier studies. The events that they defined as having a probability of .10 actually obtained in 24 percent of the cases. In contrast, subjects in the second group were too conservative. Events to which they assigned an average probability of .34 actually obtained in 26 percent of the cases. These results illustrate the manner in which the degree of calibration depends on the procedure of elicitation.

Discussion

This article has been concerned with cognitive biases that stem from the reliance on judgmental heuristics. These biases are not attributable to motivational effects such as wishful thinking or the distortion of judgments by payoffs and penalties. Indeed, several of the severe errors of judgment reported earlier occurred despite the fact that subjects were encouraged to be accurate and were rewarded for the correct answers (*2, 6*).

The reliance on heuristics and the prevalence of biases are not restricted to laymen. Experienced researchers are also prone to the same biases—when they think intuitively. For example, the tendency to predict the outcome that best represents the data, with insufficient regard for prior probability, has been observed in the intuitive judgments of individuals who have had extensive training in statistics (*1, 5*). Although the statistically sophisticated avoid elementary errors, such as the gambler's fallacy, their intuitive judgments are liable to similar fallacies in more intricate and less transparent problems.

It is not surprising that useful heuristics such as representativeness and availability are retained, even though they occasionally lead to errors in prediction or estimation. What is perhaps surprising is the failure of people to infer from lifelong experience such fundamental statistical rules as regression toward the mean, or the effect of sample size on sampling variability. Although everyone is exposed, in the normal course of life, to numerous examples from which these rules could have been induced, very few people discover the principles of sampling and regression on their own. Statistical principles are not learned from everyday experience because the relevant instances are not coded appropriately. For example, people do not discover that successive lines in a text differ more in average word length than do successive pages, because they simply do not attend to the average word length of individual lines or pages. Thus, people do not learn the relation between sample size and sampling variability, although the data for such learning are abundant.

The lack of an appropriate code also explains why people usually do not detect the biases in their judgments of probability. A person could conceivably learn whether his judgments are externally calibrated by keeping a tally of the proportion of events that actually occur among those to which he assigns the same probability. However, it is not natural to group events by their judged probability. In the absence of such grouping it is impossible for an individual to discover, for example, that only 50 percent of the predictions to which he has assigned a probability of .9 or higher actually came true.

The empirical analysis of cognitive biases has implications for the theoretical and applied role of judged probabilities. Modern decision theory (*12, 13*) regards subjective probability as the quantified opinion of an idealized person. Specifically, the subjective probability of a given event is defined by the set of bets about this event that such a person is willing to accept. An internally consistent, or coherent, subjective probability measure can be derived for an individual if his choices among bets satisfy certain principles, that is, the axioms of the theory. The derived probability is subjective in the sense that different individuals are allowed to have different probabilities for the same event. The major contribution of this approach is that it provides a rigorous subjective interpretation of probability that is applicable to unique events and is embedded in a general theory of rational decision.

It should perhaps be noted that, while subjective probabilities can sometimes be inferred from preferences among bets, they are normally not formed in this fashion. A person bets on team A rather than on team B because he believes that team A is more likely to win; he does not infer this belief from his betting preferences. Thus, in reality, subjective probabilities determine preferences among bets and are not derived from them, as in the axiomatic theory of rational decision (*12*).

The inherently subjective nature of probability has led many students to the belief that coherence, or internal consistency, is the only valid criterion by which judged probabilities should be evaluated. From the standpoint of the formal theory of subjective probability, any set of internally consistent probability judgments is as good as any other. This criterion is not entirely satisfactory, because an internally consistent set of subjective probabilities can be incompatible with other beliefs held by the individual. Consider a person whose subjective probabilities for all possible outcomes of a coin-tossing game reflect the gambler's fallacy. That is, his estimate of the probability of tails on a particular toss increases with the number of consecutive heads that preceded that toss. The judgments of such a person could be internally consistent and therefore acceptable as adequate subjective probabilities according to the criterion of the formal theory. These probabilities, however, are incompatible with the generally held belief that a coin has no memory and is therefore incapable of generating sequential dependencies. For judged probabilities to be considered adequate, or rational, internal consistency is not enough. The judgments must be compatible with the entire web of beliefs held by the individual. Unfortunately, there can be no simple formal procedure for assessing the compatibility of a set of probability judgments with the judge's total system of beliefs. The rational judge will nevertheless strive for compatibility, even though internal consistency is more easily achieved and assessed. In particular, he will attempt to make his probability judgments compatible with his knowledge about the subject matter, the laws of probability, and his own judgmental heuristics and biases.

Summary

This article described three heuristics that are employed in making judgments under uncertainty: (i) representativeness, which is usually employed when people are asked to judge the probability that an object or event A belongs to class or process B; (ii) availability of instances or scenarios, which is often employed when people are asked to assess the frequency of a class or the plausibility of a particular development; and (iii) adjustment from an anchor, which is usually employed in numerical prediction when a relevant value is available. These heuristics are highly economical and usually effective, but they lead to systematic and predictable errors. A better understanding of these heuristics and of the biases to which they lead could improve judgments and decisions in situations of uncertainty.

References and Notes

1. D. Kahneman and A. Tversky, *Psychol. Rev.* **80**, 237 (1973).
2. ———, *Cognitive Psychol.* **3**, 430 (1972).
3. W. Edwards, in *Formal Representation of Human Judgment*, B. Kleinmuntz, Ed. (Wiley, New York, 1968), pp. 17–52.
4. P. Slovic and S. Lichtenstein, *Organ. Behav. Hum. Performance* **6**, 649 (1971).
5. A. Tversky and D. Kahneman, *Psychol. Bull.* **76**, 105 (1971).
6. ———, *Cognitive Psychol.* **5**, 207 (1973).
7. R. C. Galbraith and B. J. Underwood, *Mem. Cognition* **1**, 56 (1973).
8. L. J. Chapman and J. P. Chapman, *J. Abnorm. Psychol.* **73**, 193 (1967); *ibid.*, **74**, 271 (1969).
9. M. Bar-Hillel, *Organ. Behav. Hum. Performance* **9**, 396 (1973).
10. J. Cohen, E. I. Chesnick, D. Haran, *Br. J. Psychol.* **63**, 41 (1972).
11. M. Alpert and H. Raiffa, unpublished manuscript; C. A. S. von Holstein, *Acta Psychol.* **35**, 478 (1971); R. L. Winkler, *J. Am. Stat. Assoc.* **62**, 776 (1967).
12. L. J. Savage, *The Foundations of Statistics* (Wiley, New York, 1954).
13. B. De Finetti, in *International Encyclopedia of the Social Sciences*, D. E. Sills, Ed. (Macmillan, New York, 1968), vol. 12, pp. 496–504.
14. This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by the Office of Naval Research under contract N00014-73-C-0438 to the Oregon Research Institute, Eugene. Additional support for this research was provided by the Research and Development Authority of the Hebrew University, Jerusalem, Israel.

Rural Health Care in Mexico?

Present educational and administrative structures must be changed in order to improve health care in rural areas.

Luis Cañedo

The present health care structure in Mexico focuses attention on the urban population, leaving the rural communities practically unattended. There are two main factors contributing to this situation. One is the lack of coordination among the different institutions responsible for the health of the community and among the educational institutions. The other is the lack of information concerning the nature of the problems in rural areas. In an attempt to provide a solution to these problems, a program has been designed that takes into consideration the environmental conditions, malnutrition, poverty, and negative cultural factors that are responsible for the high incidences of certain diseases among rural populations. It is based on the development of a national information system for the collection and dissemination of information related to general, as well as rural, health care, that will provide the basis for a national health care system, and depends on the establishment of a training program for professionals in community medicine.

The continental and insular area of Mexico, including interior waters, is 2,022,058 square kilometers (*1, 2*). In 1970 the population of Mexico was 48,377,363, of which 24,055,305 persons (49.7 percent) were under 15 years of age. The Indian population made up 7.9 percent of the total (*2, 3*). As indicated in Table 1, 42.3 percent of the total population live in communities of less than 2,500 inhabitants, and in such communities public services as well as means of communication are very scarce or nonexistent. A large percentage (39.5 percent) of the economically active population is engaged in agriculture (*4*).

The country's population growth rate is high, 3.5 percent annually, and it seems to depend on income, being higher among the 50 percent of the population earning less than 675 pesos ($50) per family per month (*5*). The majority of this population lives in the rural areas. The most frequent causes of mortality in rural areas are malnutrition, infectious and parasitic diseases (*6, 7*), pregnancy complications, and accidents (*2*). In 1970 there were 34,107 doctors in Mexico (*2*). The ratio of inhabitants to doctors, which is 1423.7, is not a representative index of the actual distribution of resources because there is a great scarcity of health professionals in rural areas and a high concentration in urban areas (Fig. 1) (*7, 8*).

In order to improve health at a national level, this situation must be changed. The errors made in previous attempts to improve health care must be avoided, and use must be made of the available manpower and resources of modern science to produce feasible answers at the community level. Although the main objective of a specialist in community medicine is to control disease, such control cannot be achieved unless action is taken against the underlying causes of disease; it has already been observed that partial solutions are inefficient (*9*). As a background to this new program that has been designed to provide health care in rural communities, I shall first give a summary of the previous attempts that have been made to provide such care, describing the various medical institutions and other organizations that are responsible for the training of medical personnel and for constructing the facilities required for health care.

The author is an investigator in the department of molecular biology at the Instituto de Investigaciones Biomédicas, Universidad Nacional Autónoma de México, Ciudad Universitaria, México 20, D.F. This article is adapted from a paper presented at the meeting on Science and Man in the Americas, jointly organized by the Consejo Nacional de Ciencia y Tecnología de México and the American Association for the Advancement of Science and held in Mexico City, 20 June to 4 July 1973.

LINKED CITATIONS

You have printed the following article:

Judgment under Uncertainty: Heuristics and Biases
Amos Tversky; Daniel Kahneman
Science, New Series, Vol. 185, No. 4157. (Sep. 27, 1974), pp. 1124-1131.
Stable URL:
http://links.jstor.org/sici?sici=0036-8075%2819740927%293%3A185%3A4157%3C1124%3AJUUHAB%3E2.0.CO%3B2-M

This article references the following linked citations. If you are trying to access articles from an off-campus location, you may be required to first logon via your library web site to access JSTOR. Please visit your library's website or contact a librarian to learn about options for remote access to JSTOR.

References and Notes

[11] **The Assessment of Prior Distributions in Bayesian Analysis**
Robert L. Winkler
Journal of the American Statistical Association, Vol. 62, No. 319. (Sep., 1967), pp. 776-800.
Stable URL:
http://links.jstor.org/sici?sici=0162-1459%28196709%2962%3A319%3C776%3ATAOPDI%3E2.0.CO%3B2-E

NOTE: *The reference numbering from the original has been maintained in this citation list.*

MNRD Non-Local Beings Report

Attachment 7

Journal of Experimental Psychology: General
1992, Vol. 121, No. 4, 446–458

0096-3445/92/$3.00

Dissociation of Processes in Belief: Source Recollection, Statement Familiarity, and the Illusion of Truth

Ian Maynard Begg, Ann Anas, and Suzanne Farinacci
McMaster University
Hamilton, Ontario, Canada

This article reports 4 experiments concerning the effect of repetition on rated truth (the *illusory-truth effect*). Statements were paired with differentially credible sources (*true* vs. *false*). Old *trues* would be rated true on 2 bases, source recollection and statement familiarity. Old *falses*, however, would be rated false if sources were recollected, leaving the unintentional influence of familiarity as their only basis for being rated true. Even so, *falses* were rated truer than new statements unless sources were especially memorable. Estimates showed the contributions of the 2 influences to be independent; the intentional influence of recollection was reduced if control was impaired, but the unintentional influence of familiarity remained constant.

The truth of any proposition has nothing to do with its credibility and vice versa.

—Parker's law of political statements (Bloch, 1979, p. 84)

Our interest in this article is with the cognitive processes that influence ratings of probable truth. Ideally, a statement should not be accepted as true without factual evidence in support of its claims. However, people often rely on memories for that evidence. It is sensible to base truth ratings on whether expressed facts corroborate or contradict remembered facts. But memory is imperfect, and it is sensible to trust some remembered facts more than others. We propose that there are two independent bases on which remembered facts are given credence when people rate truth. One basis is recollection: A statement will be accepted as true if it corroborates remembered facts that are associated with a known, credible source, and it will be rejected as false if the facts are associated with a discredited source. The other basis is familiarity: A statement will seem true if it expresses facts that feel familiar. We propose, furthermore, that these two bases differ in the extent to which their influence is controlled rather than automatic. Recollection of source is a controlled use of memory, and its influence on rated truth is intentional. In contrast, increased familiarity is an automatic consequence of exposure, and its influence on rated truth is unintentional.

This research was funded by Operating Grant OGP0008122 from the Natural Sciences and Engineering Research Council of Canada; a certificate of approval from the McMaster Ethics Committee is on file. Part of the research was conducted as an honors thesis by Suzanne Farinacci, who was supervised by Ian Maynard Begg.

We are grateful for the advice and discussion from our McMaster colleagues, including Marcia Barnes, Lee Brooks, Vincenza Gruppuso, Larry Jacoby, Janine Jennings, Steve Lindsay, Douglas Needham, Rohan Robertson, James Taylor, Jeff Toth, and Andy Yonelinas. We also thank Colleen Kelley of Macalester College for her counsel. Special thanks are due to Jim Anas for being a male voice on the tapes.

Correspondence concerning this article should be addressed to Ian Maynard Begg, Department of Psychology, McMaster University, Hamilton, Ontario, Canada L8S 4K1.

Our thesis is that source recollection and statement familiarity are independent influences on rated truth, because recollecting and using source information requires intent, whereas the feeling of familiarity that occurs while processing messages occurs unintentionally. An opposing view is that the two influences are not independent: Judgments depend on familiarity only when other bases for judgments are not available. In the following section, we review the empirical support for the idea that the effect of repetition on rated truth is based on familiarity. Then, we examine evidence that familiarity and recollection are independent bases for judgments of fame and that source recollection is an intentional process. Finally, we return to rated truth and develop an approach by which we can dissociate the intentional influence of source recollection from the unintentional influence of statement familiarity.

Illusory Truth

The illusory-truth effect was first observed by Hasher, Goldstein, and Toppino (1977), who found that subjects rated repeated statements as more probably true than new statements. Repetition is an illogical basis for truth; Wittgenstein likened the tendency to believe repeated information to buying a second newspaper to see if the first one was right (Kenny, 1973). Although repetition does not provide evidence for truth, repetition does increase familiarity; for example, repeated stimuli are processed relatively fluently (cf. Jacoby & Dallas, 1981), and repeated information is easily retrieved (cf. Tversky & Kahneman, 1973, 1974). Is this increased familiarity the reason for the illusory-truth effect?

If the increased familiarity of repeated statements is the reason they seem truer than new ones, then statements should seem increasingly true as they repeat more old facts and reinstate more of the original context. To illustrate, consider the test statement "The extended right arm of the Statue of Liberty is 42 feet long." The illusory-truth effect is larger if the entire statement was presented earlier than if only "Statue of Liberty" was presented earlier, and the effect is larger if earlier queries presented more rather than fewer of the tested

Attachment 7 to MNRD Non-Local Beings Report

details ("Do you have any idea how long the extended right arm of the Statue of Liberty is?" vs. "Do you have any idea how long the Statue of Liberty has been in New York?"; Begg, Armour, & Kerr, 1985). Test statements are also rated falser than new ones if they convey unfamiliar details that contradict studied statements (e.g., "The extended right arm of the Statue of Liberty is 46 feet long"; Bacon, 1979). These effects of familiarity are irrational; there is no logical reason for repetition to affect rated truth or for earlier information to be trusted more than later information.

If the influence of familiarity on rated truth is independent of the influence of recollection, then the two influences should be separately manipulable. Begg et al. (1985) found that meaningful processing enhanced recognition memory for statements but did not affect the size of the illusory-truth effect. These results are parallel to those of Jacoby and Dallas (1981), who found that meaningful processing helped recognition memory for words but did not affect identification at short exposure durations. Furthermore, the explicit provision of source information does not influence rated truth. Bacon (1979) used a test in which repeated statements, new statements, and contradictory statements were presented in correctly labeled blocks. Because subjects were explicitly told at study and at test that half the statements were actually true and half were false, they knew that repeated statements were no more likely to be true than new ones and that contradictions were as likely to be true (contradicting an old false statement) as false (contradicting an old true statement). Even with this explicit information available, repeated statements were rated truer than new statements, and contradictions were rated falser than new statements.

In summary, we propose that the illusory truth of repeated statements is based on familiarity. Familiarity increases automatically with repetition, and its influence on rated truth is unintentional. Subjects do not spontaneously monitor the source of a statement's familiarity or use that information when rating truth. We next consider research in which the intentional role of recollection was examined more specifically.

False Fame and the Sleeper Effect

The *sleeper effect* occurs if an argument from a discredited source has a greater delayed than immediate effect on attitudes (e.g., Greenwald, Pratkanis, Leippe, & Baumgardner, 1986; Pratkanis, Greenwald, Leippe, & Baumgardner, 1988). According to the *discounting-cue hypothesis*, the effect occurs because the association between memory for the message and memory for its source is lost over time (Gruder et al., 1978); the familiarity of the message is influential only because there is no associated source that would discount it if recollected. However, if the two influences are independent, source information may remain associated with the message but have no effect on judgments; subjects do not automatically identify the source of familiarity or discount its influence.

It is difficult to discriminate the independence and dependency views in most experiments. Jacoby, Kelley, Brown, and Jasechko (1989) contrasted the two views in their investigation of the *false-fame effect*, which occurs if repeated nonfamous names are called *famous* more often than new nonfamous names. They proposed that old names are called famous because they feel familiar, although their familiarity reflects prior exposure in the experiment; this familiarity gives no objective basis for fame. Jacoby et al. opposed recollection and familiarity by telling subjects that all of the old names were actually nonfamous. Hence, recollection of the source of an old name would lead to its being called *nonfamous*, but its familiarity would lead to its being called *famous*. These *exclusion* instructions eliminated the false-fame effect if the test was immediate but not if the test was delayed 24 hr. This sleeper effect shows that recollection of a discredited source and familiarity are affected differently by the passage of time.

Jacoby, Woloszyn, and Kelley (1989; see also Jacoby & Kelley, 1987, 1990, 1991) proposed that the influence of recollection is intentional and controlled but that the influence of familiarity is automatic and unintentional. Jacoby et al. impaired subjects' ability to control the encoding of nonfamous names by dividing the subjects' attention at study, and they impaired subjects' ability to recollect sources by dividing their attention at test. These impairments reduced the influence of recollection; old nonfamous names became more famous, and the false-fame effect became larger.

In summary, fame judgments are jointly determined by familiarity and by recollection. The influence of recollection is under intentional control, but the influence of familiarity is unintentional. When the capacity for control is impaired, familiarity is unopposed by recollection of discredited sources.

Dissociation of Processes

The recently developed process-dissociation procedure (Jacoby, 1991; Jacoby & Kelley, 1990, 1991) gives a theoretical basis for dissociating the influences of recollection and familiarity. An *inclusion* condition is one in which familiarity and recollection both have the same effect. For example, if a statement was initially paired with a credible source, either source recollection (R) or statement familiarity (F) would lead to a rating of true; $p(\text{true}) = R + F - RF$.[1] In contrast, an *exclusion* condition is one in which familiarity and recollection have opposite effects. A statement originally paired with an incredible source would be rated false if the source was recollected and would be rated true only if the influence of familiarity was unopposed by recollection: $p(\text{true}) = F - RF$. Solving the equations gives values for R and F, which are valid if they respond appropriately to experimental treatments.

The procedure includes the assumptions that the processes are independent and that both processes have the same degree of influence in the inclusion and the exclusion conditions. As

[1] The expression $R + F - RF$ can be expressed as $F + (1 - F)R$ or as $R + (1 - R)F$, which are exactly equivalent. We have used the $R + F - RF$ form because the other forms invite misinterpretations; $R + (1 - R)F$ might be taken to mean that familiarity is influential only in the absence of recollection, and $F + (1 - F)R$ might be taken to mean that recollection is influential only in the absence of familiarity. Those interpretations are wrong; both forms merely express the independence of the two processes.

we see it, familiarity is a global feeling that occurs when statements are processed at test. Although familiarity is expected to increase with exposure, familiarity reflects other factors as well. For example, some statements may be familiar because of preexperimental experience with the details, and some may refer to topics with which subjects are familiar. Hence, F is an estimate of the concerted influence of a feeling or impression with multiple bases. At present, the procedure does not include a way to resolve global familiarity into constituents. However, if the rated truth of new statements is about the same in conditions being compared, it is reasonable to assume that the influence of preexperimental familiarity is the same in the conditions, even though the rated truth of new statements is not a clean measure of the extent to which statements are preexperimentally familiar.

Research on judged fame included conditions in which recollection of a discredited source would discount the effect of familiarity. Begg and Armour (1991) included comparable conditions in their research on illusory truth, but they also included conditions in which recollection and familiarity would support each other. Subjects studied statements with biasing comments that were explicitly affirmative ("It is widely known that ... ") or negative ("Few people believe that ... ") and then rated the truth of the statements without the biases. Old affirmatives were rated truest, but even old negatives were rated truer than new statements. The rated truth of affirmatives includes both influences; a statement would be true if subjects recollected the original bias or if the statement felt familiar. However, the rated truth of negatives excludes the intentional influence of recollection; recollection of the bias would lead to a rating of false, but familiarity would lead to a rating of true. The finding that negatives were rated truer than new statements is dramatic; the statements' familiarity makes them seem true even when the influence of recollection would be to rate them false.

Overview of Present Experiments

The aim of our experiments is to contrast the intentional influence of source recollection and the unintentional influence of statement familiarity on rated truth. Statements were originally paired with sources and then were tested without the sources. For example, "Sharon Spencer says that 18 newborn opossums can be placed in a teaspoon" is a statement with a female source, and "John Yates says that 300,000 pencils can be made from the average cedar tree" is a statement with a male source. Subjects in *cued conditions* were told that the sources were differentially credible. They were told that females were telling the truth but males were lying, or vice versa, to define true versus false sources (we use *true* to mean a repeated statement with an original source that was defined as true). Our interest is with the rated truth of *trues*, *falses*, and *news*.

The contrast between *trues* and *falses* allows investigation of the intentional influence of source recollection to a greater extent than was possible in previous research. Although the fame research used exclusion conditions, source recollection entailed only old–new discrimination, because the discredited source was prior exposure. In the present case, both *trues* and *falses* are old, so any influence of recollection requires discrimination of sources within old statements. The *falses* will be rated true only on the basis of familiarity, because recollection of the source would lead to a rating of false. The *trues* will be rated true if the source is recollected or because they are familiar. Thus, *trues* should be rated truer than *falses*, with the difference between them reflecting recollection. The *falses* can be truer or falser than *news* because the two influences have opposite effects; they will be truer than *news* when the unintentional influence of familiarity exceeds the intentional influence of recollection and will become falser as the influence of recollection becomes stronger, eventually becoming falser than *news*. Applying the process-dissociation procedure to truth ratings makes it possible to estimate R, the influence of source recollection, and F, the influence of familiarity. If the estimates are valid, R will decline when intentional control is impaired, but F will remain constant over conditions in which control is intact or impaired.

Each experiment also included neutral conditions, in which there was no mention of the credibility of the sources. Because subjects were told that half the old statements and half the new statements were true, recollection would discount the effect of familiarity by identifying the prior exposure of the statements as a source of their familiarity. However, source recollection is not automatic. Therefore, old statements should be rated truer than new statements even though the subjects could, if asked, indicate which statements were presented in the study list. We place less emphasis on the neutral conditions than on the cued conditions, because most of the results of the neutral conditions confirm known results.

Our thesis is that source recollection and statement familiarity are independent influences on rated truth. The most direct way to determine if measures are independent is to see if they can be manipulated separately. For example, measures of recollection should be reduced if control is impaired, but measures of familiarity should be invariant over impairment of control. It is also possible to test for stochastic independence within conditions. If measures are independent, then an item's success on one measure should be uninformative about the item's success or failure on the other measure. We included direct tests of source memory. Rated truth should be associated with source judgments; for example, statements that are rated true should be judged to have had a *true* source. However, when the data are conditionalized on the basis of whether the source judgments are correct or incorrect, rated truth should be dependent only on familiarity. Therefore, we predicted that rated truth would be independent of the accuracy of source judgments. We now outline the major contrasts in each of four experiments.

In Experiment 1, each statement was paired with a male or a female name.[2] Half the names were known; they had been

[2] We did not investigate sex as a determinant of apparent truth. Our procedures favored the two sources equally often, and our results are averaged to contrast *trues* versus *falses*. Differences between male and female sources would be unimportant because the statements we used were chosen from books of trivia. Worse, differences would be uninterpretable; the experimenter was female (and it was her voice that subjects heard when studying statements), most of the subjects

learned earlier in the experiment. After subjects were told to believe females and doubt males (or vice versa), they listened to the statements and names, and then they rated the probable truth of old and new statements. The pattern in rated truth was *true* > *false* > *new*, and the *true–false* difference was larger with known than with unknown names. Hence, the known names enhanced source recollection. However, statements paired with known names were not more familiar than statements paired with unknown names.

In Experiment 2, subjects were told either to believe or to doubt male or female names; truth ratings were *true* > *false* > *new*. On a second test, subjects rated truth and made memory judgments. Truth ratings were independent of the accuracy of source judgments even though statements that were rated true tended to be judged to have had *true* sources.

In Experiment 3, we added a postcued condition in which subjects were told which names to believe and which to doubt after they had heard the statements and sources. Because these subjects had no truthful or untruthful sources at study, they could not exercise control over encoding of credibility and, hence, should show a reduced influence of recollection on rated truth. Postcued subjects failed to discriminate *true*s from *false*s in rated truth (*true* = *false* > *new*), but precued subjects showed the usual pattern (*true* > *false* > *new*). Postcuing reduced R but did not affect F. This same outcome occurred in Experiment 4, in which we used male and female voices to improve source discrimination. We also included a condition in which subjects performed mental arithmetic while listening to the statements. Dividing attention had the same effect as postcuing; it reduced R but had no effect on F.

The results confirm that the unintentional influence of familiarity is an automatic consequence of prior exposure but that the intentional influence of recollection of sources requires intentional and strategic control. Accordingly, the two influences are independent.

General Method

The experiments shared the procedural details described in this section. Departures are described in separate Method sections.

Subjects

Subjects were introductory psychology students at McMaster University who volunteered in return for course credit. They assigned themselves to groups of 9 to 15 that were assigned at random to experimental conditions, with at least two groups assigned to each condition.

Materials

Study list. Study lists consisted of statements paired with names (e.g., "Gail Logan says that house mice can run an average of 4 miles per hour"), which were tape-recorded at rates from 10 to 13 s per statement.

Statements. Statements were chosen from the pool described by Bacon (1979); each has a true version and a false version that was created by changing a detail. We reduced the pool to 196 statements; true and false versions were rated as true by .40 to .60 of the norming sample. For each experiment, we selected the number of statements needed, randomly assigned them to conditions, and then selected the true version for half the statements and the false version for the other half. Subjects were told that half the statements were actually true and half false, and the information was repeated at test to let them know that old and new statements had the same chance of being true. All results are averaged over actual truth and falsity.

Names. We chose 64 surnames from a telephone directory (Hamilton, ON). Each name filled between one quarter of a column and a full column in the directory, and each was from 4 to 9 letters long. First names were chosen from Battig and Montague (1969), including the 32 most frequent male names and the 32 most frequent female names and omitting names that are in both categories and that are derivatives of each other. First names and surnames were paired at random; some re-pairing was needed to avoid famous names. Examples include Nancy Archer, Betty Cummings, Gail Logan, and Linda Walsh versus Sam Abbott, Mike Butler, Frank Foster, and Harry Pearson.

Truth tests. Subjects rated the probable truth of old and new statements, all without names. In Experiment 1, the test was presented by tape recorder, and the response scale was *certainly true* (1), *probably true* (2), *possibly true* (3), *completely uncertain* (4), *possibly false* (5), *probably false* (6), and *certainly false* (7). In Experiments 2–4, the tests were typed, and the truth scale was reversed, that is, *certainly true* (7). Previous research has used averaged rated truth as the dependent variable, but we used the proportion of *true* ratings (1, 2, and 3 in Experiment 1; and 5, 6, and 7 in Experiments 2, 3, and 4); analyses of average ratings led to the same conclusions, but the proportions are more tractable to stochastic analyses and are easier to understand.

Procedure

The major manipulation of the experiments consisted of cuing subjects that sources were differentially credible. Cues defined a *true* source and a *false* source by telling subjects to believe one source and doubt the other. Cues were balanced in every experiment so that each statement and source was *true* or *false* about equally often. Subjects in precued conditions were told which sources were *true* and which were *false* before they heard the study list to allow intentional control over the encoding of truthful and untruthful sources. Experiments 3 and 4 also included postcued conditions; subjects were not told which sources were *true* and which were *false* until they had heard the study list to prevent intentional control over encoding of truthful and untruthful sources. Each experiment also included a neutral condition in which there was no mention of the credibility of the sources.

Experiment 1

Subjects in Experiment 1 first learned some male and female names. Then they heard a list in which statements were paired with these known names or with unknown names. Before they heard the list, subjects were told that one source was *true* and one source was *false*. They were told either that known names were truthful and unknown names were lying (or vice versa) or that females were truthful and males were lying (or vice versa). Subjects then rated the truth of old and new statements.

---

were females, and the statements were not normed as to whether the referential contents are stereotypically associated with males or females.

We have proposed that rated truth is based on source recollection and statement familiarity. Recollection is an intentional use of memory to comply with explicit information about source credibility. In contrast, familiarity is an illogical basis for rating truth, because statements originally paired with a *false* source should feel more familiar than *new* statements. Furthermore, subjects were explicitly told that half the statements were true at study and at test. Hence, subjects should discount familiarity caused by prior exposure in the experiment. We next describe the specific predictions tested in Experiment 1.

First, *true*s should be rated truer than *new*s because both familiarity and recollection would lead to a *true* rating. Second, *true*s should be rated truer than *false*s, with the difference based on recollection. Third, the *true–false* difference should be larger if the source names are known rather than unknown. Fourth, the *false–new* difference should vary inversely with the influence of recollection. The two influences have opposite effects on *false*s, which would be rated true on the basis of familiarity and false on the basis of recollection. Thus, the *false–new* difference should be greater with known than with unknown sources. We also used the process-dissociation procedure to estimate the influence of recollection and familiarity on the rated truth of the *true*s and *false*s. If the two influences are independent, then the proportion of *true*s rated true is R + F − RF, and the proportion of *false*s rated true is F − RF. We predicted that R would be higher with known than with unknown names as sources but that F would not. If anything, F could decline with known sources, because the known sources are familiar, and subjects might attribute the feeling of familiarity to the sources rather than to the statements.

Method

Subjects

A total of 195 subjects were tested; 34 were in each of two neutral conditions; 59 were cued about the credibility of known and unknown names, and 68 were cued about male and female names.

Materials

Thirty-two female and 32 male names were paired with 64 statements that were selected from the pool, as were 20 new statements for the test. There were 16 statements for each source (Known or Unknown × Male or Female), but only 10 of each were tested later. The study list was tape-recorded at a rate of 10 s per statement. The test included 20 new statements and 40 old ones (10 from each source), all without names. The statements were tape-recorded in random order at a rate of 10 s per statement by the same person who had recorded the study list.

Procedure

Known names. Subjects initially learned 16 male and 16 female names. They heard the names (e.g., Mary Freeman and Ken Rankin) at a rate of 2 s per name, then had four tests of memory for the names. On each test trial, subjects heard part of each name and had 5 s to write the rest, after which they heard the full name. Each name was tested four times, prompted twice by the first name and twice by the surname. The procedure took about 15 min.

Study. Subjects were told to imagine they were at a party where people would make statements; half the names would be known and half would be unknown, and half would be male and half female. Subjects in one neutral condition rated the truth of each statement as it appeared. All other subjects rated how interesting the statements were on a 7-point scale with *most interesting* (1); we used this task to ensure that subjects attended to the meaning of each statement. Subjects in cued conditions were told before study that one source was *true* and one was *false*; they were also told which speakers would be truthful and which would be lying. Cues were based on whether the names were known or on sex.

Results and Discussion

Our interest is with the proportion of statements subjects rated true when the statements were tested without named sources. Throughout the article, the alpha level is .05 for inferences. Simple effects were evaluated by least significant differences (LSDs) based on mean square error (MS_e) values.

Cued Conditions

Table 1 shows the results for the cued conditions, with rated truth at the left side and values of R and F at the right side. First, consider rated truth, for which the mean square error was less than 0.032. The pattern in each row is *true* > *false* > *new*. The first row shows the results when subjects were cued to believe or doubt names that were unknown or known; the main effect was reliable, $F(2, 116) = 27.4$, LSD = .06. The bottom two rows show the results when cues were based on the sex of the source. There was a reliable main effect in an analysis comparing the four kinds of old statements with the *new* ones, $F(4, 268) = 17.7$, LSD = .06. In a separate analysis of the old statements, there was a reliable interaction between *true* versus *false* and known versus unknown sources, $F(1, 67) = 9.48$, LSD = .05.

Values of R and F were computed separately for each subject. For the subjects whose cues were based on male and female names, R was larger if the sources were known rather than unknown, $F(1, 67) = 9.48$, $MS_e = 0.043$, but F was slightly smaller for known than unknown sources, $F(1, 67) = 4.38$, $MS_e = 0.016$.

Table 1
Rated Truth of Old True, Old False, and New Statements in Experiment 1

	Rated truth				
Basis of cuing	True	False	New	R	F
Known vs. unknown	.66	.59	.45	.07	.63
Male vs. female					
Known names	.63	.48	.44	.15	.57
Unknown names	.63	.58	.44	.04	.62

Note. True refers to a repeated statement with an original source that was defined as true. False refers to a repeated statement with an original source that was defined as false. New refers to a statement that was not originally studied. R = recollection; F = familiarity.

Neutral Condition

Subjects in the neutral condition showed the illusory-truth effect. They rated .60 of the old statements true, compared with .44 of the new ones; the main effect was reliable, $F(1, 33) = 11.7$, $MS_e = 0.014$. Averaged over old and new statements, subjects rated .55 of the statements true. Subjects who rated truth at study rated .54 of the statements true ($MS_e = 0.033$). Hence, subjects adopted a criterion level of plausibility that accepted about half the statements as true. The mean ratings at study, when all statements were new, fell between the means for old and new statements rated after study. The familiarity of the old statements increased their apparent truth and the relative unfamiliarity of the new statements reduced their apparent truth. The occurrence of the illusory-truth effect in the neutral condition implies that subjects did not spontaneously identify the source of the statements' increased familiarity as being prior exposure in the experiment and discount the influence of familiarity.

Summary and Conclusions

The pattern in rated truth was *true* > *false* > *new*. The *true*s were rated truest because familiarity and source recollection both lead to a rating of true. These two influences have opposite effects with *false*s because source recollection would lead to a rating of false. Furthermore, recollection was more influential if the sources were known than if they were unknown; known sources increased the *true–false* difference and decreased the *false–new* difference. Although R was larger with known than unknown sources, F was not, indicating that they respond differently to the manipulation of whether sources are known or unknown.

Experiment 2

Subjects in Experiment 2 studied statements paired with female and male names before rating the truth of old and new statements. As in Experiment 1, we expected that rated truth would be *true* > *false* > *new*. Subjects then completed a second test that included truth ratings and source judgments. Statements that are rated true should be attributed to the *true* source, whether the basis for apparent truth is recollection or familiarity. To the extent that rated truth reflects familiarity, rated truth should be independent of the accuracy of source judgments.

Method

Subjects

There were 75 subjects, 25 in the neutral condition and 50 in the cued condition.

Materials

We chose 30 new statements for the tests, 60 studied statements, and 4 untested fillers (2 at each end of the study list). The 64 names were paired with the 64 studied statements and tape-recorded at a 12-s rate. Subjects rated interest at study, circling a digit from 1 to 7 for each statement, with *most interesting* (7). The truth test had 20 new statements and 20 old statements (10 from each source). Each statement was typed beside the 7-point truth scale, with *certainly true* (7). The truth-and-memory test had another 20 old statements (10 from each source) and 10 new statements. Each statement was accompanied by the truth scale and by *N* for new, *M* for male, and *F* for female.

Procedure

Subjects were to imagine they were at a party playing Trivial Pursuit and that 32 women and 32 men would each present a trivial statement. They rated how interesting each one was. Subjects in the neutral condition received no biasing cues. Subjects in the cued condition were told that the men would most often be telling the truth and the women would most often be lying, or vice versa. Subjects completed the truth test (7 min) and then the truth-and-memory test (6 min).

Results and Discussion

Cued Condition

Rated truth. Table 2 shows the truth ratings for the cued condition. Ratings showed the same pattern as in Experiment 1, *true* > *false* > *new*. The main effect was reliable on each test, $F(2, 98) > 21.7$, $MS_e < 0.024$, LSD = .06. Table 2 also shows the R and F values. Neither R ($MS_e = 0.039$) nor F ($MS_e = 0.021$) differed over tests. Thus, the requirement to make memory judgments did not affect truth ratings.

Memory. Subjects accurately discriminated old from new statements. They recognized .94 of the *true*s and .93 of the *false*s, and falsely recognized only .10 of the *new*s (.05 were attributed to each source; $MS_e < 0.020$). However, subjects were less accurate in judging whether recognized statements had *true* or *false* sources. Source discrimination was assessed by D = *p*("*true*" | *true*) − *p*("*true*" | *false*);[3] subjects showed reliable discrimination, D = .63 − .45 = .18, $F(1, 49) = 28.9$, $MS_e = 0.029$. Finally, we assessed the relationship between rated truth and the accuracy of source judgments and found that the two were independent. Rated truth was about the same for correctly judged *true*s as for *false*s that were misjudged as having *true* sources (.82 vs. .84) and for *true*s that

[3] Batchelder and Riefer (1990) observed that there is no theory-free way to measure the accuracy of memory for source. They presented a multinomial model in which memory for source can be measured under defined sets of assumptions. The traditional measure of source memory is *I* (the average proportion of correct source judgments, given recognition). Batchelder and Riefer showed that *I* is not independent of recognition. However, when hit rates are high and false alarm rates are low, the dependency has little effect; $2I - 1$ is approximately equal to their parameter that estimates discriminability of sources. We used their model to analyze the data from each experiment, but there was rarely more than a 1% discrepancy in estimates of discriminability computed by the multinomial model and computed as the difference between hits ("true" | *true*) and false alarms ("true" | *false*), given recognition. We present the simpler, traditional estimates.

Table 2
Truth of Old True, Old False, and New Statements in Experiment 2

	Rated truth				
Test	True	False	New	R	F
1	.70	.60	.49	.11	.68
2	.71	.65	.49	.07	.71

Note. True refers to a repeated statement with an original source that was defined as true. False refers to a repeated statement with an original source that was defined as false. New refers to a statement that was not originally studied. R = recollection; F = familiarity.

were misjudged as having *false* sources as for correctly judged *falses* (.54 vs. .52). Analysis revealed a main effect of judged source, $F(1, 49) = 34.7$, $MS_e = 0.13$, but no effect of actual source, $F(1, 49) = 0.012$, $MS_e = 0.052$.

Neutral Condition

Subjects in the neutral condition rated more old than new statements true on the first test (.73 > .46) and on the second test (.80 > .46). Both main effects were reliable, $F(1, 24) > 20.8$, $MS_e < 0.045$. On the second test, subjects correctly recognized .96 of the old statements and falsely recognized .10 of the new ones ($MS_e = 0.012$). Thus, the illusory-truth effect occurs even when subjects know that the statements were presented recently.

Summary and Conclusions

The results support and extend the conclusions from Experiment 1. Rated truth was *true* > *false* > *new*. On the memory test, subjects discriminated old and new statements very accurately. Memory for sources was modest, even though subjects were explicitly directed to attend to the sources at study. Rated truth was independent of whether source judgments were correct or incorrect, even though there was a strong association between rated truth and source judgments.

Experiment 3

Statements were paired with male and female names at study but not at test. We added a postcued condition in which the credibility of the sources was not mentioned until after the statements and sources had been heard. Because subjects in postcued conditions did not have *true* versus *false* sources while studying, they could not control encoding to take account of source credibility. Impairing their control should reduce their ability to discriminate between *true* and *false* sources in truth ratings and also on direct test of memory. However, because the influence of familiarity on rated truth is unintentional, impairment of control should have no effect on familiarity. We predicted that precued and postcued conditions would differ in R but not in F.

After subjects rated truth, they completed a memory test on which some of the statements were repeated from the truth test. We extended the process-dissociation procedure as follows. We used the ratings from the truth test to identify consistent statements (*trues* rated true and *falses* rated false) and inconsistent statement (*trues* rated false and *falses* rated true), and then we examined source judgments from the memory test. In both cases, source judgments would be correct if they were based on recollection. However, judgments based on apparent truth or falsity would give different answers for the two sorts of statement. Consistent statements that seem true actually had a *true* source, and those that seem false had a *false* source. With inconsistent statements, the ones that seem true actually had a *false* source, and the ones that seem false had a *true* source; judgments that accord with apparent truth would be wrong. For consistent statements, the probability of a correct source judgment is $R + F - RF$; for inconsistent statements, the probability is $F - RF$ that the statement will be attributed to the accordant but incorrect source. Solving these equations for R and F allows comparison of the influences on a direct test of memory with those on a test of truth, which is an indirect test of memory.

Method

Subjects

There were 74 subjects, 25 in the neutral condition, 25 in the precued condition, and 24 in the postcued condition.

Materials

We chose 60 new statements for the tests, 60 old statements, and 4 fillers (2 at each end of the list). Each statement was paired with a name and tape-recorded at a rate of 13 s per pair, of which 4 s was blank. The truth test had 40 new statements and 40 old statements (20 from each source). At the top of each page was the legend for the 7-point scale, with the digits 1 to 7 typed beside each statement. The memory test had 20 new statements, 20 old statements that had not been rated for truth, and 20 that had been rated for truth; half of the old statements were from each source. Beside each statement were *M* for male, *F* for female, and *N* for new.

Procedure

Subjects in the neutral condition were not told to believe or to doubt either source. Precued subjects were told before study to believe one sex and doubt the other; the instructions were repeated at test. Postcued subjects received the same test instructions after hearing the statements and sources. Subjects were told to listen carefully to each statement. Immediately after each statement, the experimenter held up a card (8.5 × 11 in.) with a number from 11 to 89 on it; subjects recorded this number on a sheet that was numbered to correspond to the presented statements. Subjects then completed the two tests, which required about 13 min and 6 min, respectively.

Results and Discussion

Cued Conditions

Rated truth. Rated truth for the cued conditions is shown at the left side of Table 3. Rated truth in the precued condition showed the same pattern as in Experiments 1 and 2: *true* >

Table 3
Rated Truth of Old True, Old False, and New Statements in Experiment 3

	Rated truth			Truth data		Memory data		
Condition	True	False	New	R	F	D	R	F
Precued	.77	.58	.43	.19	.71	.23	.20	.75
Postcued	.66	.66	.50	.00	.67	.10	.10	.72

Note. True refers to a repeated statement with an original source that was defined as true. False refers to a repeated statement with an original source that was defined as false. New refers to a statement that was not originally studied. R = recollection; F = familiarity; D = accuracy of source discrimination.

false > *new*. However, the pattern in the postcued condition was *true* = *false* > *new*. Analysis revealed a reliable interaction between the types of statements and cuing conditions, $F(2, 94) = 6.67$, $MS_e = 0.021$, LSD = .09. Table 3 also shows R and F values computed from the truth data. As predicted, R was larger in the precued than the postcued condition, $F(1, 49) = 9.53$, $MS_e = 0.046$, but F did not differ, $F(1, 49) = 1.36$, $MS_e = 0.019$.

Memory for statements. Statements that were previously tested for truth were recognized better than statements that were tested only for memory, .92 > .85, $F(1, 46) = 20.7$, $MS_e = 0.013$. Recognition was equally good for precued subjects and postcued subjects (.89 vs. .87) and for statements with *true* and *false* sources (.88 vs. .88). The false recognition rate was .10; of these false recognitions, .06 were judged to have a *true* source, and .05 were judged to have a *false* source ($MS_e = 0.0049$).

Memory for sources. The discrimination between sources of recognized statements was assessed by D = *p*("true" | *true*) − *p*("true" | *false*); these values are shown in Table 3. Discrimination was better for the precued condition (D = .67 − .44 = .23) than the postcued condition (D = .62 − .52 = .10); the interaction was nearly reliable, $F(1, 46) = 3.19$, $MS_e = 0.069$, $p < .08$, LSD = .15. As in Experiment 2, statements that were judged to have had *true* sources were more likely to have been rated true than statements judged to have had *false* sources, .82 > .45, $F(1, 42) = 55.6$, $MS_e = 0.111$, and there was no effect of whether statements actually had *true* or *false* sources (.65 vs. .62). However, there was an interaction between actual source and conditions, $F(1, 42) = 9.03$, $MS_e = 0.048$, LSD = .13; rated truth was higher for *true* than *false* sources in the precued condition (.71 > .58) but not in the postcued condition (.59 vs. .66).

We now contrast consistent statements (which had truth ratings in accord with the source) with inconsistent statements (which had truth ratings opposite to the source); analyses are based on group totals. On the memory test, subjects would attribute consistent statements to the accordant, correct source on the basis of source recollection or familiarity; respective means were .80 and .75 for the precued and postcued conditions. Inconsistent statements, however, would be attributed to the accordant, incorrect source only if familiarity was unopposed by recollection; respective means were .60 and .65. Values of R and F are shown at the right side of Table 3. The R and F values from the different sets of data are similar enough to be seen as telling the same story, and the R values are similar to the D values from the preceding analysis.

Neutral Condition

Subjects in the neutral condition rated more old than new statements true (.72 > .55); the main effect was reliable, $F(1, 24) = 17.9$, $MS_e = 0.019$. On the memory test, subjects recognized more statements that had been rated for truth than statements that were tested only for memory (.90 vs. .81); $F(1, 24) = 15.7$, $MS_e = 0.013$. Subjects falsely recognized .05 of the new statements. To analyze memory for the sources of the recognized statements, we tagged sources as A versus B (males were A for about half the subjects); D = *p*("A" | A) − *p*("A" | B). Analysis revealed a slight but reliable main effect; D = .57 − .48 = .09, $F(1, 24) = 4.74$, $MS_e = 0.038$. Source recollection had a negative effect on rated truth; statements with correctly judged sources were rated true on the prior test less often than statements with incorrectly judged sources (.67 < .76), $F(1, 23) = 4.72$, $MS_e = 0.020$.

Summary and Conclusions

The results of Experiment 3 extend those from Experiments 1 and 2. Truth ratings did not differ for statements paired with *true* versus *false* sources in postcued conditions, and these subjects did not exceed chance accuracy on a direct test of source memory. Precued and postcued conditions differed in R but not in F, whether R and F were computed from truth ratings or from memory judgments. Source judgments about consistent and inconsistent statements showed that familiarity was so influential that statements were attributed to the accordant but incorrect source more often than to the correct source, just as the rated truth of *false*s exceeded the rated truth of *news*. Despite the association between rated truth and source judgments, rated truth remained nearly independent of the accuracy of source judgments. An interesting finding occurred in the neutral condition, in which prior ratings of truth were higher for statements with incorrectly rather than correctly judged sources on a later test of memory; recollection of the sources was thus negatively associated with the size of the illusory-truth effect.

Experiment 4

One aim in Experiment 4 was to increase the influence of recollection by improving memory for sources; statements were recorded in a male voice or a female voice rather than being presented by male or female names. As source recollection becomes more influential, the rated truth of *true*s and *falses* should diverge, with *false*s becoming falser than *new*s if recollection becomes influential enough. We included a postcued condition to impair intentional control over encoding of the credibility of the sources. We also included a condition in which subjects' attention was divided at study by doing mental arithmetic while listening to the statements.

Dividing attention should impair subjects' ability to encode the credibility of the sources. If so, R will be higher in the precued condition than in the postcued condition or the divided-attention condition; F will remain constant over conditions if the unintentional influence of familiarity is insensitive to impairments in control.

Method

Subjects and Materials

There were 144 subjects, with from 22 to 26 in each of 6 conditions. The materials were the same as in Experiment 3 except that the statements were recorded without names. Instead, a man recorded the statements that were paired with male names, and a woman recorded those that were paired with female names. The same tests were used as in Experiment 3 (the two experiments were set up and conducted together).

Procedure

The neutral, precued, and postcued conditions were the same as in Experiment 3 except that the sources were defined by voices rather than by names. Immediately after each statement, the experimenter held up a card containing a 2-digit numeral from 11 to 89; subjects recorded this number on an answer sheet. Subjects in the divided-attention condition listened to the same tape, but the 2-digit number was held up before rather than after the statement, and they recorded the difference between the number on the card and 100 after the statement had been presented. For example, they might see 27, then hear a statement, then record 73. The 2-digit numbers were different for all 64 trials, and very easy numbers (e.g., 25, 50, and 80) were not used. There were two divided-attention conditions (precued and postcued), but they are averaged in all later analyses because they were never reliably different from each other; if subjects are prevented from attending to source credibility, it does not matter if they are told to do so or not. After study, subjects completed the truth test (13 min) and then the memory test (6 min).

Results and Discussion

Cued Conditions

Rated truth. Rated truth from the cued conditions is shown at the left side of Table 4. Analysis revealed a three-way interaction among cuing (precued vs. postcued), attention (full vs. divided), and source (*true* vs. *false* vs. *new*), $F(2, 186) = 2.99$, $p = .05$, $MS_e = 0.023$, LSD = .09. The row called *divided attention* shows the average of the two divided-attention conditions, which did not differ reliably from each other. The pattern in the precued condition was *true* > *new* ≥ *false*; *falses* were not reliably falser than *news*. The *falses* in the postcued and divided-attention conditions were truer than in the precued condition, but they were not reliably truer than *news*; the pattern was *true* > *false* ≥ *new*.

Table 4 also shows values of R and F computed from the truth ratings. Analysis of R revealed an interaction between attention and when cuing occurred, $F(1, 93) = 5.07$, $MS_e = 0.053$, LSD = .13; R was higher in the precued condition than in the postcued condition or the divided-attention condition. In contrast, the F values for the three conditions did not differ reliably ($MS_e = 0.031$, LSD = .10).

Memory for statements. The major result in recognition memory was that dividing attention reduced memory. More of the previously untested statements were recognized in the precued and postcued conditions (.87 in both conditions) than in the divided-attention condition (.74); the difference was reduced for statements that were previously rated for truth (.95 and .93 vs. .90); for the interaction, $F(2, 93) = 5.11$, $MS_e = 0.062$. Recognition was equally good for *trues* and *falses* (.87 and .85). False recognition rates were lower in the precued and postcued conditions (.07 and .08) than in the divided-attention condition (.18); $F(2, 93) = 6.11$, $MS_e = 0.021$. Falsely recognized statements were equally often attributed to *true* and *false* sources (.06 vs. .05, $MS_e = 0.0047$). Hence, the only factor that influenced old–new recognition was attention.

Memory for sources. Source discrimination was better in the precued condition (D = .73 − .30 = .43) than in the postcued condition (D = .65 − .40 = .25) or in the divided-attention condition (D = .65 − .41 = .24); for the interaction, $F(2, 93) = 4.36$, $MS_e = 0.079$, LSD = .14. Table 4 shows that the D values are higher than the R values from truth ratings, but the D values show the same pattern. The next analysis concerns rated truth for statements with actual sources that were *true* versus *false* and were judged to have had *true* versus *false* sources. There was a large effect of whether statements were judged to have *true* versus *false* sources (.81 > .44); $F(1, 86) = 108$, $MS_e = 0.093$, and a reliable effect of actual *true* versus *false* sources (.68 > .57), $F(1, 86) = 11.3$, $MS_e = 0.084$.

As in Experiment 3, we compared consistent and inconsistent statements. For the consistent statements, people correctly identified the source, with respective means of .86, .79, and .81 for the precued, postcued, and divided-attention conditions. For the inconsistent statements, people attributed the statements to the accordant but incorrect source, with respective means of .49, .57, and .60. The R and F values from these means are shown at the right side of Table 4. Values of R were reasonably close to the values computed from truth ratings, indicating that the intentional influence of recollection was about the same for rated truth as for a direct test of memory for sources. Values of F were higher on the memory test because the statements received an extra pres-

Table 4
Rated Truth of Old True, Old False, and New Statements in Experiment 4

	Rated truth			Truth data		Memory data		
Condition	True	False	New	R	F	D	R	F
Precued	.78	.40	.46	.38	.64	.43	.37	.78
Postcued	.72	.59	.51	.13	.68	.25	.22	.73
Divided attention	.72	.50	.47	.21	.64	.24	.21	.76

Note. True refers to a repeated statement with an original source that was defined as true. False refers to a repeated statement with an original source that was defined as false. New refers to a statement that was not originally studied. R = recollection; F = familiarity; D = accuracy of discrimination.

entation on the truth test, but F was nearly constant over conditions, implying that the influence of familiarity is unaffected when control is impaired.

Neutral Conditions

Subjects in the neutral conditions rated more old than new statements true, and the difference was larger if subjects' attention was divided at study (.70 > .51) than if attention was undivided (.64 > .57); for the interaction, $F(1, 45) = 7.56$, $MS_e = 0.013$, LSD = .07. In recognition memory, subjects whose attention was divided recognized fewer statements than subjects whose attention was undivided (.79 < .88), and they falsely recognized more of the new statements (.13 > .01); both main effects were reliable, $F(1, 45) = 10.4$ and 12.2, MS_e = 0.042 and 0.013. Subjects showed better discrimination of sources if their attention was undivided (D = .69 − .31 = .38) than if their attention was divided (D = .62 − .54 = .08); for the interaction, $F(1, 45) = 11.3$, $MS_e = 0.093$, LSD = .17.

Thus, dividing attention increased the size of the illusory-truth effect but reduced memory for statements and sources. Because dividing attention made memory worse but increased the illusory-truth effect, one would not want to explain the increased illusion of truth on the basis of recollection.

Summary and Conclusions

In Experiment 4, we used male and female voices rather than names, and the sources were more discriminable than in previous experiments. Accordingly, the *true–false* difference was large in the precued condition, and *false*s became slightly falser than *news*. Impairing control by postcuing or by dividing attention reduced the influence of recollection on rated truth, and the *false*s became truer than in the precued condition. Despite these changes in truth ratings, values of F were nearly constant over the conditions. All measures of the accuracy of memory were reduced by dividing attention. Like dividing attention, postcuing reduced source discrimination on the direct test and on truth ratings, but postcuing had no effect on memory for statements. Hence, the similar effects on rated truth for the postcued and divided-attention conditions cannot be explained on the basis of recollection of statements. Finally, the values of R and F from the memory test told the same story as those from the truth ratings: Impaired control reduced R, but F was approximately constant.

General Discussion

We conclude that rated truth is influenced by source recollection and statement familiarity and that the two influences are independent of each other. Recollection is a controlled and intentional use of cognitive information, but familiarity's influence is unintentional. We now summarize the results that support this conclusion, then review related ideas.

The illusory-truth effect occurred in the neutral conditions of each experiment, and rated truth was dissociated from the accuracy of memory judgments. For example, dividing attention impaired memory for the statements and sources but increased the illusory-truth effect. Recognition memory was very accurate, indicating that subjects can identify the source of the familiarity of old statements as being their prior exposure in the experiment. However, they do not spontaneously use that information to discount the illusion of truth engendered by familiarity.

The most important results occurred when the influence of recollection of *true* or *false* sources supported or opposed the influence of familiarity on truth ratings. In Experiments 1, 2, and 3, rated truth was *true* > *false* > *new* when subjects were precued about source credibility. Experiment 3 included a postcued condition, in which the pattern, *true* = *false* > *new*, indicates that subjects did not discriminate the sources. The conclusions were strengthened by using a process-dissociation procedure to obtain separate estimates of the influence of recollection and familiarity. If source recollection is an intentional use of memory, R should decline as intentional control is impaired. If the influence of statement familiarity is unintentional, F should be unaffected by impairment of control. We found that R was lower in the postcued condition than in the precued condition, but F did not change. As well, R was increased by the use of known rather than unknown sources in Experiment 1, but without an increase in F. The conclusions were strengthened further in Experiment 4. Source recollection was more influential with voices than with names as the basis for defining *true* versus *false* sources, and the illusory-truth effect with *false*s was eliminated. When control was impaired, *false*s were more likely to be rated true. The value of R was lower in the postcued condition and the divided-attention condition than in the precued condition. However, F was nearly constant over the conditions.

The most interesting result concerning the relationship between rated truth and memory judgments occurred when we compared statements having truth ratings that were consistent with the credibility cues with statements having truth ratings that were inconsistent with the cues. On a test of memory for source, both types of statements would be correctly classified if sources were recollected. The consistent statements would also be correct if they were classified on the basis of their apparent truth, but the inconsistent ones would not. Estimates of R from the direct test of memory were higher in precued conditions than in the postcued or divided-attention conditions, and the estimates were similar to the estimates from rated truth and from direct measures of source discrimination. Nonetheless, F remained constant over impairment of control.

Memory-Based Misattributions

We have stressed unintentional versus intentional influences of memory rather than implicit versus explicit tests of memory (Schacter, 1987; Tulving & Schacter, 1990). Rated truth is an implicit test of memory that does not require memory for the occasion on which the statements first appeared. We have no quarrel with naming tests by whether they refer to prior events in the experiment. However, we do not want to associate each test with a different memory system. We prefer to think there is only one memory but that it can have different influences depending on how and why it is used.

A typical dictionary defines memory as the capacity to bring previous experiences back to mind. Memory researchers, however, consider conscious recollection to be only one side of memory. There has been much recent interest in cases in which a person's performance is influenced by specific prior events even though the person fails to remember those events on explicit tests (Jacoby, 1991; Richardson-Klavehn & Bjork, 1988; Roediger, 1990; Roediger & Blaxton, 1987; Schacter, 1987; Tulving & Schacter, 1990). For example, amnesic patients usually fail to recall or recognize words studied earlier in an experiment, but they commonly produce those words as solutions on fragment-completion tests and as intrusions on other tests (Warrington & Weiskrantz, 1974; Weiskrantz & Warrington, 1975). Jacoby and Kelley (1987) described an amnesic patient who laughed at a joke but did not laugh when the joke was repeated; he said the joke was "dumb." Tulving (1983, p. 114) described a patient who was told that Marlboros are the world's most popular brand of cigarettes and who later was able to provide that information when asked. However, he did not recollect the source of the information; he said, "I must have read it somewhere." From our point of view, amnesic patients show extreme deficits in source recollection, but familiarity is relatively intact.

Because source recollection is not automatic, people with normal memories make errors by failing to identify the source of current experiences. For example, unconscious plagiarism occurs when an idea is attributed to one's creative process rather than to a particular past, external source; ideas do not automatically indicate whether they are being remembered or created (Jacoby, Kelley, & Dywan, 1989). People also misattribute a current experience to the past when a new item that is related to an old one is falsely recognized as old (Underwood, 1965). The confusion between the present and the past has a parallel with confusions between internal and external sources (e.g., Johnson, 1988).

Global impressions like the feeling of familiarity are usually caused by many factors. Some have their source in the present, some in the past; some sources are internal, some external. We can separate these factors in experiments, but impressions do not automatically identify their sources, and people fail to discount the influence of irrelevant factors. Tversky and Kahneman's (1973) availability heuristic leads to errors if examples are available for the wrong reasons; for example, if a list includes names of familiar females and unknown males, subjects judge there were more females even if there were more males. Chapman (1967; see also Chapman & Chapman, 1969; Golding & Rorer, 1972; Yates, 1990) reported similar results for illusory correlation; clinicians overestimate the frequency of co-occurrence of symptoms that seem to go well together. Even though there are many avenues for error, estimates of frequency tend to be accurate, so much so that some theorists propose that people encode frequency automatically by changes in a dedicated frequency attribute (Hasher & Zacks, 1979, 1984). In our view, people infer frequency from the experience of retrieval initiated by the current stimulus (Begg, Maxwell, Mitterer, & Harris, 1986). Estimates are accurate because frequent occurrence is a major reason for experiences at retrieval. Estimates become inaccurate, however, when factors that are independent of frequency cause changes in experiences.

Subjective impressions are bases for many attributions people make about stimuli. For example, repeated words are processed more fluently than new words (Jacoby & Dallas, 1981), but subjects may attribute that fluency to environmental conditions; they judge that the words are presented clearly and underestimate the level of background noise (Jacoby, Allan, Collins, & Larwill, 1988). When Whittlesea, Jacoby, and Girard (1990) manipulated repetition and item clarity, they found that judgments of repetition were influenced by clarity and that judgments of clarity were influenced by repetition. They proposed that these illusions of memory and illusions of perception occur because subjects attribute fluent processing to past experiences or current circumstances, depending on the task. Similarly, Begg, Duft, Lalonde, Melnick, and Sanvito (1989) proposed that easily processed items give an illusion of memorability; memory predictions are accurate if the factors that cause easy processing are relevant for the memory test but are inaccurate when easy processing is because of irrelevant factors that people fail to discount.

Truth Versus Belief

We have proposed that rated truth is one member of a family of measures that are influenced by feelings or impressions that occur on a test. These impressions are often the only basis for attributing qualities to stimuli, but they are imperfectly correlated with external stimuli, and it would be smart to keep their imperfections in mind. In our experiments, any difference between old and new statements has its source in the recent past under conditions that invalidate newly learned facts as evidence for truth. The variables that make statements ring true have their source in the recent past, but they are experienced as effects of the stimulus, and the apparent truth is illusory.

It is a large step from ratings of truth to belief. Does the rated truth of trivial statements reveal anything general about belief in the world outside the laboratory? It is easy to show that belief is influenced by impressions that are created by factors that are irrelevant for truth. John Dean's confident testimony at the Watergate hearings made him a credible witness, although later comparisons between his testimony and the taped record of the events revealed many instances in which he was incorrect (Neisser, 1981). From our point of view, witness demeanor may be correlated with whether witnesses believe what they are saying, but it is absurd to assume that confident witnesses are expressing true statements, whereas witnesses who are less assured are telling untruths. For example, hypnotized subjects show increased confidence in their memories but without increases in accuracy; perhaps this is the reason for the widespread misconception that hypnosis aids memory (cf. Begg, Martin, & Needham, in press).

Our results indicate that one basis for belief is memory; people believe statements that confirm remembered information and doubt statements that contradict it. Gilbert (1991) presented a general analysis of belief, in which he contrasted two models of belief, called the *Cartesian model* and the *Spinozan model.* The Cartesian model paints a picture of a rational subject. New information is registered relatively passively and is held in an unanalyzed form until detailed analysis can sort out fact from fiction. The Cartesian model gives no basis for repetition to influence apparent truth. In contrast, the Spinozan model proposes that newly registered information is tacitly accepted as true pending more detailed analysis, which can lead to the rejection of the information as false. Our results are more consistent with the Spinozan model than with the Cartesian model. We stress again, however, that there is no logical reason to place more stock in information that was encountered earlier rather than later.

Final Words

In this article, our interest has been the attribution of truth to statements that feel familiar. A direction for future research is to look at cases in which apparent truth is itself a basis for attributions. For example, people tend to accept that a conclusion is based on sound reasoning if they believe the conclusion (Wilkins, 1928), although the truth of a conclusion is irrelevant to the validity of an argument. Illusory validity is also seen when subjects accept logical arguments with conclusions that have the same atmosphere as the premises (Begg & Denny, 1969; Sells, 1936; Woodworth & Sells, 1935). The words used in logical tasks, like *some,* unintentionally and despite instructions to the contrary, are interpreted in the way they are in informal communication; these intuitive interpretations are irrelevant for validity and often lead to "illogical" decisions (Begg, 1987; Begg & Harris, 1982). Using the process-dissociation procedure, one can contrast inclusion (intuitive conclusions that are logically valid) with exclusion (intuitive conclusions that are illogical) to separate the influence of the deliberate process of logical reasoning from the unintentional influence of intuition. We expect that logic and intuition, like recollection and familiarity, will turn out to be independent.

References

Bacon, F. T. (1979). Credibility of repeated statements: Memory for trivia. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 241–252.

Batchelder, W. H., & Riefer, W. M. (1990). Multinomial processing models of source monitoring. *Psychological Review, 97,* 548–564.

Battig, W. F., & Montague, W. E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monographs, 80*(3, Pt. 2).

Begg, I. (1987). Some. *Canadian Journal of Psychology, 41,* 62–73.

Begg, I., & Armour, V. (1991). Repetition and the ring of truth: Biasing comments. *Canadian Journal of Behavioral Science, 23,* 195–213.

Begg, I., Armour, V., & Kerr, T. (1985). On believing what we remember. *Canadian Journal of Behavioral Science, 17,* 199–214.

Begg, I., & Denny, J. P. (1969). Empirical reconciliation of atmosphere and conversion interpretations of syllogistic reasoning errors. *Journal of Experimental Psychology, 81,* 351–354.

Begg, I., Duft, S., Lalonde, P., Melnick, R., & Sanvito, J. (1989). Memory predictions are based on ease of processing. *Journal of Memory and Language, 28,* 610–632.

Begg, I., & Harris, G. (1982). On the interpretation of syllogisms. *Journal of Verbal Learning and Verbal Behavior, 21,* 595–620.

Begg, I. M., Martin, L. A., & Needham, D. R. (in press). Memory monitoring: How useful is self-knowledge about memory? *European Journal of Cognitive Psychology.*

Begg, I., Maxwell, D., Mitterer, J. O., & Harris, G. (1986). Estimates of frequency: Attribute or attribution? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 496–508.

Bloch, A. (1979). *Murphy's Law and other reasons why things go wrong.* Los Angeles, CA: Price-Stern-Sloan.

Chapman, L. J. (1967). Illusory correlation in the observational report. *Journal of Verbal Learning and Verbal Behavior, 6,* 151–155.

Chapman, L. J., & Chapman, J. P. (1969). Illusory correlation as an obstacle to the use of valid psychodiagnostic signs. *Journal of Abnormal Psychology, 74,* 271–280.

Gilbert, D. T. (1991). How mental systems believe. *American Psychologist, 46,* 107–119.

Golding, S. L., & Rorer, L. G. (1972). Illusory correlation and subjective judgment. *Journal of Abnormal Psychology, 80,* 249–260.

Greenwald, A. G., Pratkanis, A. R., Leippe, M. R., & Baumgardner, M. H. (1986). Under what conditions does theory obstruct research progress? *Psychological Review, 93,* 216–229.

Gruder, C. L., Cook, T. D., Hennigan, K. M., Flay, B. R., Alessis, C., & Halamaj, J. (1978). Empirical tests of the absolute sleeper effect predicted from the discounting cue hypothesis. *Journal of Personality and Social Psychology, 36,* 1061–1074.

Hasher, L., Goldstein, D., & Toppino, T. (1977). Frequency and the conference of referential validity. *Journal of Verbal Learning and Verbal Behavior, 16,* 107–112.

Hasher, L., & Zacks, R. T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General, 108,* 356–388.

Hasher, L., & Zacks, R. T. (1984). Automatic processing of fundamental information: The case of frequency of occurrence. *American Psychologist, 39,* 1372–1388.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional influences of memory. *Journal of Memory and Language, 30,* 513–541.

Jacoby, L. L., Allan, L. G., Collins, J. C., & Larwill, L. K. (1988). Memory influences subjective experience: Noise judgments. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14,* 240–247.

Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General, 110,* 306–340.

Jacoby, L. L., & Kelley, C. M. (1987). Unconscious influences of memory for a prior event. *Personality and Social Psychology Bulletin, 13,* 314–336.

Jacoby, L. L., & Kelley, C. M. (1990). An episodic view of motivation: Unconscious influences of memory. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 451–481). New York: Guilford Press.

Jacoby, L. L., & Kelley, C. M. (1991). Unconscious influences of memory: Dissociations and automaticity. In D. Milner & M. Rugg (Eds.), *Neuropsychology of consciousness* (pp. 201–233). San Diego, CA: Academic Press.

Jacoby, L. L., Kelley, C. M., Brown, J., & Jasechko, J. (1989). Becoming famous overnight: Limits on the ability to avoid unconscious influences of the past. *Journal of Personality and Social Psychology, 56,* 326–338.

Jacoby, L. L., Kelley, C. M., & Dywan, J. (1989). Memory attributions. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 391–422). Hillsdale, NJ: Erlbaum.
Jacoby, L. L., Woloshyn, V., & Kelley, C. M. (1989). Becoming famous without being recognized: Unconscious influences of memory provided by dividing attention. *Journal of Experimental Psychology: General, 118,* 115–125.
Johnson, M. K. (1988). Discriminating the origin of information. In T. F. Oltmanns & B. A. Maher (Eds.), *Delusional beliefs: Interdisciplinary perspectives* (pp. 34–65). New York: Wiley.
Kenny, A. (1973). *Wittgenstein.* Harmonsworth, Middlesex, England: Penguin Books.
Neisser, U. (1981). John Dean's memory: A case study. *Cognition, 9,* 1–22.
Pratkanis, A. R., Greenwald, A. G., Leippe, M. R., & Baumgardner, M. H. (1988). In search of reliable persuasion effect: III. The sleeper effect is dead. Long live the sleeper effect. *Journal of Personality and Social Psychology, 54,* 203–218.
Richardson-Klavehn, A., & Bjork, R. A. (1988). Measures of memory. *Annual Review of Psychology, 39,* 475–543.
Roediger, H. L. (1990). Implicit memory: Retention without remembering. *American Psychologist, 45,* 1043–1056.
Roediger, H. L., & Blaxton, T. A. (1987). Retrieval modes produce dissociations in memory for surface information. In D. S. Gorfein & R. R. Hoffman (Eds.), *Memory and cognitive processes: The Ebbinghaus centennial conference* (pp. 349–379). Hillsdale, NJ: Erlbaum.
Schacter, D. L. (1987). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 501–518.
Sells, S. B. (1936). The atmosphere effect: An experimental study of reasoning. *Archives of Psychology, 29,* 3–72.
Tulving, E. (1983). *Elements of episodic memory.* New York: Oxford University Press.
Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science, 247,* 301–305.
Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology, 5,* 207–232.
Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185,* 1124–1131.
Underwood, B. J. (1965). False recognition produced by implicit verbal responses. *Journal of Experimental Psychology, 70,* 122–129.
Warrington, E. K., & Weiskrantz, L. (1974). The effect of prior learning on subsequent retention in amnesic patients. *Neuropsychologia, 12,* 419–428.
Weiskrantz, L., & Warrington, E. K. (1975). The problems of the amnesic syndrome in man and animals. In R. L. Isaacson & K. H. Pribram (Eds.), *The hippocampus* (Vol. 2, pp. 411–428). New York: Plenum Press.
Whittlesea, B. W. A., Jacoby, L. L., & Girard, K. (1990). Illusions of immediate memory: Evidence of an attributional basis for feelings of familiarity and perceptual quality. *Journal of Memory and Language, 29,* 716–732.
Wilkins, M. C. (1928). The effect of changed material on ability to do formal syllogistic reasoning. *Archives of Psychology, 16,* 102.
Woodworth, R. S., & Sells, S. B. (1935). An atmosphere effect in formal syllogistic reasoning. *Journal of Experimental Psychology, 18,* 451–460.
Yates, J. F. (1990). *Judgment and decision making.* Englewood Cliffs, NJ: Prentice-Hall.

Received October 30, 1991
Revision received February 4, 1992
Accepted May 13, 1992 ■

MNRD Non-Local Beings Report

Attachment 8

Journal of Personality and Social Psychology
2009, Vol. 96, No. 1, 32–44

0022-3514/09/$12.00 DOI: 10.1037/a0013461

The Impact of Repetition-Induced Familiarity on Agreement With Weak and Strong Arguments

Wesley G. Moons and Diane M. Mackie
University of California, Santa Barbara

Teresa Garcia-Marques
ISPA, Lisbon, Portugal

Repeated statements are perceived as more valid than novel ones, termed the *illusion of truth effect*, presumably because repetition imbues the statement with familiarity. In 3 studies, the authors examined the conditions under which and the processes by which familiarity signals from repetition and argument quality signals from processing of message content influenced agreement with persuasive arguments. Participants with low or high motivation to process information were presented persuasive arguments seen once or twice. In all 3 studies, repetition increased the persuasiveness of weak and strong arguments when little processing of message content occurred. Two of the studies used a process dissociation procedure to reveal that both greater controlled processing (which reflected argument content) and the greater automatic influence of familiarity (which reflected repetition) were associated with increased acceptance of strong arguments but that greater controlled processing dissipated the benefits of familiarity for agreement with weak arguments.

Keywords: familiarity, repetition, argument quality, process dissociation procedure, information processing

I have said it thrice: What I tell you three times is true.

—Lewis Carroll, *The Hunting of the Snark, an Agony, in Eight Fits*

The Bellman from Lewis Carroll's (1876) *Hunting of the Snark* knew his psychology, if nothing else. In fact, statements repeated even once are rated as truer or more valid than statements heard for the first time, an effect called the *illusion of truth*, or IOT. The IOT was first demonstrated in a two-stage paradigm developed by Hasher, Goldstein, and Toppino (1977). They asked participants in the study phase of their experiment to guess the truth of both objectively true (*Lithium is the lightest of all metals*) and objectively false (*The People's Republic of China was founded in 1947*) statements, although participants were unaware of which ones were true and which were false. One week later, in the test phase, participants were shown a mix of old and new statements and asked to judge each one's validity. Repeated sentences (both true and false ones) were perceived as truer than novel sentences. The IOT has since been demonstrated for statements repeated anywhere from within an hour to over a period of 2 weeks (Begg, Armour, & Kerr, 1985; Hasher et al., 1977). Thus, even a single repetition can apparently make information appear more valid.

Wesley G. Moons and Diane M. Mackie, Department of Psychology, University of California, Santa Barbara; Teresa Garcia-Marques, ISPA, Lisbon, Portugal.

This research was supported by National Research Service Award MH070355 awarded to Wesley Moons as well as National Science Foundation Grant 9975204 and a University of California, Santa Barbara Academic Senate Faculty Research Grant awarded to Diane Mackie. We thank the members of the Social Emotions Lab, F. Gregory Ashby, and Leonel Garcia-Marques for their supportive and helpful comments on this research.

Correspondence concerning this article should be addressed to Wesley Moons, who is now at the Department of Psychology, University of California, Los Angeles, Los Angeles, CA 90095. E-mail: Moons@ucla.edu

Why might repetition have this effect? Begg, Anas, and Farinacci (1992) argued that what they called a "feeling of familiarity" produced the repetition-based IOT. According to these authors, any factor that generates a typically nonconscious sense of familiarity automatically and unintentionally increases validity (Begg et al., 1992, p. 447). Perhaps influenced by Bacon's (1979) finding that perceived familiarity has a stronger impact on validity than actual familiarity, Begg et al. (1992) did not endorse any particular aspect of actual repetition as the mechanism that imbues statements with familiarity. Instead they argued that anything that made a statement "feel familiar" would increase its perceived validity. Their own work showed that the IOT emerges as long as even part of the test phase statements has been encountered before (Begg et al., 1985). For example, the statement "The extended right arm of the Statue of Liberty is 42 feet long" is rated as truer if the phrase "Statue of Liberty" has been seen earlier. Thus, even activating the topic of statements increases the perceived truth value of those statements when they are presented later. One explanation of such familiarity effects in the absence of actual repetition relies on the ease or fluency with which stimuli are processed (Lee & Labroo, 2004; Reber & Schwarz, 1999). The subjective positivity typically associated with processing fluency (e.g., Garcia-Marques & Mackie, 2000; Winkielman & Cacioppo, 2001; but see Briñol, Petty, & Tormala, 2006; Unkelbach, 2007) can be mistakenly attributed to the stimulus itself and not to the relatively effortless processing. Thus, fluent processing of even completely novel stimuli can increase positive evaluations on multiple dimensions. However, as might be predicted from such a fluency account, the strongest IOT effects seem to be produced by verbatim repetition when processing fluency is maximal (Begg et al., 1985).

Evidence for the automatic effect of familiarity on validity comes from studies that have shown that although explicit recall of a statement's actual truth value can attenuate the IOT, it does not always completely eliminate it (Arkes, Hackett, & Boehm, 1989;

Attachment 8 to MNRD Non-Local Beings Report

Begg et al., 1992). In one such study, participants heard statements read by either a man who always lied or by a woman who always told the truth (Begg et al., 1992). Participants were later asked to evaluate the statements without being told whether the man or the woman stated it initially. When participants explicitly recalled the source, the IOT effect was moderated: Statements from the lying man were perceived as less true than statements by the truthful woman. Nevertheless, both true repeated statements and false repeated statements were perceived as truer than novel statements. Similarly, participants exposed to statements with either truth-biased ("It is well-known that . . . ") or false-biased tags ("Few people believe that . . . ") rated both types of statements truer when they were repeated than they did novel statements, although initially truth-biased statements were rated as truer than initially false-biased statements (Begg & Armour, 1991). Begg and Armor (1991) used a process dissociation procedure (PDP; Jacoby, 1991) to assess the impact of resource-intensive explicit memory for the truth or falsehood of the statement and the automatic impact of increased familiarity on truth judgments. For truth-biased statements, both explicit recall and repetition consistently signaled validity, but for false-biased statements, these two processes produced divergent signals, allowing the contributing processes to be dissociated. On the basis of the assumptions of the PDP (Jacoby, Begg, & Toth, 1997; Jacoby & Shrout, 1997), these analyses revealed that the increased validity ratings given to repeated statements, even in the face of contradictory information, are due to an unintentional, automatic familiarity signal associated with repeated statements (Skurnik, Yoon, Park, & Schwarz, 2005).

Such an unfettered impact of repetition is obviously of great theoretical and practical importance to persuasion research. Indeed, repetition has been found to increase the perceived validity of and agreement with both persuasive arguments (Arkes et al., 1989; Moons, Mackie, & Garcia-Marques, 2007) and persuasive messages (Garcia-Marques & Mackie, 2001), extending the IOT effect to statements of opinion. For example, Arkes et al. (1989) showed that statements of opinion became more compelling upon repetition, and Garcia-Marques and Mackie (2001) showed that the persuasiveness of messages composed of weak arguments was particularly enhanced by repetition.

Nevertheless, it is not always the case that repetition of arguments increases agreement with them. Studies in which the content of persuasive arguments is manipulated to be relatively compelling or relatively specious have produced findings indicating that repetition sometimes increases agreement with weak arguments and sometimes does not. For example, Cacioppo and Petty (1989) demonstrated that agreement with weak arguments decreased upon repetition, whereas Garcia-Marques and Mackie's (2001) findings indicated that weak appeals benefited from repetition. Thus, the contribution of repetition to agreement with persuasive arguments, especially persuasive arguments of varying content quality, is more complex than simple application of IOT effects to persuasion would suggest.

In the three studies reported here, we examined the conditions under which and the processes by which familiarity signals from repetition of arguments with differing content quality influence agreement with persuasive arguments. Like Begg et al. (1992), we applied a process dissociation approach to this problem. We assumed that agreement with a particular statement may come from multiple sources, but most importantly for our purposes from the automatic implications of statement familiarity as well as from the implications of a more controlled processing of the persuasive arguments' content. The first of these processes was seen as automatic and universal: Because the feeling of fluency generated by repetition is typically attributed to either liking for or validity of the repeated statement (Bornstein, 1989; Hasher et al., 1977; Reber & Schwarz, 1999), we assumed that argument familiarity (induced by repetition) would automatically increase agreement, regardless of the argument content and regardless of information-processing conditions.

In contrast, the persuasive implications of argument content are quite different for weak and strong arguments and depend on a controlled process. Strong arguments are by definition ones whose content, when considered, triggers favorable reactions or elaborations, which, in turn, engender persuasion. However, weak arguments are those whose content, when considered, triggers unfavorable reactions and elaborations that make persuasion less likely (Petty & Cacioppo, 1986). Such differentiated persuasion outcomes depend on controlled resource-intensive consideration of argument content: Increased processing of message content produces increased persuasion in the case of strong arguments and lack of persuasion, or even a boomerang effect, in the case of weak arguments. Thus, increased capacity and motivation to process is typically thought necessary to distinguish the persuasive implications of weak and strong arguments (Eagly & Chaiken, 1993; Petty & Cacioppo, 1986; Petty & Wegener, 1998).

The repetition of strong or weak persuasive arguments thus potentially provides recipients with two signals that contribute to agreement: an automatic signal associated with argument familiarity and a controlled resource-dependent signal on the basis of argument content. The familiarity signal automatically increases agreement regardless of argument content and regardless of controlled processing. The quality of the argument content signal impacts agreement as the result of a more controlled and differentiated process. The more message content is processed, the more strong and compelling arguments signal increased agreement, whereas weak, specious arguments provide a negative signal that inhibits agreement.

When controlled processing occurs, signals from argument content and signals from argument familiarity can thus provide congruent or incongruent types of influence for repeated arguments. When processing is extensive and repeated arguments are strong, both argument familiarity and argument quality have congruent effects that increase agreement, and, thus, repeated strong arguments are expected to be readily accepted. In contrast, when processing is extensive but repeated arguments are weak, repetition-induced familiarity signals increase agreement, but message content signals decrease agreement. Thus, for repeated weak arguments, argument familiarity and argument quality have incongruent effects on agreement, and agreement is expected to be inhibited. Although it is possible that some impact of argument quality could be apparent even at minimal levels of processing, the resource-dependent nature of the controlled processing of argument content means that the congruence of content and familiarity signals for strong arguments and the incongruence of signals for weak arguments would be most associated or disassociated, respectively, when processing is more extensive.

Thus in all three experiments, participants were experimentally motivated to engage in relatively less or more information processing of weak or strong persuasive arguments that were either novel or repeated. We expected a three-way interaction among processing, repetition, and argument quality. When processing was minimal, we expected repeated arguments to garner greater acceptance, regardless of argument quality. When processing was extensive, we expected an interaction between argument quality and repetition. Specifically, we expected that when processing was extensive, repetition would enhance acceptance of strong arguments, whereas repetition would have little or no impact on agreement with weak arguments.

In addition to leading to this predicted three-way interaction on agreement, the simultaneous manipulation of argument quality, argument repetition, and motivation to process made the investigation of the various contributions of argument repetition and processing-dependent argument content tractable by PDP analysis. Because application of a PDP analysis requires some changes in procedure that deviate from those typically found in persuasion studies, we sought in a first experiment to establish that repetition and argument quality affected agreement as expected under different levels of information processing in a typical persuasion paradigm. In Experiments 2 and 3, we then applied the logic underlying the PDP analysis developed by Jacoby (1991) to explore further the contributions of the controlled processing of argument content and the automatic processing of repetition-based familiarity on agreement under different levels of motivation.

Experiment 1

The goal of the first experiment was to demonstrate that extent of information processing moderated the interaction between argument quality and repetition in determining agreement with persuasive arguments. During an initial exposure phase of the experiment, participants simply read individual counterattitudinal weak or strong persuasive arguments in favor of implementing comprehensive exams. A target subset of arguments was displayed a single time and was then repeated later when participants were asked to report their agreement with each argument as well as entirely novel arguments for implementing comprehensive exams. The effect of repetition was examined by comparing agreement with the novel arguments to agreement with the arguments repeated once.

In order to manipulate participants' motivation to process, thus experimentally inducing relatively low or high levels of analytic processing, we framed the experiment as either relevant or irrelevant to our student population. The manipulation was modified from earlier research on information processing (Petty, Cacioppo, & Goldman, 1981). Half the participants were informed that implementation of comprehensive exams was being considered at their university and would affect them personally, thus increasing personal relevance and the motivation to process. The other half of the participants were informed that implementation of comprehensive exams was being considered at a distant university and would not affect them personally, thus reducing personal relevance and the motivation to process.

We expected that when people had relatively little motivation to process, repetition would increase agreement with both weak and strong arguments similarly. In contrast, people with high motivation to process were expected to show an interaction between repetition and argument quality. Specifically, we expected the positive aspects of strong arguments to be congruent with repetitions' enhancing of agreement. In contrast, we expected the negative aspects of weak arguments to be incongruent and, thus, dampen the agreement-enhancing effects of repetition when arguments were more extensively processed.

Method

Participants and Design

Participants were 39 undergraduate women at the University of California, Santa Barbara (UCSB) who participated in exchange for partial course credit. Participants were randomly assigned to a 2 (relevance: low or high) $\times$ 2 (argument quality: weak or strong) $\times$ 2 (repetition: novel and repeated) mixed-model design, with repetition as a within-subjects factor. The presentation of items in each level of the repetition factor was randomly determined in two counterbalancing conditions.[1]

Procedure

All participants were presented weak or strong arguments advocating the counterattitudinal position that comprehensive exams be implemented (Petty & Cacioppo, 1986). Arguments were modified to be of roughly equal length and were pilot tested to ensure that weak arguments were indeed less compelling than strong arguments.

Participants first received a manipulation of personal relevance to motivate relatively less or more information processing. In the low-relevance condition, our student participants from UCSB were informed that the study dealt with a Miami University campus issue and that Miami University administrators were considering the implementation of comprehensive exams for the upcoming 2007–2008 school year. Participants in the low-relevance condition were also told that their opinion was being collected on this matter even though it would have no effect on them at all. In contrast, UCSB participants in the high-relevance condition were given the same information, but UCSB was substituted for the university at which comprehensive exams were being considered. Additionally, these high-relevance participants were told that their opinion was being collected on this matter because it would affect them directly.

Participants were then presented the arguments in favor of implementing comprehensive exams. During an initial exposure phase, four weak or four strong arguments were presented for 6 s each. These target arguments were randomly presented among other persuasive arguments on the same topic that were repeated several times. Immediately after this presentation phase, participants reported their agreement with numerous weak or strong arguments, including the four arguments previously seen once and four entirely novel weak or strong arguments. Agreement was indicated on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Agreement ratings among the four repeated arguments were averaged, as were agreement ratings among the four novel arguments to reflect the two levels of the repetition factor.

[1] The counterbalancing factor did not moderate the predicted significant three-way interaction among relevance, argument quality, and repetition and thus is not discussed further.

Results and Discussion

We conducted a 2 (relevance) × 2 (argument quality) × 2 (repetition) mixed-model analysis of variance (ANOVA). There were significant main effects of repetition, $F(1, 31) = 15.39$, $p < .001$, and argument quality, $F(1, 31) = 54.79$, $p < .001$. More importantly, the predicted interaction among relevance, argument quality, and repetition emerged, $F(1, 31) = 4.34$, $p < .05$ (see Figure 1).

To further examine the three-way interaction, we analyzed the two Argument Quality× Repetition interactions for low-relevance and high-relevance participants separately. Low-relevance participants agreed less with weak arguments ($M = 3.34$) than with strong arguments ($M = 5.01$) overall, $F(1, 31) = 33.13$, $p < .001$. As expected, participants agreed less with novel arguments ($M = 3.78$) than with repeated arguments ($M = 4.57$), $F(1, 31) = 15.71$, $p < .001$. Thus, when participants had little motivation to process, repetition similarly affected acceptance of weak and strong arguments, as predicted. There was no interaction between argument quality and repetition ($F < 1$).

High-relevance participants with more motivation to process showed a different pattern. They agreed less with weak arguments ($M = 3.27$) than with strong arguments ($M = 4.74$) overall, $F(1, 31) = 22.58$, $p < .001$. This was qualified by the predicted Argument Quality×Repetition interaction, $F(1, 31) = 5.49$, $p < .05$. When participants were experimentally motivated to process, they agreed less with novel strong arguments ($M = 4.32$) than with repeated strong arguments ($M = 5.17$), $t(31) = 2.84$, $p < .01$, consistent with both argument quality and familiarity providing congruent favorable signals that increased agreement. In contrast, participants motivated to process agreed equally with novel weak arguments ($M = 3.34$) and repeated weak arguments ($M = 3.20$; $t < 1$), consistent with the deficits of well-processed weak arguments counteracting repetitions' enhancement of agreement.

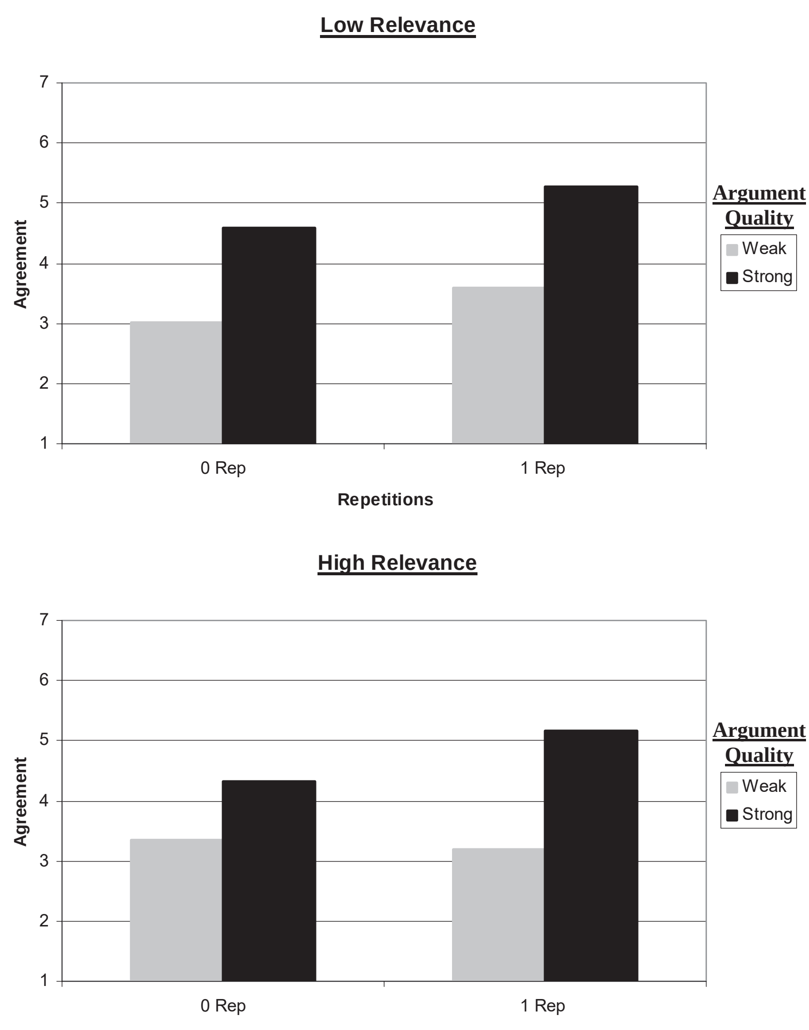


Figure 1. Mean agreement with novel and repeated weak and strong arguments for participants in the low-relevance condition (top panel) and the high-relevance condition (bottom panel) in Experiment 1. Rep = Repetition.

In summary, these results are consistent with hypotheses that repetition of weak and strong arguments would cause people with little motivation to increase their acceptance of the arguments, regardless of quality. Thus, when the actual content of the arguments was given relatively less weight, argument quality did not moderate the positive impact of repetition. In contrast, for participants who were motivated to process, repetition increased agreement with only strong arguments whose compelling content was consistent with the positive influence of familiarity. However, motivated processors did not increase agreement with repeated weak arguments, demonstrating that the limitations of specious arguments can negate the benefits of repetition, but only when those weak arguments are more extensively processed.

The results of Experiment 1 are consistent with the idea that there are two components that contribute to agreement with repeated weak and strong arguments. We have suggested that the first of these is an automatic component (familiarity) that directly influences agreement and that the second is a controlled component that reveals and is revealed by the quality of the persuasive arguments. We have also suggested that the second component depends on a deliberate, effortful, and controlled evaluation of the inherent quality of the persuasive arguments, and its impact is thus increased whenever processors have the motivation and ability to evaluate, elaborate, and integrate the arguments' content. To further examine the effect of these two contributors to agreement, and particularly to ascertain the relative role of each under different processing conditions, we used an experimental design and the logic underlying the PDP that allowed us to assess the impact of each component of agreement independently.

Experiment 2

Following Begg et al. (1992), we used a modified version of Jacoby's (1991) process dissociation procedure to examine the independent influences of controlled and automatic processes on agreement. The PDP depends on each participant completing trials in which controlled and automatic processes exert congruent influences (i.e., inclusive tests) as well as trials in which controlled and automatic processes exert incongruent, or oppositional, influences (i.e., exclusive tests).

In terms of memory judgments, Jacoby (1991) established inclusive tests by instructing participants to base their decisions on any of the components of recognition: if a previously seen stimulus either felt familiar or was actually recollected. In terms of agreement decisions, a similar situation occurs when participants evaluate strong persuasive arguments. In this case, agreement with strong arguments may be based on either the quality of the argument that engenders a favorable response under controlled processing (C) or the feeling of familiarity (F) associated with it in the absence of controlled processing (1 − C). This is represented mathematically as:

$$P(\text{Agree}|\text{Strong argument}) = C + F(1 - C). \quad (1)$$

Jacoby (1991) created an exclusive test of memory in which both components act in opposite directions, and favorable responses are only achieved without the contribution of the control component. In terms of agreement decisions, a similar exclusive test occurs for agreement with specious arguments. Agreement with weak arguments will only occur when the influence of an automatic component of familiarity (F) functions in the absence of controlled processing (1 − C):

$$P(\text{Agree}|\text{Weak argument}) = F(1 - C). \quad (2)$$

As suggested by Jacoby (1991), the estimates of controlled and automatic processes can be derived algebraically:

$$C = P(\text{Agree}|\text{Strong argument}) - P(\text{Agree}|\text{Weak argument}). \quad (3)$$

$$F = P(\text{Agree}|\text{Weak argument})/(1 - C). \quad (4)$$

This use of the PDP allows for the estimation of a component influenced by the controlled processing of argument quality and a component influenced by automatic processes such as familiarity with the persuasive arguments. We used this procedure to examine how controlled processing and familiarity functioned under different levels of motivation and repetition and also to determine whether these underlying processes resulted in the pattern of agreement observed in Experiment 1 (see Jacoby, 1991, and Payne, 2005, for other descriptions of the PDP).

In Experiment 2, participants' motivation to process was once again manipulated by making the task irrelevant or relevant. Subsequently, all participants were exposed once to weak and strong arguments embedded within neutral filler arguments during an initial exposure phase. They then reported their agreement with previously seen arguments as well as with novel weak and strong persuasive arguments. A notable change to the experiment design was that both weak and strong arguments were presented to all participants, a within-subjects factor that permits the calculation of the PDP component estimates.

For participants' reported agreement with presented arguments, we once again expected a three-way interaction among relevance, argument quality, and repetition, such that participants with little motivation to process would respond similarly to both weak and strong arguments and be influenced primarily by repetition. In contrast, we predicted that participants highly motivated to process would show increased agreement with repeated strong arguments, but no such increase in agreement with repeated weak arguments. Thus, we expected to replicate the same pattern for agreement as in the previous study.

In terms of the PDP, we expected to show that increasing relevance would increase participants' information processing as reflected in the increased influence of the controlled component. Additionally, we predicted that repetition would generally increase familiarity as reflected in the increased influence of the automatic component regardless of how extensive controlled processing was, consistent with an automatic influence of familiarity on agreement. Thus, the results would show that relevance and repetition manipulations affected the controlled and automatic components, respectively, thereby clarifying the underlying effects responsible for the pattern of agreement observed.

However, we sought to provide further converging evidence that the automatic influence of familiarity and the impact of controlled processing affected agreement in hypothesized ways. To do this, we adapted a generalization criterion methodology (Busemeyer & Wang, 2000) and randomly selected half of participants' responses to calculate the automatic and controlled components of the PDP. We then used these estimates to examine how automatic and controlled processes influenced participants' agreement with the other half of the weak and strong arguments. We expected that the automatic and controlled components would work quite differently for agreement with strong arguments than for agreement with weak arguments. For strong arguments, we anticipated that more familiarity and greater controlled processing would produce congruent effects such that both processes would increase agreement. In contrast, for weak arguments, we anticipated an interaction between automatic and controlled processing such that familiarity would increase agreement with weak arguments only when little controlled processing occurred. When controlled processing of weak arguments was greater, we expected little or no impact of familiarity on agreement. These analyses therefore provide an internal replication of the direct and interactive effects of automatic and controlled processes on agreement with weak and strong persuasive arguments.

Method

Participants and Design

Participants were 52 undergraduates (11 men and 41 women) who participated in exchange for partial course credit. Participants were randomly assigned to a 2 (relevance: low or high) $\times$ 2 (argument quality: weak and strong) $\times$ 2 (repetition: novel and repeated) mixed-model design, with both argument quality and repetition as within-subjects factors. The presentation of weak and strong arguments within each level of repetition was counterbalanced.[2]

Procedure

Agreement. Participants were presented the identical relevance manipulation used in Experiment 1 immediately before the exposure phase. During the exposure phase, participants read 30 arguments for 5 s each: 10 weak, 10 strong, and 10 neutral filler arguments used to dilute the contrast between weak and strong arguments. Immediately afterward, participants reported agreement with all previously seen 30 arguments as well as 30 novel arguments (10 weak, 10 strong, 10 neutral) using a 6-point scale, where1 = *strongly disagree*, 2 = *disagree*, 3 = *somewhat disagree*, 4 = *somewhat agree*, 5 = *agree*, and 6 = *strongly agree*. Participants reported standard demographic variables before being debriefed and thanked.

Automatic and controlled process estimates. Analysis of the PDP-controlled component revealed only the predicted main effect of relevance such that participants in the low-relevance condition engaged in less controlled processing ($M = 0.16$) than participants in the high-relevance condition ($M = 0.32$), $F(1, 50) = 6.83$, $p < .001$. We followed Begg et al.'s (1992) procedures and rationale that dichotomizing the scale to produce proportion scores is analytically preferable over analysis of average agreement ratings, even though analysis of average agreement ratings resulted in the same conclusions. Participants' reported agreement with each weak and strong argument was dichotomized such that scores of three and below were coded as zero, and scores of four and above were coded as one. Averaging these scores for weak arguments and strong arguments separately produced two scores reflecting the proportion of both weak and strong arguments that participants considered relatively compelling. Following Equation 3, controlled processing was estimated for each participant by subtracting the proportion of actually weak arguments considered compelling from the proportion of actually strong arguments considered compelling. This produced a proportion score that estimated the control component (C), which reflected discrimination of weak and strong arguments. Subtracting this proportion score from one resulted in the estimate of a lack of controlled processing (1−C). Finally, Equation 4 was used to estimate the automatic influence of familiarity (F) by dividing the proportion of actually weak arguments participants considered compelling by the estimate of the lack of controlled processing, thus isolating the remaining automatic influences such as familiarity.

Results and Discussion

Agreement

To test for the predicted three-way interaction on agreement with the persuasive arguments, we conducted a 2 (relevance) $\times$ 2 (argument quality) $\times$ 2 (repetition) mixed-model analysis of variance (ANOVA), with argument quality and repetition as within-subjects factors. Results revealed significant main effects for argument quality, $F(1, 48) = 197.31$, $p < .001$, and repetition, $F(1, 48) = 15.93$, $p < .001$. Additionally, a Relevance $\times$ Argument Quality interaction emerged, $F(1, 48) = 13.49$, $p = .001$. All these effects were qualified by the predicted three-way interaction among relevance, argument quality, and repetition, $F(1, 48) = 4.33$, $p < .05$ (see Figure 2).

Participants in the low-relevance condition agreed less with weak arguments ($M = 3.36$) than with strong arguments ($M = 3.85$), $F(1, 48) = 53.60$, $p < .001$. They also agreed less with novel arguments ($M = 3.37$) than arguments repeated once ($M = 3.84$), $F(1, 48) = 15.68$, $p < .001$. These two main effects were not qualified by an interaction between argument quality and repetition, $F(1, 48) = 1.17$, $p > .28$.

Participants in the high-relevance condition agreed less with weak arguments ($M = 3.16$) than with strong arguments ($M = 4.00$) overall, $F(1, 48) = 156.38$, $p < .001$. However, their responses also revealed an interaction that approached significance between argument quality and repetition that replicated the effect observed in Experiment 1, $F(1, 48) = 3.46$, $p < .07$. Specifically, novel strong arguments were agreed with less ($M = 3.85$) than strong arguments repeated once ($M = 4.15$), $t(48) = 2.24$, $p < .05$, whereas there was no difference in agreement with novel weak arguments ($M = 3.11$) and weak arguments repeated once ($M = 3.21$) ($F < 1$, $p > .45$). As predicted, participants with little motivation to process showed an increase in agreement due to repetition regardless of argument quality, but more motivation to process once again increased agreement as strong arguments were repeated, but eliminated the effect of repetition on weak arguments.

Automatic and Controlled Process Estimates

PDP analysis of the controlled component revealed only the predicted main effect of relevance such that participants in the

[2] The counterbalancing factor did not moderate the predicted significant three-way interaction among relevance, argument quality, and repetition on agreement and thus is not discussed further.

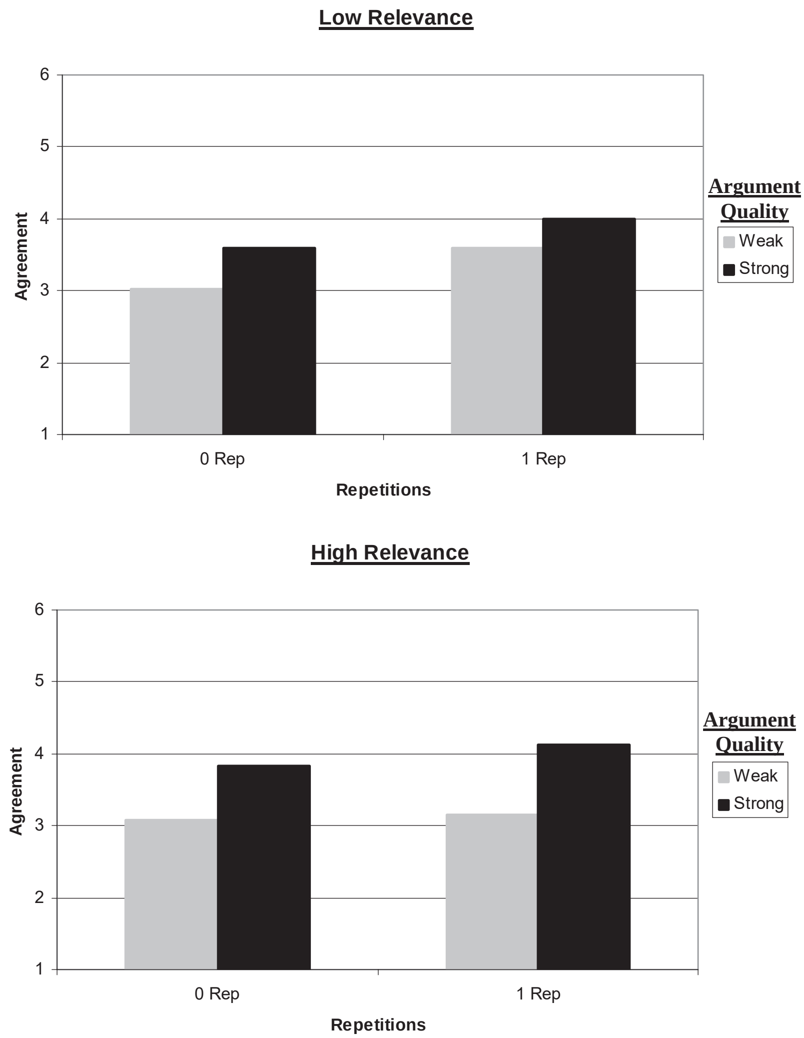


Figure 2. Mean agreement with novel and repeated weak and strong arguments for participants in the low-relevance condition (top panel) and the high-relevance condition (bottom panel) in Experiment 2. Rep = Repetition.

low-relevance condition engaged in less controlled processing ($M = 0.16$) than participants in the high-relevance condition ($M = 0.32$), $F(1, 50) = 16.83$, $p < .001$. Also as predicted, analysis of the automatic component revealed only an effect of repetition such that there was less automatic influence for novel arguments ($M = 0.56$) than for repeated arguments ($M = 0.67$), $F(1, 50) = 11.48$, $p = .001$. Thus, participants engaged in more controlled processing when they were more motivated, and participants were more influenced by familiarity when persuasive arguments were repeated, exactly as expected. This pattern of results is consistent with the notion that familiarity exerted an automatic influence regardless of how extensive controlled processing was. These results also reveal that highly motivated processors evaluating repeated persuasive arguments were most likely to be influenced by both argument quality and familiarity, whereas participants with little motivation to process were most influenced by familiarity alone.

Although these findings clarify what processes were most influential under each experimental condition, the question of how these processes directly and interactively affected agreement with strong and weak persuasive arguments remains unanswered. In fact, controlled processing and familiarity could have exerted any of several types of direct or interactive effects on agreement. However, we specifically anticipated that both processes would have a direct and congruent effect of increasing agreement with strong arguments but have an interactive effect on agreement with weak arguments. To investigate this, we used the estimates of controlled and automatic processes to predict participants' agreement with weak and strong arguments. However, because calculating the PDP components required using participants' reported agreement with the arguments, the same data we were interested in predicting, we needed to recalculate the PDP components using only half of participants' agreement data. That is, we randomly selected participants' reported agreement for half of the presented persuasive arguments and recalculated the control and automatic component estimates. This strategy left a randomly determined set of different weak and strong arguments to serve as dependent

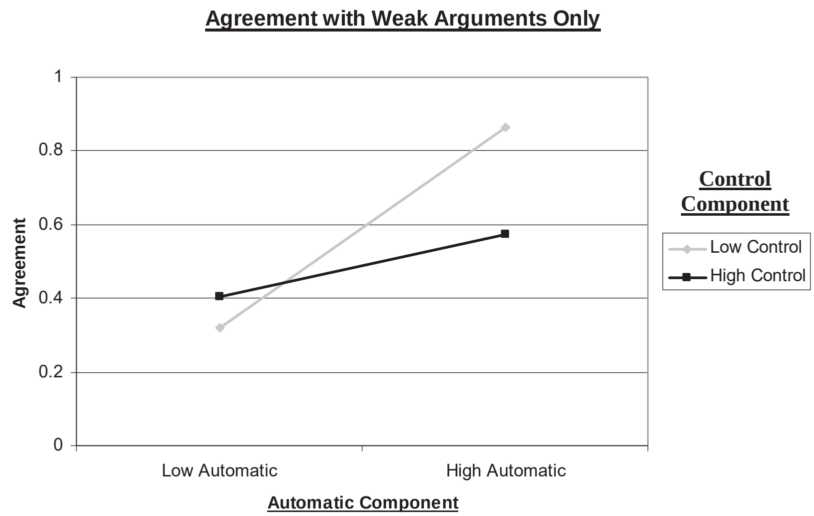


Figure 3. Agreement with repeated weak arguments as a function of the automatic component estimate (plotted at one standard deviation below and above the mean) and the controlled component estimate (plotted at one standard deviation below and above the mean) in Experiment 2.

variables in subsequent regressions. Although this split-half analytic strategy undoubtedly increases the covariation between regression predictors and dependent variables, this inflated association would be equivalent across conditions, thus controlling for any artificial overestimation of parameter estimates. This methodology extended the value of the PDP approach by allowing for examination not only of how experimental conditions increased controlled and automatic processing but also of how controlled and automatic processing impacted the outcome variable of interest, in this case agreement with persuasive arguments.

We investigated how controlled and automatic processes impacted agreement with weak and strong persuasive arguments by performing two regressions: one regression for agreement with weak arguments and a separate regression for agreement with strong arguments. In both regressions, the centered controlled component estimate and the centered automatic component estimate were entered at Step 1 in order to evaluate the main effects of each component on agreement. The interaction between the controlled component and automatic component was entered at Step 2 in order to evaluate whether the automatic influence of familiarity influenced agreement differently under different levels of controlled processing.

The first regression examined how control and automatic processes impacted agreement with strong arguments.[3] Two main effects emerged reflecting the congruent influence of controlled processing of strong arguments and familiarity with strong arguments. More controlled processing was associated with more agreement ($\beta = .23$, $p < .05$), consistent with more extensive consideration of strong arguments underscoring their compelling nature. Additionally, increased automatic influence was associated with increased agreement ($\beta = .68$, $p < .001$), consistent with familiarity uniformly enhancing acceptance of persuasive arguments. As anticipated, both automatic and controlled processes consistently increased acceptance of strong arguments.

A second regression examined how controlled and automatic processes impacted agreement with repeated weak arguments. The observed main effect of the automatic component on agreement with weak arguments ($\beta = .43$, $p < .01$) was expected to be qualified by a significant interaction. Because relatively high levels of controlled processing would highlight the inherent speciousness of weak arguments, and this specious message content was expected to counteract the agreement-enhancing effects of familiarity, we anticipated an interaction such that the automatic familiarity component would only increase agreement with weak arguments when there was little controlled processing. Regression results confirmed this predicted interaction ($\beta = -.33$, $p < .05$). As illustrated in Figure 3, when controlled processing was relatively low, agreement with weak arguments increased as automatic influences increased ($\beta = .83$, $p < .001$). In contrast, when controlled processing was relatively high, the beneficial impact of automatic influences only approached significance ($\beta = .26$, $p > .07$).

The results from Experiment 2 replicated nicely the three-way interaction found in the first experiment among relevance, argument quality, and repetition on participants' agreement with persuasive arguments. Moreover, the use of the PDP provided several new insights into the processes underlying this three-way interaction. The PDP findings provided evidence that personal relevance increased the controlled processing of persuasive arguments, without affecting the automatic influence of familiarity. In addition, the repetition of persuasive arguments was shown to increase the automatic influence of familiarity independent of controlled processing. This suggests that the impact of familiarity can function automatically and regardless of constraints on people's cognitive capacity or motivation to process information deeply.

Further analyses using the control and automatic components to predict agreement with persuasive arguments were entirely consistent with expectations. In the case of strong arguments, controlled and automatic processing worked in conjunction to increase

[3] Results from both reported regressions also held when controlling for the influence of the relevance manipulation.

agreement. In contrast, the impact of controlled processing opposed the positive automatic influence of familiarity in the case of weak arguments. This pattern is consistent with our account that increased controlled processing of specious arguments underscores the limitations of those arguments, which dramatically reduces the benefits of familiarity for agreement. In short, this experiment supported hypotheses that these two types of cognitive processes can directly and interactively impact acceptance of persuasive arguments.

Despite the theoretical insights provided by the use of this PDP approach, both the novelty of its application to the persuasion arena and our decision to deviate from typical PDP procedure by using more persuasion-relevant subjective agreement ratings mandate that these effects be replicated. Because agreement is idiosyncratic to each individual, it is possible that any particular participant processed to the fullest extent but did not produce a perfect score on the control component due to the fact that they simply did not agree with the pretested categorization of the arguments as weak or strong. Although relying on the social consensus of a pilot sample to identify unconvincing and convincing arguments still provides valuable information about the relative levels of controlled and automatic processes across experimental conditions, as in Experiment 2, this approach may not best capture each participant's individual cognitive processes. Thus, we sought to replicate the informative PDP findings from Experiment 2 by using a paradigm that better assessed the occurrence of controlled and automatic processes within each individual.

Experiment 3

We used an idiographic approach in Experiment 3 in order to more accurately estimate the control and automatic processes influencing the acceptance of persuasive arguments. During an initial exposure phase, participants evaluated every persuasive argument and categorically reported whether they either agreed or disagreed with the arguments. This dichotomous categorization of the persuasive arguments provided a baseline assessment of which arguments participants personally considered to be convincing and which they considered to be unconvincing. By using participants' reported agreement in the first phase of the experiment as a classification variable, we were able to determine whether participants agreed with their own earlier judgments upon judging the persuasive arguments again at a later time.

We also wanted to provide evidence that the controlled and automatic processes underlying the effects on agreement functioned similarly for subjective agreement judgments (which are atypical but not unused with PDP analysis; Begg et al., 1992) as well as for objective memory judgments (more commonly used in prior implementations of the PDP; Jacoby, 1991; Payne, 2005). Therefore, upon seeing the persuasive arguments the second time, participants were randomly assigned to make one of two different types of judgments. In the agreement judgment condition, parallel to the previous experiments, participants reported whether they agreed or disagreed with each argument during the initial exposure phase, and then in the later repetition phase once again reported whether they agreed or disagreed with each argument.

However, in the recall judgment condition, participants initially indicated whether they either agreed or disagreed with each argument but were later asked in the repetition phase to *recall* their earlier response, saying whether they had agreed or disagreed with each argument when asked during the initial exposure phase. Recall of initial judgments of the persuasive argument provided an objective criterion with which controlled processing could be assessed. Perfect recollection of earlier responses would produce an identical set of responses during the repetition phase of the experiment. However, we did not expect participants to perfectly recall their earlier responses. Indeed, we expected a specific pattern of errors in recall that would reflect participants' changes in agreement upon repeated exposure to the arguments (as evidenced by participants in the agreement judgment condition). We expected that upon a second exposure to the persuasive arguments, all participants would form a new evaluation of the argument that would determine their reported agreement and that would bias participants' recall of their earlier responses. Just as repetition might change what appeared to be a weak argument into a strong one, we assumed that the same processes underlying this change would mean that a statement originally judged to be weak and specious might now be mistakenly recalled as having been strong and convincing. Thus, we anticipated a similar pattern of results for both agreement and recall judgments, which would provide converging evidence of the powerful influence exerted by argument quality and repetition, even with "objective" rather than "subjective" judgments.

Because participants' initial dichotomous judgments were used to classify the persuasive arguments, these data were not used in analyses. Instead, analyses were performed on participants' second evaluation of the persuasive arguments, when all the arguments had been seen twice (i.e., repeated). We anticipated that all participants, regardless of their level of motivation to process, would make comparably favorable judgments of repeated strong arguments (i.e., equally high agreement or equal errors in recalling initial agreement with originally strong arguments). In contrast, we anticipated that participants with little motivation would make more favorable judgments of repeated weak arguments (i.e., greater agreement or increased misremembering of originally weak arguments as strong) than participants with greater motivation to process. This pattern would once again show that increased processing reduced agreement with specious arguments, consistent with the notion that increased processing highlighted the limitations of weak arguments, negating the positive impact of familiarity.

In terms of the PDP, we expected to replicate the finding that increased motivation to process affected controlled processing but did not impact the automatic influence of familiarity, thus confirming the generally positive impact of familiarity regardless of the extent of controlled processing. Furthermore, we expected to replicate findings from Experiment 2 by using the split-half analytic approach. In the case of strong, compelling arguments, we expected that both controlled processing and familiarity would increase the favorability of evaluations. In contrast, in the case of weak, specious arguments, we expected that familiarity would increase the favorability of evaluations only when controlled processing was low. Thus, we once again predicted that the manipulation of personal relevance would impact controlled processing but not familiarity and that the variation in controlled processing and familiarity would be associated with changes in the favorability of evaluations in theoretically predictable ways.

Method

Participants and Design

Participants were 83 undergraduates (15 men and 68 women) who participated in exchange for partial course credit. Participants were randomly assigned to a 2 (relevance: low or high) × 2 (judgment: repeated agreement or recall) × 2 (argument quality: weak and strong) mixed-model design, with argument quality as a within-subjects factor. Because the initial judgments of agreement with the persuasive arguments were used to classify arguments as weak or strong, repetition was not a factor.

Procedure

The procedures closely followed those of Experiment 2. The identical manipulation of personal relevance was provided before participants completed an initial exposure phase. In this version of the exposure phase, participants were asked to make a dichotomous judgment by reporting whether they either disagreed (coded as 0) or agreed (coded as 1) with each of 60 persuasive arguments in favor of implementing comprehensive exams. Participants were provided with a 1-min pause before evaluating the arguments for the second time.

Agreement or recall of agreement. Participants in the repeated agreement condition were simply asked once again to make a dichotomous judgment of whether they disagreed or agreed with each persuasive argument. Participants in the recall condition were asked to remember how they categorized each argument during the initial exposure phase and respond in the identical manner. Thus, all judgments of the persuasive arguments were dichotomous in nature.

Check on manipulation of relevance. As a check on the manipulation of personal relevance, participants used 7-point scales to report how carefully they read the statements (1 = *not at all carefully*, 7 = *very carefully*), how much effort they put into reading the statements (1 = *very little*, 7 = *very much*), and how motivated they were to read the statements carefully (1 = *very unmotivated*, 7 = *very motivated*). These items were combined into a single motivation index ($\alpha = .85$). Participants completed standard demographic questions before being debriefed and thanked.

Results

Check on Manipulation of Relevance

To confirm the effectiveness of the manipulation of personal relevance, we subjected the motivation index to a 2 (relevance) × 2 (judgment) between-subjects ANOVA. As expected, only a main effect of the relevance condition emerged such that participants in the low-relevance condition expressed less motivation ($M = 4.23$) than participants in the high-relevance condition ($M = 5.23$), $F(1, 79) = 9.77$, $p < .01$.

Agreement or Recall of Agreement

We performed a 2 (relevance) × 2 (judgment) × 2 (argument quality) mixed-model ANOVA to examine how both participants' agreement with repeated persuasive arguments and their recall for their earlier agreement with persuasive arguments was influenced by motivation and idiographic argument quality.

A main effect of argument quality emerged such that participants made more favorable judgments of compelling arguments ($M = 0.78$) than of specious arguments ($M = 0.22$), $F(1, 79) = 541.72$, $p < .001$. Additionally, a main effect of relevance emerged such that participants in the low-relevance condition made more favorable judgments of the arguments ($M = 0.53$) than participants in the high-relevance condition ($M = 0.48$), $F(1, 79) = 4.00$, $p < .05$.

Of more theoretical importance, the predicted interaction between relevance and argument quality emerged, $F(1, 79) = 6.49$, $p < .05$. Consistent with hypotheses, repeated strong arguments were judged similarly by participants in both the low-relevance condition ($M = 0.78$) and the high-relevance condition ($M = 0.79$) ($t < 1$). In contrast, just as predicted, repeated weak arguments were judged more favorably by participants in the low-relevance condition ($M = 0.28$) than by participants in the high-relevance condition ($M = 0.17$), $t(79) = 3.11$, $p < .01$.

As anticipated, neither the three-way interaction nor any of the two-way interactions involving judgment type emerged ($Fs < 1$), indicating that the biasing influences of argument quality and repetition functioned similarly whether participants reported their subjective agreement or whether they attempted to recall their earlier judgment explicitly.

Automatic and Controlled Process Estimates

Analysis of the control and automatic PDP components indicated that the relevance manipulation only impacted controlled processing, $E(1, 79) = 6.49$, $p < .05$, such that less controlled processing occurred in the low-relevance condition ($M = 0.50$) than in the high-relavance condition ($M = 0.62$). This is consistent with familiarity exerting its influence regardless of participants' extent of controlled processing. As in Experiment 2, by recalculating the PDP control and automatic components using participants' judgments for only one randomly selected half of the persuasive arguments, we were again able to use the control and automatic components, along with their interaction, to predict participants' evaluations of repeated strong arguments and repeated weak arguments.

We conducted two regressions to examine the main effect of controlled processing and the main effect of familiarity entered at Step 1, along with their interaction term entered at Step 2. One regression examined how these components influenced evaluations of compelling arguments, whereas the second regression examined how the components influenced evaluations of specious arguments.[4]

The first regression examined how controlled and automatic processes impacted judgments of strong arguments. Two main effects emerged, reflecting the congruent influence of controlled processing of strong arguments and familiarity with strong arguments. More controlled processing was associated with more favorable evaluations ($\beta = .43$, $p < .001$), and increased automatic

[4] Because the judgment factor produced no differences in the agreement results, it was not included in the presented regression analyses. However, the same conclusions held even when the judgment and relevance factors were taken into account.

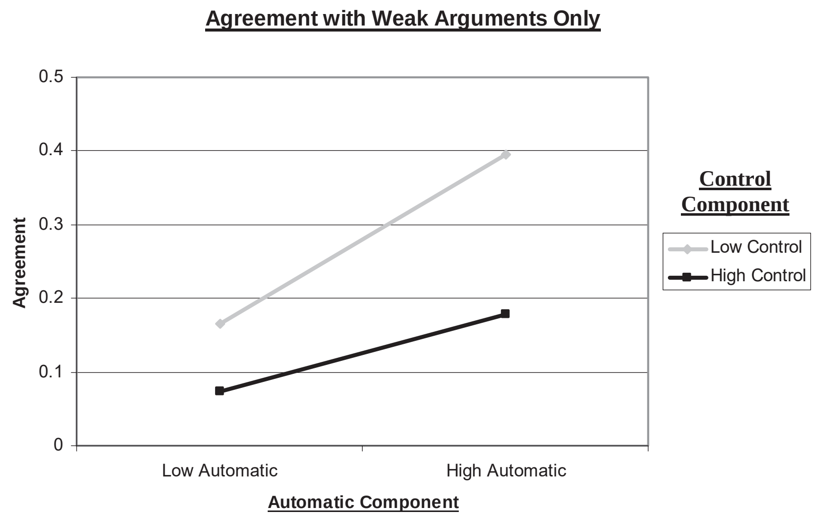


Figure 4. Agreement with repeated arguments that were originally disagreed with as a function of the automatic component estimate (plotted at one standard deviation below and above the mean) and the controlled component estimate (plotted at one standard deviation below and above the mean) in Experiment 3.

influence was associated with more favorable evaluations (β = .34, p = .001), consistent with hypotheses. Once again, both automatic and controlled processes consistently increased acceptance of strong arguments.

A second regression examined how control and automatic processes impacted judgments of weak arguments (see Figure 4). More controlled processing was associated with less favorable evaluations ($\beta = -.46$, $p < .001$), and increased automatic influence was associated with more favorable evaluations ($\beta = .43$, $p < .001$). However, we anticipated an interaction such that familiarity would improve evaluations of weak arguments to a greater extent when little controlled processing occurred. A marginal interaction was consistent with this hypothesis ($\beta = -.16$, $p < .09$). When controlled processing was relatively low, evaluations of weak arguments were improved as automatic influences increased ($\beta = .65$, $p < .001$). In contrast, when controlled processing was relatively high, the beneficial impact of automatic influences was weaker ($\beta = .29$, $p < .05$) but not eliminated.

Overall, these findings closely match results from Experiment 2. Once again, more extensive information processing reduced the impact of familiarity on agreement with weak arguments. This follows from our account that increased processing of weak arguments highlights the limitations of these arguments, which then works to counteract, but not necessarily fully eliminate, the positive impact of repetition. Moreover, the relevance manipulation impacted only controlled processing, suggesting that the automatic influence of familiarity consistently worked to increase agreement with persuasive arguments regardless of controlled processing.

Finally, the estimated controlled and automatic processes were shown to influence agreement with strong and weak arguments in predicted ways. Just as in Experiment 2, controlled and automatic processes worked to increase acceptance of compelling arguments. In contrast, the increased controlled processing of weak arguments reduced familiarity's beneficial effect on agreement.

General Discussion

The present experiments extend previous work on the impact of repetition on ratings of validity (the IOT) to show the ways in which repetition can increase acceptance of persuasive arguments depending on the quality of those arguments and the way in which those arguments are processed. All three experiments demonstrated that although the quality of persuasive arguments can qualify repetition's enhancement of agreement, this depends on the extent to which people have the capacity and motivation to detect and be influenced by the quality of those arguments. When people have little motivation to process, their diminished sensitivity to argument quality reduces its impact and produces increased acceptance of repeated arguments regardless of their quality. In contrast, people motivated to process are persuaded by the quality of strong arguments along with the repetition of those arguments, but when these motivated processors detect the specious nature of weak arguments, the effect of repetition is overridden.

A similar pattern of results emerged when the processes hypothesized to underlie these agreement effects were estimated and analyzed directly using a PDP approach (Experiments 2 and 3). Both controlled processing of message content and the automatic impact of repetition-induced familiarity contribute to agreement. Increased controlled processing enhances the impact of the quality of message content, whereas increased familiarity consistently provides a positive signal that increases agreement. In the case of strong arguments, both controlled and automatic processes enhance agreement, but increased controlled processing makes the limitations of specious arguments more evident and counteracts the benefits of familiarity. In summary, the extent of information processing can determine how repetition will impact agreement because people can potentially be influenced by both repetition-induced familiarity and the actual quality of the persuasive arguments presented.

The present findings were greatly informed by the dissociation of underlying controlled and automatic processes responsible for the effects on agreement. To our knowledge, this is the first application of the PDP to the persuasion domain, in which the discrepancy in response to weak and strong arguments has long been acknowledged as an index of analytic information processing. The application of the PDP technique to the contribution of argument repetition and argument content to agreement necessitated changes both in the typical persuasion-based IOT paradigm and in the typical application of PDP measures. We resolved these difficulties by first establishing that the factors of interest interacted as would be expected in a typical persuasion paradigm (Experiment 1), and then by changing primarily the application of the PDP (by using a subjective dependent variable in Experiment 2) and then primarily features of the persuasive paradigm (with an idiographic approach comparing only repeated arguments but using an objective criterion measure in Experiment 3). Because we were able to replicate the same pattern of agreement responses across various conditions of multiple studies, and also show that variations in the judgments that we asked people to make across studies did not change the basic findings, we were able to provide converging evidence for the contribution of an automatic familiarity process and a controlled process of message content evaluation to agreement, under the processing conditions that determine their relative impact.

However, these results diverge in some ways from previous research. Claypool, Mackie, Garcia-Marques, McIntosh, and Udall (2004) showed that three repetitions of a weak or strong message of little personal relevance reduced participants' differential agreement with the weak or strong message. In the present studies, we found no such decrease in participants' differential agreement with repeated weak and strong arguments under low personal relevance. However, a number of methodological differences might explain these different findings. Claypool et al. (2004) repeated full messages three times in identical, uniform, and homogeneous presentations, whereas in the present experiments, single arguments were repeated just once in a heterogeneous presentation of target arguments randomly presented among filler items. Relative to Claypool et al. (2004), it is possible that the fewer repetitions and more complex presentation of weak and strong arguments in these experiments reduced participants' feeling that the stimuli were entirely identical and did not merit at least some analytic processing (Garcia-Marques & Mackie, 2001).

Our measure of controlled processing also differed somewhat from previous implementations of the PDP that focused on explicit memory as the controlled process of interest. We construed controlled processing as people's ability to discriminate between weak and strong arguments, a measure paralleling processing indices in countless persuasion studies. That is, to the extent that people are capable and motivated to engage in more analytic, controlled processing they are sensitive to argument quality. However, previous IOT studies provided cues that were incongruent or congruent with familiarity's effects only at the learning phase, and then used the extent to which people recalled those earlier cues as an estimate of controlled processing. In contrast, argument quality was inherent in the persuasive appeals used in our studies, and thus the basis for effortful discrimination was available at both the learning and judgment phases. Because of these and other potential differences, future research should investigate the consequences of controlled processing signals being available at learning, judgment, or both.

The present application of the PDP to persuasion and attitude change research has several theoretical and methodological implications. First, the PDP provides an independent assessment of two processes that contribute to agreement. Assessing controlled processing and the automatic influence of familiarity clarifies when and how controlled processes and the automatic effect of familiarity work in conjunction or in opposition. In the present studies, the PDP allowed for close examination of the antecedents that determine the extent of controlled processing (e.g., motivation) and, separately, the antecedents that determine familiarity (e.g., repetition). As a result, the direct and interactive consequences that these two processes have on agreement were observable, which clarified when familiarity remains influential and when its impact is dissipated. More precisely, these experiments extend the Cacioppo and Petty (1989) findings by first providing an estimate of familiarity's impact then revealing that familiarity has an impact even when processing motivation is high but that that motivation can sometimes counteract familiarity (i.e., when arguments are weak) and sometimes augment it (i.e., when arguments are strong). Thus, utilization of the PDP in a persuasion context provided direct evidence for the simultaneous operation and influence of two independent processes, the antecedents that shape those processes, and the consequences of those processes in producing attitude change.

Second, these experiments offer an important methodological advance in the study of persuasion processes. The presentation of both weak and strong arguments to every participant successfully produced a within-subjects measure of controlled processing. Rather than comparing across groups of people who receive either weak or strong arguments, indexing the extent of information processing within individuals increases researchers' methodological flexibility and the statistical power to investigate additional research questions in the area of information processing and attitude change. Rather than the typical examination of analytic processing across groups of people under different conditions, this paradigm allows researchers to examine how a wide variety of factors impact a person's motivation or capacity to engage in extensive controlled processing from one moment to the next. That is, changes within an individual's extent of information processing, as well as their reliance on automatic processes, are now simultaneously discernable in paradigms such as this one, in which each participant receives both weak and strong arguments.

Third, the presented research underscores the value of applying procedures developed in one area of psychology to other areas. Begg et al. (1992) extended Jacoby's (1991) PDP, originally based on memory research, to automatic and controlled components of validity judgments. Social psychologists have adapted the PDP to study the automatic and controlled components of prejudiced judgments (Ferreira, Garcia-Marques, Sherman, & Sherman, 2006; Payne, 2005; Sherman, Groom, Ehrenberg, & Klauer, 2003). We in turn adapted the procedure to the understanding of the processes driving acceptance of persuasive arguments and attitude change, extending its usefulness to an entirely new domain of social psychological research. Indeed, the parallels between the PDP and dual-process frameworks in the persuasion domain are evident in that the difference between agreement with weak arguments and agreement with strong arguments serves as a measure of controlled processing in PDP, just as this same weak–strong difference has indicated more controlled and analytic processing in countless persuasion studies. Thus, these experiments serve as examples of how theoretical and methodological innovations emerge by bridging across scientific subdisciplines.

Persuasion is a pervasive and crucial component of social life. Marketers target consumers, lawyers plead with juries, and doctors implore patients to take their medication. Beyond the theoretical advances rendered by application of the PDP method to the assessment of repetition's impact on agreement, knowing how and when repeating persuasive appeals induces desired attitude change has practical implications. These studies show that simply relying on repetition as a blunt persuasive instrument is inefficient, regardless of The Bellman's confidence in the strategy. As our findings show, not only does the Bellman need to know whether the recipients of his repeated statements are likely to process more or less extensively, he also needs to consider, at least in cases in which they are motivated and able to do so, the quality of what he has to say.

References

Arkes, H. R., Hackett, C., & Boehm, L. (1989). The generality of the relation between familiarity and judged validity. *Journal of Behavioral Decision Making, 2,* 81–94.

Bacon, F. T. (1979). Credibility of repeated statements. *Journal of Experimental Psychology: Human Learning & Memory, 5,* 241–252.

Begg, I., & Armour, V. (1991). Repetition and the ring of truth: Biasing comments. *Canadian Journal of Behavioral Science, 23,* 195–213.

Begg, I. M., Anas, A., & Farinacci, S. (1992). Dissociation of processes in belief: Source recollection, statement familiarity, and the illusion of truth. *Journal of Experimental Psychology: General, 121,* 446–458.

Begg, I., Armour, V., & Kerr, T. (1985). On believing what we remember. *Canadian Journal of Behavioral Science, 17,* 199–214.

Bornstein, R. F. (1989). Exposure and affect: Overview and meta-analysis of research, 1969–1987. *Psychological Bulletin, 106,* 265–289.

Briñol, P., Petty, R. E., & Tormala, Z. L. (2006). The malleable meaning of subjective ease. *Psychological Science, 17,* 200–206.

Busemeyer, J. R., & Wang, Y. M. (2000). Model comparisons and model selection based on generalization criterion methodology. *Journal of Mathematical Psychology, 44,* 171–189.

Cacioppo, J. T., & Petty, R. E. (1989). Effects of message repetition on argument processing, recall and persuasion. *Basic and Applied Social Psychology, 10,* 3–12.

Carroll, L. (1876). *The hunting of the snark, an agony, in eight fits.* London: Macmillan and Co.

Claypool, H. M., Mackie, D. M., Garcia-Marques, T., McIntosh, A., & Udall, A. (2004). The effects of personal relevance and repetition on persuasive processing. *Social Cognition, 22,* 310–335.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes.* Orlando, FL: Harcourt Brace Jovanovich College.

Ferreira, M. B., Garcia-Marques, L., Sherman, S. J., & Sherman, J. W. (2006). Automatic and controlled components of judgment and decision making. *Journal of Personality and Social Psychology, 91,* 797–813.

Garcia-Marques, T., & Mackie, D. M. (2000). The positive feeling of familiarity: Mood as an information processing regulation mechanism. In H. Bless, & J. P. Forgas (Eds.), *The message within: The role of subjective experience in social cognition and behavior* (pp. 240–261). New York: Psychology Press.

Garcia-Marques, T., & Mackie, D. M. (2001). The feeling of familiarity as a regulator of persuasive processing. *Social Cognition, 19,* 9–34.

Hasher, L., Goldstein, D., & Toppino, T. (1977). Frequency and the conference of referential validity. *Journal of Verbal Learning and Verbal Behavior, 16,* 107–112.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30,* 513–541.

Jacoby, L. L., Begg, I. M., & Toth, J. P. (1997). In defense of functional independence: Violations of assumptions underlying the process-dissociation procedure? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 484–495.

Jacoby, L. L., & Shrout, P. E. (1997). Toward a psychometric analysis of violations of the independence assumption in process dissociation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 505–510.

Lee, A. Y., & Labroo, A. A. (2004). The effect of conceptual and perceptual fluency on brand evaluation. *Journal of Marketing Research, 41,* 151–165.

Moons, W. G., Mackie, D. M., Garcia-Marques, T. (2007). *Increasing agreement with repeatedly presented persuasive arguments.* Unpublished manuscript.

Payne, B. K. (2005). Conceptualizing control in social cognition: How executive functioning modulates the expression of automatic stereotyping. *Journal of Personality and Social Psychology, 89,* 488–503.

Petty, R. E., & Cacioppo, J. T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change.* New York: Springer-Verlag.

Petty, R. E., Cacioppo, J. T., & Goldman, R. (1981). Personal involvement as a determinant of argument-based persuasion. *Journal of Personality and Social Psychology, 41,* 847–855.

Petty, R. E., & Wegener, D. T. (1998). Attitude change: Multiple roles for persuasion variables. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (Vol. 1, pp. 323–390). New York: McGraw-Hill.

Reber, R., & Schwarz, N. (1999). Effects of perceptual fluency on judgments of truth. *Consciousness and Cognition: An International Journal, 8,* 338–342.

Sherman, J. W., Groom, C. J., Ehrenberg, K., & Klauer, K. C. (2003). Bearing false witness under pressure: Implicit and explicit components of stereotype-driven memory distortions. *Social Cognition, 21,* 213–246.

Skurnik, I., Yoon, C., Park, D. C., Schwarz, N. (2005). How warnings about false claims become recommendations. *Journal of Consumer Research, 31,* 713–724.

Unkelbach, C. (2007). Reversing the truth effect: Learning the interpretation of processing fluency in judgments of truth. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33,* 219–230.

Winkielman, P., & Cacioppo, J. T. (2001). Mind at ease puts a smile on the face: Psychophysiological evidence that processing facilitation elicits positive affect. *Journal of Personality and Social Psychology, 81,* 989–1000.

Received September 5, 2007
Revision received June 10, 2008
Accepted June 17, 2008 ■

MNRD NON-LOCAL BEINGS REPORT

ATTACHMENT 9

Consciousness and Cognition 78 (2020) 102866

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Truthiness, the illusory truth effect, and the role of need for cognition

Eryn. J. Newman[a,*], Madeline C. Jalbert[b], Norbert Schwarz[b], Deva P. Ly[a]

[a] Australian National University, Australia
[b] University of Southern California, United States

ARTICLE INFO

Keywords:
Truthiness
Illusory truth effect
Need for Cognition
Cognitive fluency
Individual differences

ABSTRACT

Ease of processing—cognitive fluency—is a central input in assessments of truth, but little is known about individual differences in susceptibility to fluency-based biases in truth assessment. Focusing on two paradigms—truthiness and the illusory truth effect—we consider the role of Need for Cognition (NFC), an individual difference variable capturing one's preference for elaborative thought. Across five experiments, we replicated basic truthiness and illusory truth effects. We found very little evidence that NFC moderates truthiness. However, we found some evidence that (without an experimental warning), people high on NFC may be more susceptible to the illusory truth effect. This may reflect that elaborative thought increases the fluency with which encoded statements are processed after a delay (thus increasing the illusory truth effect). Future research may fruitfully test whether the influence of NFC and other individual difference measures depends on whether people are making immediate or delayed truth judgments.

1. Introduction

Consider the following claim: "Woodpeckers are the only bird that can fly backwards." One might hope that people draw on general knowledge or other external sources to conclude that it is, in fact, *hummingbirds* that can fly backwards, and so reject this claim as false. But a large literature on cognitive fluency shows that people also rely on how easy it is to process a claim or idea to establish whether it is true (Fazio, Brashier, Payne, & Marsh, 2015; Unkelbach & Greifeneder, 2018). The robust finding in this body of research is that when information feels easy to process, people are more likely to believe it (for reviews, see Schwarz, 2015; Schwarz & Jalbert, in press). Across a wide variety of studies, manipulations such as repetition, the addition of photographs, changes in colour contrast, and semantic primes—variables that increase the ease of perceiving, understanding, or recalling an idea—bias people's assessments of truth (Cardwell, Henkel, Garry, Newman, & Foster, 2016; Hansen & Wanke, 2010; Newman, Garry, Bernstein, Kantner, & Lindsay, 2012; Reber & Schwarz, 1999). While it is well-established that cognitive fluency is a central input in assessments of truth, much less is known about individual variation in susceptibility to these fluency-based biases. Across five experiments focusing on two paradigms—the truthiness effect and the illusory truth effect—we examine the role of Need for Cognition, an individual difference variable that captures variation in individuals' predisposition to engage in elaborative information processing, as reviewed below. Considering the role of individual differences in both the truthiness effect and the illusory truth effect also allows for examination of the cognitive mechanisms and theoretical accounts of both effects.

* Corresponding author.

https://doi.org/10.1016/j.concog.2019.102866
Received 3 May 2019; Received in revised form 25 December 2019; Accepted 27 December 2019
Available online 11 January 2020

Attachment 9 to MNRD Non-Local Beings Report

1.1. Declarative and experiential inputs

While fluency influences people's assessments of truth even in the presence of more informative declarative inputs such as general knowledge or available source information (Brashier, Umanath, Cabeza, & Marsh, 2017; Fazio et al., 2015; Unkelbach & Greifeneder, 2018), there is much that remains to be learned about the conditions that govern the relative impact of declarative and experiential information. For instance, when people judge claims for which they have relevant knowledge (e.g., "The White House is in Washington, DC") the influence of incidental fluency manipulations is diminished (Newman et al., 2012; Parks & Toth, 2006; Unkelbach, 2007). Note, however, that this does not necessarily imply that fluency plays no role in these judgments (e.g., Brashier, Umanath, Cabeza, & Marsh, 2017). Familiar claims are easy to process at a conceptual level and either declarative knowledge or the resulting conceptual fluency may limit the impact of additional incidental fluency manipulations, such as repetition or readability. Other evidence suggests that experimental instructions can affect people's relative reliance on declarative and experiential information in assessing truth. For example, encouraging a careful and accurate analysis or explicitly warning people about the influence of repetition on judgments of truth can reduce the impact of fluency (e.g., (Garcia-Marques, Silva, & Mello, 2016; Jalbert, Newman, & Schwarz, 2019; Nadarevic & Aßfalg, 2017). A wide range of investigations into the relative contributions of declarative and experiential information indicates that people are less likely to rely on experiential information when the judgment is important to them and they have the time and motivation to search for, and elaborate on, declarative inputs (for reviews, see Greifeneder, Bless, & Pham, 2011; Greifeneder & Schwarz, 2014).

These observations parallel lessons from decades of persuasion research into the conditions that foster thoughtful processing of a persuasive message (for a review, see Wegener, Clark, & Petty, 2019). Persuasion research has also identified individual differences that influence the extent to which message recipients think about the content of a message or rely on heuristic cues, such as the communicator's status or affiliation, to evaluate the arguments (for a review, see Briñol & Petty, 2019). One of the most impactful of these variables is Need for Cognition, to which we turn next.

1.2. Need for Cognition

Cacioppo and Petty (1982) Need for Cognition (NFC) scale measures how much people enjoy thinking and engage in it. Example items are, "I prefer my life to be filled with puzzles that I must solve" and "I like to have the responsibility of handling a situation that requires a lot of thinking." Those who score high on NFC are more likely to consider the quality of an argument and the consistency of the evidence presented, and are therefore persuaded by strong arguments more than weak arguments (for reviews, see Briñol & Petty, 2019; Cacioppo, Petty, Feinstein, & Jarvis, 1996). In contrast, those who score low on NFC attend less to the substance of the arguments and are often equally persuaded by strong and weak arguments. Moreover, those low on NFC are more likely to be influenced by attributes of a message that are not diagnostic of its accuracy but make its content easy to process, such as anecdotes, heuristically useful cues (e.g., a message with more arguments is better), easy to read fonts, and semantic primes (e.g., Bornstein, 2004; Cho & Schwarz, 2006; Petty, DeMarree, Briñol, Horcajo, & Strathman, 2008). These observations suggest that those high on NFC may be less susceptible to the biasing effects of incidental fluency in assessments of truth. We examine this prediction using two well-established paradigms from the truth literature—the truthiness paradigm and the illusory truth effect paradigm.

1.3. Truthiness

Consider Fig. 1. The accompanying photo tells you nothing about the veracity of the claim. It merely decorates. And so one might

Fig. 1. Example claim and photo, as in the truthiness paradigm.

Attachment 9 to MNRD Non-Local Beings Report

expect that such a photo does not influence people's assessments of whether that claim is true. A growing body of work suggests that expectation is wrong. In fact, photos that are thematically related to a claim but do not provide any evidence for the claim's veracity – like the woodpecker in Fig. 1 – can systematically bias people into believing claims are true (Fenn, Newman, Pezdek, & Garry, 2013; Newman et al., 2012; for a review see Newman & Zhang, in press).

In the truthiness paradigm, people quickly judge a series of trivia claims (e.g., "The liquid metal inside a thermometer is magnesium") as true or false. Sometimes the claims appear with a nonprobative photo (such as a thermometer), and other times the claims appear without a photo. The consistent finding is that when people make rapid judgments about the truth of a claim, nonprobative but related photos nudge them toward believing that claim—an effect known as "truthiness." This influence of photos is robust across materials and contexts; nonprobative photos bias people's beliefs about general trivia facts, claims about products, predictions about the future, and even memories of their own recent actions (e.g., Cardwell et al., 2016; Cardwell, Newman, Garry, Mantonakis, & Beckett, 2017; Newman, Azad, Lindsay, & Garry, 2018; Newman et al., 2012).

The leading theoretical account for truthiness is that the addition of a related photo facilitates the conceptual processing of the claim by making it easier to imagine and understand in the recipient's mind. That is, the photos boost conceptual fluency—the ease and speed with which one can extract meaning and comprehend information they encounter—a metacognitive experience that increases perceived truth (Kelley & Lindsay, 1993; Newman et al., 2012; Whittlesea, 1993). A growing body of research supports this idea. For instance, adding semantically related words extracted from the photo (red feathers, bird, tree, beak) can produce the same pattern of results and increase people's belief in an associated claim (Newman et al., 2012). That is, it is not the photo per se, but the additional semantic content that increases perceived truth (see also Bernstein, 2005). Like many other fluency effects, truthiness is larger when photos are manipulated within-subjects rather than between-subjects, suggesting that one important input in the truthiness effect is the relative ease of processing a claim that appears with a photo, compared to without a photo (Newman et al., 2015; see also Dechêne, Stahl, Hansen, & Wänke, 2009).

Given that those who are high on NFC are less likely to rely on experiential features of a message, they may be less influenced by the presence of a photograph and accompanying ease of processing. Moreover, research on NFC shows that those who are high on NFC are better at detecting when evidence is probative or not (McAuliff & Kovera, 2008; see also Reinhard, 2010) and are more inclined to correct for any salient source of bias on their judgements (Wegener & Petty, 1997). These findings from the persuasion literature suggest that those who are high on NFC may be less influenced by a photo because they are more likely to notice that the photo is nondiagnostic of whether the claim is true and account for potential bias.

1.4. Illusory truth effect

Now consider that we have already presented the woodpecker claim several times in the present article. Despite the fact that repeating the claim about woodpeckers does not change the likelihood that the claim is actually accurate, a large literature shows that the mere repetition of information can systematically bias people to believe that information is true (Bacon, 1979; Begg, Anas, & Farinacci, 1992; Hasher, Goldstein, & Toppino, 1977; for a review see Dechêne, Stahl, Hansen, & Wänke, 2010).

In a typical illusory truth effect study, people see some claims at time 1, the exposure phase. After a delay (ranging from minutes to weeks), at time 2, the test phase, people assess the truth of another series of claims. Some of these claims they have already seen at time 1, and some are new. The key finding, first reported by Hasher et al. (1977), is that people are biased to rate old claims as true, compared to new claims they have never seen before. A growing literature shows that this repetition-based illusory truth effect is robust, holding across a variety of domains and despite having general knowledge about a claim, and occurring even when other more probative information is available (for a *meta*-analysis, see Dechêne et al., 2010).

Repetition is thought to increase truth via an increase in processing fluency, consistent with the observation that many other variables that increase fluency also increase truth (Reber & Schwarz, 1999; for a review, Schwarz, 2015). Multinomial modeling approaches support this conclusion (e.g., Fazio et al., 2015). Like other fluency-based effects, the illusory truth effect is sensitive to experimental context and is more robust in within-subjects than between-subjects paradigms (Dechêne et al., 2009). While warnings and other instructional manipulations can reduce susceptibility to the truth effect, little is known about how individual difference variables may moderate illusory truth (see Jalbert, Newman, & Schwarz, 2019; Nadarevic & Aßfalg, 2017, on effects of warnings and experimental instructions; see Brashier et al., 2017; Dekeersmaecker et al., 2019, on the influence of individual variables).

Assuming that those who are high on NFC draw more on the content of the message and less on accompanying experiential inputs, it is possible that those individuals are less sensitive to feelings of fluency when they judge truth at time 2. But it is also possible that being high on NFC backfires due to the influence of high NFC on the encoding of claims at time 1. Research shows that those who score high on NFC elaborate more on the content of a message and have better recall for its details than those who score low on NFC (Cacioppo, Petty, & Morris, 1983; LaTour, LaTour, & Brainerd, 2014; Wootan & Leding, 2015). This may protect high NFC individuals on immediate tests, as in the truthiness paradigm, where more elaborate processing of available information may make it easier to disentangle probative from nonprobative details. But in the illusory truth effect paradigm, engaging in elaboration at time 1 may result in higher fluency and familiarity when high NFC individuals encounter previously seen statements at time 2 (see, for example, Unkelbach & Rom, 2017). There is some evidence for this possibility in the false memory literature—those who are high on NFC are more susceptible to illusory recognition due to increased semantic elaboration at encoding (Graham, 2007; LaTour et al., 2014; Leding, 2011; Wootan & Leding, 2015). We examine whether high NFC reduces or enhances the illusory truth effect in the experiments reported here.

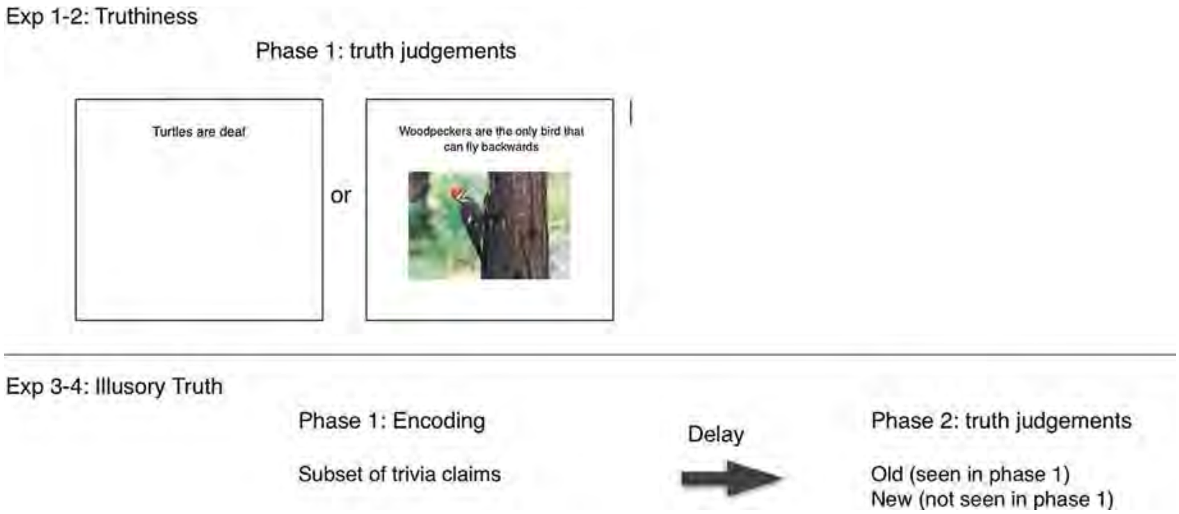


Fig. 2. Summary of methods across Experiments 1–4.

1.5. Present research

The present studies are a preliminary set of experiments to explore whether individual differences in NFC can moderate the size of two fluency-based biases in assessments of truth: the truthiness effect and the illusory truth effect. In Experiment 1, participants evaluated the truth of a series of trivia claims, half of which appeared with a nonprobative photo. After completing this trivia judgement task, participants completed a NFC Scale. As anticipated, those who were high in NFC were less susceptible to the truthiness effect than those who were low in NFC. In Experiment 2a and 2b we aimed to replicate the findings from Experiment 1 and examined whether we could encourage a high NFC mindset by asking people to "think deeply [critically]." While these instructions increased people's discrimination on the trivia claims, truthiness was robust across both instruction conditions and across variations in NFC. While we obtained similar NFC patterns to Experiment 1, these effects did not reach significance.

In Experiment 3, we used an existing dataset (Jalbert, Newman, & Schwarz, 2019) to examine whether high NFC protects people from the illusory truth effect or whether being high on NFC increases the illusory truth effect via an increase in elaboration at time 1. Participants first viewed a series of trivia claims (time 1). Following a delay of three to six days, they were asked to rate the truth of another series trivia claims, some of which they had seen at time 1 and some of which were new. Finally, participants completed the NFC scale. Compared to participants who scored low on NFC, those who scored high on NFC showed a larger illusory truth effect. Experiment 4 replicated this basic pattern, but the effect of NFC did not reach significance. Taken together—considering the truthiness and illusory truth data in mini meta-analyses—these findings suggest that there is very little evidence that NFC moderates the truthiness effect, but there is some evidence that, when people are not warned they may be exposed to false information, NFC moderates illusory truth. We summarise the methods across Experiments 1–4 in Fig. 2.

2. Experiment 1: truthiness

2.1. Method

2.1.1. Participants

We used Amazon's Mechanical Turk (MTurk; www.mturk.com/mturk) to recruit participants in the US and paid them $0.60 for completing the experiment.[1] Across all three MTurk experiments, we downloaded data after the HITs were completed. We posted 400 available slots on MTurk and a total of 317[2] participants completed all phases of the study with no missing data. In all the experiments reported here, we used an online script through Turkitron.com to randomly assign participants to conditions and administered the experiment through Qualtrics.

2.1.2. Design

The presence of a nonprobative photo was manipulated as a within-subjects factor (Photo presence: photo, no photo). We also included an exploratory between-subjects component, claim presentation: whether participants saw the photo first or the claim first, before responding to the full claim (photo or no photo + claim). We found no effects of claim presentation in this experiment, but to

[1] Previous studies have established the reliability of MTurk data through multiple replications of the effect within and outside the current lab (Abed et al., 2017; Newman et al., 2015).

[2] Across the 3 experiments reported here, completed data represented Exp 1, 79%, Exp 2a, 92%, Exp 2b, 85% of the posted HITs.

be transparent we include the full design in all analyses, making this a 2 (Claim presentation: photo first, claim first) × 2 (Photo presence: photo, no photo) mixed model design. We analyzed NFC both as a continuous between-subjects variable, and, in a separate analysis, as a categorical between-subjects variable (NFC: high, low).

2.1.3. Materials and procedure

We used norming data from previous research and selected trivia claims where the truth status was unclear—the 32 critical trivia claims we used have a normed accuracy rate of between 40 and 60% (Newman et al., 2015; see also Nelson & Narens, 1980; Unkelbach, 2007). Before beginning the experiment, participants were told that they would see a series of trivia claims and that sometimes these claims would appear with photos, while other times they would not. They were also told that their primary task was to decide whether those claims were true or false.

The trivia claims appeared individually in large black font against a white background. Participants saw 32 difficult trivia claims, half true and half false. For half of the trials, a related nonprobative photo depicted the grammatical subject of the claim. For example, the claim "Macadamia nuts are in the same evolutionary family as peaches" appeared with a photo of a bowl of macadamia nuts, "Cactuses can reproduce by parthenogenesis" appeared with a photo of a cactus, and "The plastic things on the ends of shoelaces are called aglets" appeared with a photo of a shoe with a shoelace. For the other half of trials, the trivia claim appeared without a photograph (see Newman et al., 2012). We counterbalanced between-subjects so that the claims appeared equally often with and without a nonprobative photo and the order of trivia claims was randomized for each participant.

As noted above, half of the participants saw the trivia claim first, and half of the participants saw the photo first. That is, in the trivia first condition, each trivia claim appeared on the screen for 3.5 seconds before a photo (or no photo) was added to the screen. In the photo first condition, people saw the photo (or no photo/blank screen) for 3.5 seconds before the trivia claim was added to the screen. We did not find any interactive effects of this manipulation, but we include the full analyses in our results section below. Once participants had completed the trivia phase of the experiment, we asked them to complete the 18-item Need for Cognition scale (Cacioppo, Petty, & Feng Kao, 1984). Participants responded on a 5 point scale with responses labelled −2, "very uncharacteristic for me" to +2, "very characteristic for me", with 0 being "uncertain".

2.2. Results and discussion

Would high NFC participants show a reduced truthiness effect, or would high and low NFC participants similarly fall victim to the presence of nonprobative photos? To answer this question, we first calculated the proportion of times people responded true to claims presented with or without photos. We then calculated the NFC scale score for all participants (Cronbach's $\alpha = 0.920$; $M = 8.52$, $SD = 13.30$). As Fig. 3 shows, people were biased to believe claims that appeared with photos, but that pattern was less pronounced for those with high NFC.

That is, a 2 (Order: photo first, trivia first) × 2 (Photo presence: photo, no photo) mixed model ANOVA with NFC as a continuous variable showed a main effect of photo, $F(1, 313) = 29.15$, $p < .001$, partial $eta^2 = 0.09$, and an interaction between photo presence and NFC, $F(1, 313) = 6.84$, $p = .009$, partial $eta^2 = 0.02$. When we used a spotlight analysis to examine the photo effect at one SD above and below the mean, we found that there was a truthiness bias for those with low NFC, $F(1, 313) = 27.00$, $p < .001$, partial $eta^2 = 0.08$, raw mean difference between photo and no photo condition = 0.07, 95% CI [0.04, 0.09]; this bias was smaller and not significant for those with high NFC, raw mean difference between photo and no photo condition = 0.02, 95% CI [−0.01, 0.05]. There was a main effect for order, $F(1, 313) = 6.62$, $p = .011$, partial $eta^2 = 0.02$—those who saw the trivia claim first responded true more often ($M = 0.57$, $SD = 0.13$) than those who saw the photo first ($M = 0.54$, $SD = 0.13$). The main effect of NFC and all other interactions did not reach statistical significance, all *F*s < 1.06, and *p*s > 0.304. We replicated these basic analyses using a categorical median split NFC classification and found the same significant pattern of results, although a main effect of NFC now emerged.[3]

Taken together, Experiment 1 suggests that susceptibility to truthiness may indeed vary across individuals; being high on NFC reduced the likelihood that people were influenced by the presence of a related photo. This pattern of data fits with existing literature on persuasion showing that those who are high on NFC are less influenced by tangential details and weak evidence (Briñol & Petty, 2019; Cacioppo & Petty, 1982).[4] As research in social cognition and persuasion has highlighted, individual differences in elaboration

[3] In order to examine the effects of high and low levels of NFC, we split our participants into "high" and "low" NFC groups, using a median split approach. A total of 8 participants had NFC scale scores exactly the same as the median ($Mdn = 9$), and so were not included in the following analysis. We found the same significant pattern when we analyzed our data classifying NFC using a median split approach. That is, a 2 (NFC: high, low) × 2 (Order: photo first, trivia first) × 2 (Photo presence: photo, no photo) mixed model ANOVA showed a main effect of photo, $F(1, 305) = 19.13$, $p < .001$, partial $eta^2 = 0.06$ and an interaction between photo presence and NFC, $F(1, 305) = 6.18$, $p = .031$, partial $eta^2 = 0.02$. While there was a truthiness bias for those with low NFC, $F(1, 305) = 23.46$, $p < .001$, partial $eta^2 = 0.07$ (raw mean difference between photo and no photo condition = 0.06, 95% CI [0.04, 0.09]), there was no such bias for those with high NFC, $F(1, 305) = 1.79$, $p = .182$, partial $eta^2 = 0.01$ (raw mean difference between photo and no photo condition = 0.02, 95% CI [−0.01, 0.04]). There was a main effect for order, $F(1, 305) = 5.73$, $p = .017$, partial $eta^2 = 0.02$—those who saw the trivia claim first, responded true more often than those who saw the photo first. There was also a main effect for NFC group, $F(1, 305) = 4.63$, $p = .032$, partial $eta^2 = 0.02$—those with low NFC ($M = 0.57$, $SD = 0.14$) responded true more often than those with high NFC ($M = 0.54$, $SD = 0.12$). No other interactions reached statistical significance, all *F*s < 1.03, and *p*s > 0.312.

[4] It is possible of course that those who are higher on NFC have higher accuracy, reducing the effect of photos. We examined this question using a

Attachment 9 to MNRD Non-Local Beings Report

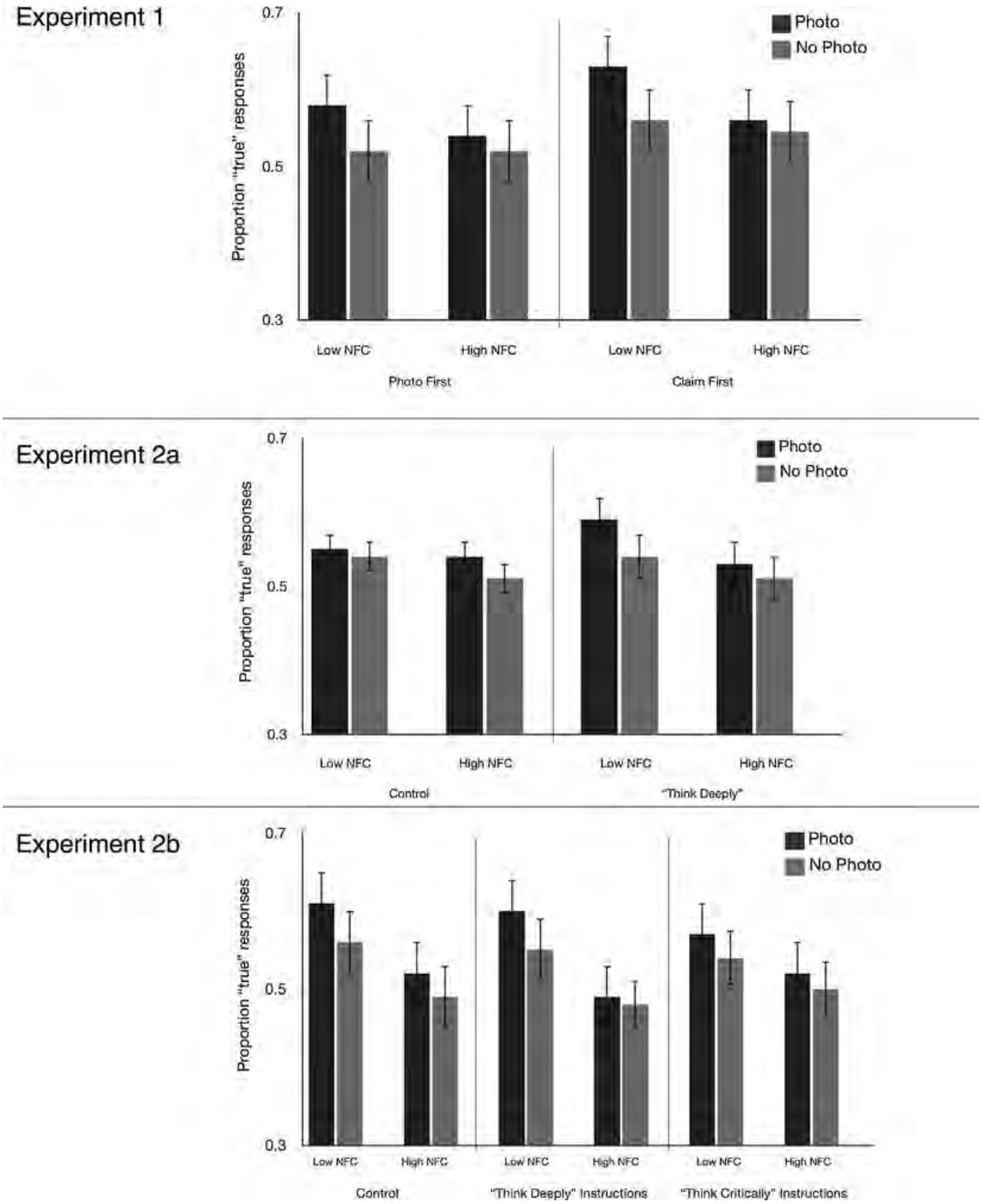


Fig. 3. Proportion of true responses by whether people were "High" or "Low" on Need for Cognition (median split) and whether claims appeared with or without nonprobative photos across Experiments 1, 2a and 2b. Error bars represent 95% within-subjects confidence intervals (Masson & Loftus, 2003).

(as captured by NFC) and situationally induced differences in elaboration have parallel effects (for a review, see Greifeneder et al., 2011). For instance, asking people to evaluate the truth of claims under conditions of high cognitive capacity (no cognitive load) and with motivation to be careful in assessing the validity of claims can reduce susceptibility to the repetition-based illusory truth effect

(*footnote continued*)
signal detection approach. If discrimination ability (d′) explained the effect of NFC, we would expect that average d' scores relate to the size of the truthiness effect—the higher one's average d', the less one's susceptibility to the effect of photos. The relationship between d' and truthiness, however, was very small and did not reach significance $r\,(315) = -0.07$, $p = .188$. Conducting the same analysis with NFC, we found that the NFC score was related to truthiness—the higher one's NFC score, the smaller the effect of photos, $r\,(315) = -0.15$, $p = .008$.

(Garcia-Marques et al., 2016). Put simply, when people can engage in more careful processing and are motivated to do so, they are less likely to be influenced by the fluency of processing claims—an experiential input—when assessing their truth.

Would these parallels between NFC and situational influences also hold for the emergence of truthiness effects? In Experiment 2a and 2b, we examine this possibility: do experimental instructions that reduce time pressure and encourage people to think more deeply (critically) reduce truthiness, paralleling the influence of being high on NFC? In Experiment 2a and 2b we also attempt to replicate the findings of Experiment 1. We describe those experiments together, given the similarity in the design.

3. Experiment 2a and 2b: truthiness

3.1. Method

3.1.1. Participants

We used Amazon's Mechanical Turk (MTurk; www.mturk.com) to recruit participants and paid them the prorated US federal minimum wage for completing the experiment. In Experiment 2a, we posted 400 available slots on MTurk and a total of 369 participants completed all phases of the study and had no missing data. In Experiment 2b, we posted 600 available slots on MTurk and 538 completed all phases of the study and had no missing data. We excluded 30 people from Experiment 2b who said that they looked up the answers.

3.1.2. Design

As in Experiment 1, we manipulated photo presence within-subjects. The instructions that were presented prior to completing the experiment were manipulated between-subjects. Thus, Experiment 2a followed a 2 (Photo presence: photo, no photo) × 2 (Instructions: control, think deeply) mixed model design, with photo presence manipulated within-subjects and instructions between-subjects. In Experiment 2b, we added an additional instructions condition, resulting in a 2 (Photo presence: photo, no photo) × 3 (Instructions: control, think deeply, think critically) mixed model design. As in Experiment 1, we analyzed NFC both as a continuous between-subjects variable, and, in a separate analysis, as a categorical between-subjects variable (NFC: high, low).

3.1.3. Materials and procedure

Experiment 2a and 2b were identical to Experiment 1 with three key changes. First, the trivia claims were presented intact on the screen—there was no initial exposure to the photo or the trivia claim. This presentation format is identical to other truthiness studies (Newman et al., 2012, 2015). Second, we added an instruction manipulation before the judgement task. In Experiment 2a, half of the participants received the same instructions as Experiment 1, the "control" condition and half were told "It is important that you take your time to respond and think deeply before responding to each claim," the "Think deeply" condition. In Experiment 2b, one third received "control" instructions, one third received the "think deeply" instructions, and one third were told "It is important that you take your time to respond and think critically before responding to each claim", the "think critically" instructions. Third, we recorded response times to examine whether the instructions did in fact lead participants to take longer when they evaluated the claims. After completing the NFC scale in position 1, participants also completed a few additional individual difference measures for exploratory purposes (political affiliation, religiosity, and the Cognitive Reflection Task). In Experiment 2b, we included a check at the end of the study to establish whether people had indeed answered questions drawing on their own general knowledge instead of looking them up. We stated that we would pay them regardless of their response.

3.2. Results and discussion

3.2.1. Manipulation check

To examine whether the instructions in Experiment 2a and 2b led to more careful processing, we calculated the average response time and average discrimination (d'), a measure of the ability to accurately detect true from false claims, for each condition (see Stanislaw & Todorov, 1999). If the instructions did indeed lead people to slow down and think more carefully, we would expect that they took longer and were better able to discriminate between true and false claims. That is exactly what we found. Our response time data show that in Experiment 2a, control participants ($M = 5.86$, $SD = 3.56$) responded faster than the "think deeply" participants ($M = 10.81$, $SD = 9.24$), $t(367) = 6.73$, $p < .001$, raw mean difference = −4.95, 95% CI [−6.40, −3.51]. And in Experiment 2b, control participants ($M = 8.02$, $SD = 8.44$) responded faster than both the "think deeply" ($M = 14.21$, $SD = 14.64$), raw mean difference = −6.19, 95% CI [−8.80, −3.58] and "think critically" participants ($M = 12.46$, $SD = 12.59$), raw mean difference = -4.45, 95% CI [−6.99, −1.90], $F(2, 505) = 11.77$, $p < .001$, $eta^2 = 0.04$.

Our d' data are consistent with these patterns and show that in Experiment 2a, those in the "think deeply" condition had higher d' ($M = 0.33$, $SD = 0.65$) compared to those who in the control condition ($M = 0.10$, $SD = 0.50$), $t(367) = 3.76$, $p < .001$, $d = 0.39$. We found the same pattern in Experiment 2b, $F(2, 505) = 6.14$, $p = .002$, $eta^2 = 0.02$ (Control, $M = 0.16$, $SD = 0.48$; Deeply, $M = 0.35$, $SD = 0.60$; Critically, $M = 0.35$, $SD = 0.62$). Follow-up analyses showed that both the "think deeply" and "think critically" conditions differed from the control condition; the raw mean difference for "think deeply" vs control was $M = 0.19$, 95% CI [0.03, 0.34] and the raw mean difference for "think critically" vs control was $M = 0.19$, 95% CI [0.03, 0.34]. But "think deeply" and "think critically" not differ from each other, $M = 0.01$, 95% CI [−0.14, 0.15]. Taken together, these data suggest that our instructions in both experimental conditions did indeed lead people to take their time and more carefully consider the truth of claims. Notably, however, the difference in d' between conditions is small, likely reflecting the difficulty of accurately answering ambiguous trivia claims.

3.2.2. Truth judgments

As in Experiment 1, in Experiment 2a and 2b, we calculated the proportion of true responses for claims presented with and without photos. We also calculated a NFC score for each participant (Experiment 2a Cronbach's $\alpha = 0.937$; $M = 7.73$, $SD = 15.81$; Experiment 2b Cronbach's $\alpha = 0.934$; $M = 8.08$, $SD = 15.42$). As shown in Fig. 3, the NFC results showed a similar pattern as in Experiment 1—those with high NFC tended to show a smaller truthiness bias than their low NFC counterparts. However, these differences did not reach significance when we conducted the same statistical analyses as in Experiment 1.

For Experiment 2a, a 2 (Photo presence: photo, no photo) × 2 (Instructions: control, think deeply) mixed model ANOVA with NFC as a continuous variable showed a main effect of photo presence, reflecting a typical truthiness effect, $F(1, 365) = 13.88$, $p < .001$, partial $eta^2 = 0.04$ (Photo, $M = 0.55$, $SD = 0.17$; No photo, $M = 0.52$, $SD = 0.17$). We may have expected to observe a three-way interaction for both experiments. Indeed, the effect of NFC on truthiness should be most pronounced in the control condition while the "think deeply [critically]" instructions may have washed out any effects of NFC. But the expected three-way interaction of photo, instructions, and NFC was not significant, $F(1, 365) = 2.75$, $p = .098$, partial $eta^2 = 0.01$. The interaction of photo presence by NFC was also not significant, $F(1, 365) = 1.39$, $p = .239$, partial $eta^2 < 0.01$. All other main effects and interactions in the ANOVA model were not significant $Fs < 2.62$ and $ps > 0.099$. In short, while the pattern in Fig. 3 suggests a replication of the NFC effect for people who received the "think deeply" instructions, that pattern did not reach significance. We replicated these basic analyses using a categorical median split NFC classification and found the same pattern of results.[5]

We conducted parallel analyses in Experiment 2b. A 2 (Photo presence: photo, no photo) × 3 (Instructions: control, think deeply, think critically) mixed model ANOVA with NFC as a continuous variable. This analysis showed a main effect of photo presence $F(1, 502) = 21.48$, $p < .001$, partial $eta^2 = 0.04$, reflecting a truthiness effect (Photo, $M = 0.56$, $SD = 0.17$; No photo, $M = 0.52$, $SD = 0.17$). A main effect of NFC also emerged, $F(1, 502) = 8.48$, $p = .004$, partial $eta^2 = 0.02$, indicating that with increasing NFC people said true less often. However, the expected interaction of photo presence by NFC was not significant, $F(1, 502) = 1.23$, $p = .268$, partial $eta^2 < 0.01$. Again, while Fig. 3 suggests a similar pattern—a reduced truthiness effect in those with higher NFC—that pattern did not reach significance by treating NFC as a continuous variable, nor by replicating these basic analyses using a categorical median split NFC classification.[6] The main effect of instruction and all other interactions did not reach significance, all $Fs < 0.89$, $ps > 0.41$.

4. Truthiness effect size analysis

We conducted a mini meta-analysis across the three experiments to more precisely estimate the influence of NFC on truthiness. Fig. 4 shows a forest plot of all effect size estimates for truthiness for high and low NFC participants across the three experiments reported here, collapsed across other between-subjects conditions. The analysis was performed using Comprehensive Meta-Analysis Software (Version 3.0). Due to the small number of studies, tau-squared was pooled across studies, following recommendations by Borenstein, Hedges, Higgins, and Rothstein (2009). A random effects model was used and effect sizes were fixed across subgroups. Effect sizes were corrected for small sample biases (Borenstein et al., 2009).

As Fig. 4 shows, the total truthiness effect size across all conditions was $d = 0.23$, 95% CI [0.15, 0.30]. The truthiness effect for participants with high NFC was $d = 0.17$, 95% CI [0.05, 0.29] and for those with low NFC, $d = 0.27$, 95% CI [0.17, 0.37]—this difference did not reach significance, $Q(1) = 1.62$, $p = .203$, $d = 0.07$, 95% CI [−0.08, 0.22]. Taken together, these preliminary data suggest no reliable moderating effect of NFC on truthiness, but further research is warranted. It is of course possible that any reliable effect of NFC is difficult to capture due to the small size of the truthiness effect. The finding that NFC effects tended to be weak, squares with the small literature on individual differences and fluency-based assessments of truth, showing very few reliable moderating effects of individual difference variables (e.g., Dekeersmaecker et al., 2019, see also Brashier et al., 2017). We consider avenues for future research and other theoretical implications in the general discussion.

[5] In order to examine the effects of high and low levels of NFC, we split our participants into "high" and "low" NFC groups, using a median split approach. A total of 5 participants had NFC scale scores exactly the same as the median ($Mdn = 9$), and so were not included in the following analysis. A 2 (NFC: high, low) × (Photo presence: photo, no photo) × 2 (Instructions: control, think deeply) mixed model ANOVA showed a main effect of photo, $F(1, 360) = 11.83$, $p = .001$, partial $eta^2 = 0.03$, (Photo, $M = 0.55$, $SD = 0.17$; No photo, $M = 0.52$, $SD = 0.17$) and that the NFC × photo presence × instruction condition interaction was not significant, $F(1, 360) = 1.57$, $p = .211$, partial $eta^2 < 0.01$. There was a main effect for NFC, $F(1, 360) = 4.25$, $p = .040$, partial $eta^2 = 0.01$—those with low NFC, responded true more often than those with high NFC (Low NFC, $M = 0.55$, $SD = 0.18$; High NFC, $M = 0.52$, $SD = 0.11$). No other effects reached statistical significance, all $Fs < 0.77$, $ps > 0.383$).

[6] In order to examine the effects of high and low levels of NFC, we split our participants into "high" and "low" NFC groups using a median split approach. A total of 11 participants had NFC scale scores exactly the same as the median ($Mdn = 8$) and so were not included in the following analysis. A 2 (NFC: high, low) × (Photo presence: photo, no photo) × 3 (Instructions: control, think deeply, think critically) mixed model ANOVA showed a main effect of photo, $F(1, 491) = 23.17$, $p < .001$, partial $eta^2 = 0.05$ (Photo, $M = 0.57$, $SD = 0.17$; No photo, $M = 0.52$, $SD = 0.17$), and that the NFC by photo presence interaction did not reach significance, $F(1, 491) = 2.51$, $p = .114$, partial $eta^2 = 0.01$. There was a main effect for NFC, $F(1, 491) = 31.39$, $p < .001$, partial $eta^2 = 0.06$—those with low NFC responded true more often than those with high NFC (Low NFC, $M = 0.57$, $SD = 0.16$; High NFC, $M = 0.50$, $SD = 0.11$). The remaining main effect of instruction and all other interactions were also not significant, $Fs < 1.05$, $ps > 0.351$.

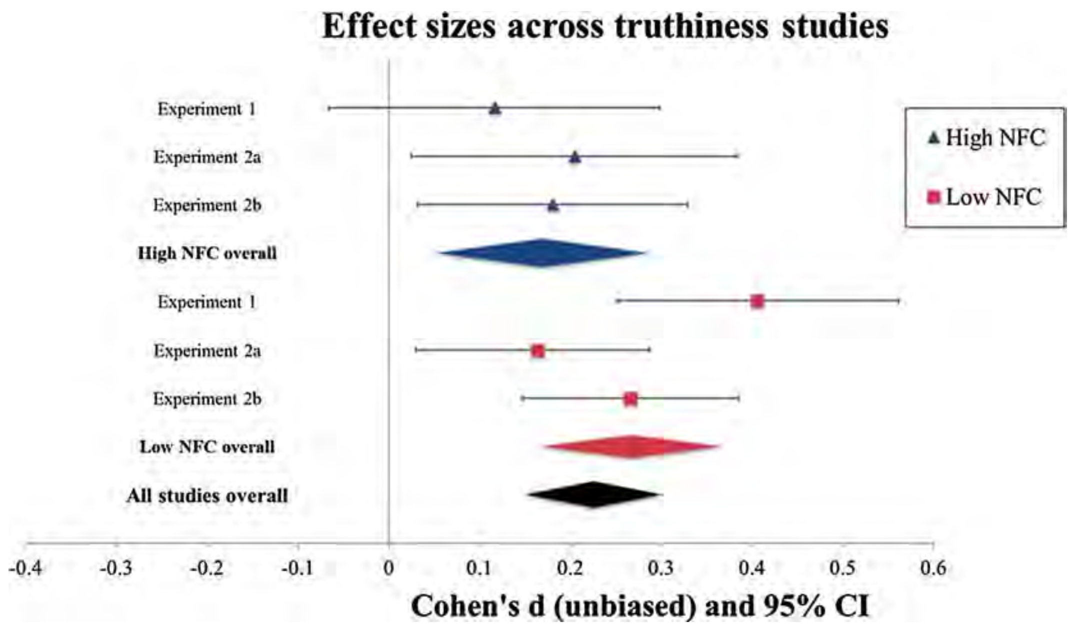


Fig. 4. Effect sizes (*d* unbiased) for the truthiness effect for high and low NFC across all experiments.

5. Experiments 3: illusory truth

Turning from the influence of non-probative photos to the influence of repetition, Experiment 3 is a reanalysis of an existing dataset that allows us to explore the influence of NFC on the size of the illusory truth effect. Here we consider the possibility that thinking more about the content of a claim at time 1 (being high on NFC) may ironically, make the claim easier to process after a delay, potentially resulting in an increased illusory truth effect. We examine the influence of NFC on illusory truth by reanalyzing a previously reported experiment (Jalbert, Newman, & Schwarz, 2019, Experiment 1) with NFC as a continuous variable. NFC was not part of the original report, which focused on the effect of warnings.

Next, we summarize the methods of Jalbert, Newman, & Schwarz, 2019, Exp. 1) and describe the inclusion of NFC as a factor in our analysis of susceptibility to the illusory truth effect. We focus on methodological details and procedures that are most relevant for the present analysis. For a full report please see Jalbert, Newman, & Schwarz, 2019, Exp. 1).

5.1. Method

5.1.1. Participants

We exclude one participant included in the original Jalbert, Newman, & Schwarz, 2019 report in our analysis because they did not complete the full NFC scale.

Overall, 219 participants (58 male; M_{age} = 20.51, SD = 2.64, one not reporting) completed both parts of the experiment: 54 in the first wave of data collection and 165 in the second wave. As described in Jalbert, Newman, & Schwarz, 2019, we collapsed our analysis across the two waves. There were 112 participants in the no warning condition and 107 participants in the pre-exposure warning condition.

5.1.2. Materials

Ambiguous true and false trivia claims were selected on a variety of topics (sports, geography, food, animals, and science) from a larger set of previously normed claims (Jalbert, Newman, & Schwarz, 2019). During the initial exposure phase, participants were presented with 36 of these trivia claims. Half of the trivia claims were true and half were false. In the final test phase, participants saw these same 36 claims as well as 36 new claims (also half true and half false), for a total of 72 claims. In each session, claims were presented in a random order for five seconds each.

The trivia claims were counterbalanced such that half of the participants saw one set of 36 claims repeated, and half of the participants saw the other set of 36 claims repeated.

5.1.3. Procedure

When participants signed up for the study, they agreed to complete both parts of a two-part online survey. In part 1 of the study, the exposure phase, participants simply read 36 trivia claims. In the pre-exposure warning condition, participants received the warning "half the statements are true and half the statements are false" prior to reading the claims. In the no warning condition, participants did not receive any warning. We included a few general questions at the end of part 1 to provide a rationale for presenting the claims, including “How many statements do you think you read?” and “How many minutes do you think it took you to read the statements?”

After a three day delay, participants received a link to part 2 of the survey and were given 48 hours to complete it. In part 2 of the experiment, the test phase, participants were shown another series of trivia claims. All participants were correctly told that half of the statements were ones that they had seen before and half of the statements were new. None of the participants were told anything about the truth of the claims. For each claim, all participants answered the question “Is this statement true or false?” on an unnumbered six-point scale from “definitively true” (coded as 6) to “definitely false” (coded as 1).

5.1.3.1. Individual differences. Following the truth ratings in part 2, participants completed the 18-item NFC scale. In the second wave of data collection, this NFC scale was followed with a few additional individual difference measures for exploratory purposes. As described earlier, NFC was always collected in position 1 and the primary individual difference measure.

5.1.3.2. Demographics. Finally, participants answered demographic questions, including gender and age.

5.2. Results and discussion

As reported by Jalbert, Newman, & Schwarz, 2019, people rated repeated claims as more true than new claims, and this pattern was most pronounced in the no warning condition. Of interest is whether high NFC participants show a larger illusory truth effect, or whether being high on NFC protects people from this bias. Participants' mean NFC score (Cronbach's $\alpha = 0.891$) was $M = 7.97$, $SD = 11.87$. As shown in Fig. 5, our reanalysis reveals that being high on NFC led to a larger illusory truth effect.

5.2.1. Statistical design

We reanalyzed these data using the full design from Jalbert, Newman, & Schwarz, 2019. Thus the design was a 2 (Warning: warning, no warning) × 2 (Claim type: repeated, new) mixed model design and including NFC analyzed both as a continuous between-subjects variable, and, in a separate analysis, as a categoricalbetween-subjects variable (NFC: high, low).

5.2.2. Illusory truth effect and NFC

Our reanalysis with NFC as the added individual difference variable showed a main effect of NFC on truth judgements, with increasing NFC associated with an increase in truth ratings, F (1, 215) = 11.95, p = .001, partial $eta^2 = 0.05$. There was also a significant interaction of NFC and repetition, F (1, 215) = 4.31, p = .039, partial $eta^2 = 0.02$. When we conducted a further spotlight analysis to examine the interaction, we found that the size of truth effect one SD above the mean of NFC was, F (1, 215) = 130.57, $p < .001$, partial $eta^2 = 0.38$, raw mean difference = 0.68, 95% CI [0.57, 0.80], and one SD below the mean was, F (1, 215) = 71.97, $p < .001$, partial $eta^2 = 0.25$, raw mean difference = 0.51, 95% CI [0.39, 0.63].

There was no significant interaction of warning and NFC, F (1, 215) = 0.17, p = .684, partial $eta^2 < 0.01$, nor a significant three way interaction of warning, NFC, and repetition, F (1, 215) = 1.47, p = .226, partial $eta^2 = 0.01$.[7]

We once again replicated these analyses using a categorical median split NFC classification. We found the same significant pattern of results, although now a significant three-way interaction between warning, NFC, and repetition emerged.[8]

Taken together, our reanalysis of Experiment 3 of Jalbert, Newman, & Schwarz, 2019 suggests that susceptibility to the illusory truth effect does indeed vary across individuals; being high on NFC ironically makes people more vulnerable to this cognitive bias. This is consistent with the assumption that being high on NFC elicits more elaborative processing at time 1, which increases the fluency with which previously seen claims can be processed at time 2. In Experiment 4, we aim to replicate these findings.

[7] We also further investigated whether the influence of NFC on the size of the truth effect held up in each warning condition when analyzed separately. Thus, we conducted a 2 (Claim type: repeated, new) mixed model analyses adding NFC as a continuous variable in each warning condition alone. In the no warning condition, a significant interaction remained, F (1, 110) = 4.32, p = .040, partial $eta^2 = 0.04$. However, the influence of NFC on the truth effect did not hold up in the warning condition alone, F (1, 105) = 0.50, p = .481, partial $eta^2 = 0.01$. This indicates that NFC has a more robust influence with no warning, mirroring our analysis with NFC as a categorical variable and results of our mini-meta analysis.

[8] In order to examine the effects of high and low levels of NFC, we split our participants into “high” and “low” NFC groups, using a median split approach. A total of 10 participants had NFC scale scores exactly the same as the median (Mdn = 7) and so were not included in the following analysis. We performed a 2 (Warning: warning, no warning) × 2 (NFC: high, low) × 2 (Claim type: repeated, new) mixed model ANOVA. Replicating Jalbert et al. (2019), there were significant main effects of warning and claim type, with a significant interaction such that with a larger truth effect emerged in the no warning condition than in the warning condition. Additionally, there was a main effect of NFC, F (1, 205) = 8.69, p = .004, partial $eta^2 = 0.04$, with high NFC participants rating claims more true than low NFC participants. However, these effects were modified by a three way interaction of warning, NFC, and repetition, F (1, 204) = 4.78, p = .030, partial $eta^2 = 0.02$. We followed up this three way interaction with simple effects analysis corrected for multiple comparisons with a Bonferroni correction. As shown in Fig. 5, there was the expected effect of NFC on the truth effect in the no warning condition, with high NFC participants showing a larger truth effect, mean difference between repeated and new claims = 1.04, 95% CI [0.87, 1.203] than for low NFC participants, mean difference between repeated and new claims = 0.614, 95% CI [0.45, 0.78]. This was driven by ratings of repeated claims: However, when given a warning, there was no difference in the size of the truth effect between low and high NFC participants, However, when given a warning, the two were not different, high NFC mean difference = 0.394, 95% CI [0.230, 0.558]), low NFC mean difference = 0.346, 95% CI [0.170, 0.521].

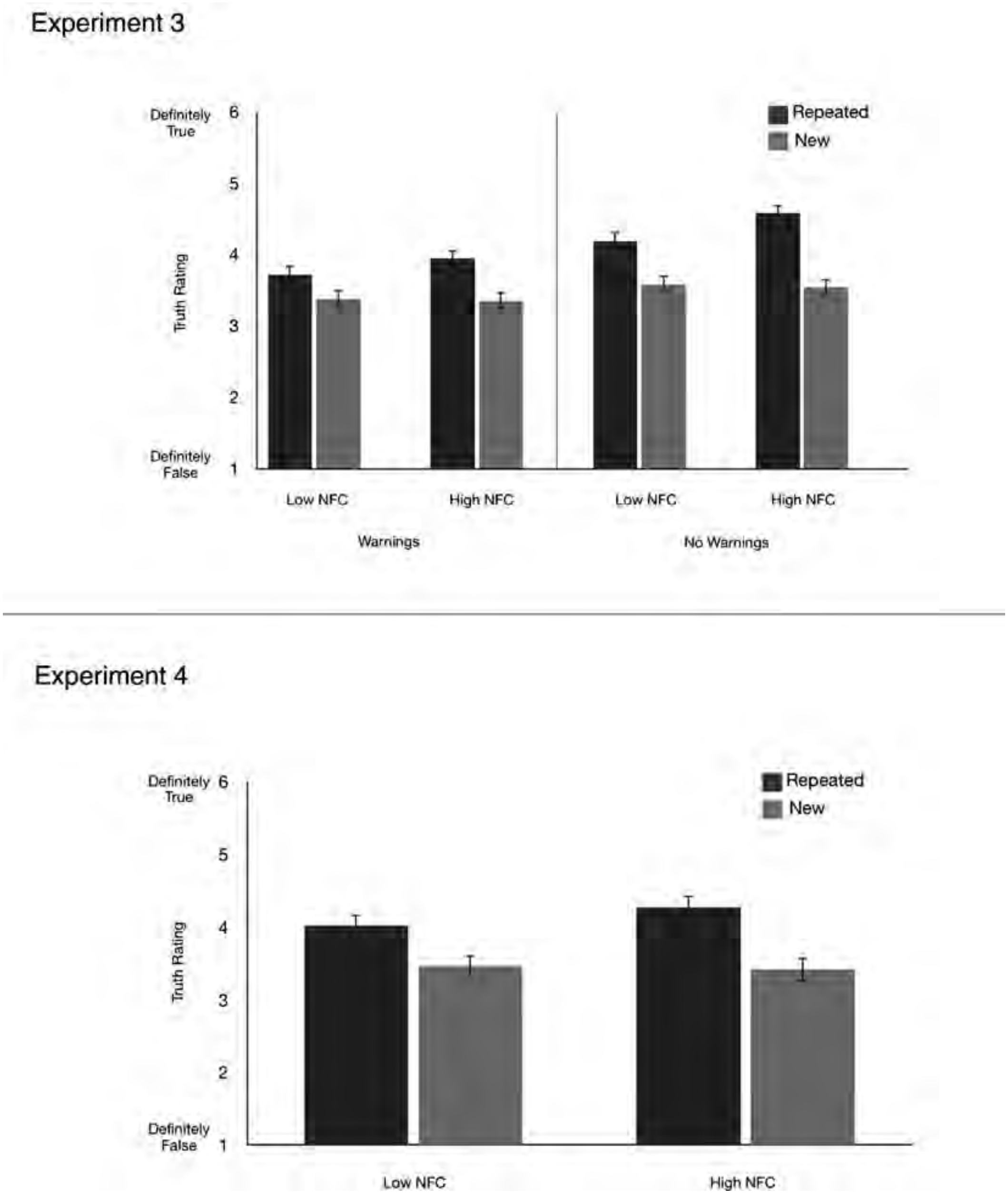


Fig. 5. Truth ratings by whether people were "High" or "Low" on Need for Cognition (median split) and whether claims were repeated or new across Experiments 3a, 3b and 4. Error bars represent 95% within-subjects confidence intervals (Masson & Loftus, 2003).

6. Experiment 4: illusory truth

6.1. Method

6.1.1. Participants

Students from the University of Southern California psychology participant pool completed the study for course credit. Jalbert, Newman, & Schwarz, 2019 attempted to recruit up to 100 participants. Replicating Jalbert, Newman, & Schwarz, 2019, we included all participants who had completed both parts of the study, except for two participants who did not complete part two within the 48 h window after the email invitation. One additional participant was excluded because they completed part 1 twice prior to part 2. Overall, 89 participants (28 male; M_{age} = 20.52, SD = 2.07, one not reporting) completed both parts of the experiment and were included in the analysis.

6.1.2. Design

The design was a 2 (Claim type: repeated, new) condition repeated measures design with NFC analyzed as a continuous between-subjects variable, and, in a separate analysis, as a categorical between-subjects variable (NFC: high, low). We also had a between-subjects variable, cultural fluency (high or low) intended to prime careful processing under conditions of low cultural fluency, but this manipulation had no effect on susceptibility to the illusory truth effect and did not interact with other variables, so we collapsed across this factor in our subsequent analyses.[9]

6.1.3. Materials and procedure

The materials and procedure were an exact replication of the no-warning condition of Experiment 3 with two exceptions: First, at the end of the test phase (time 2), a 12 item Faith in Intuition scale was added to the NFC scale. Second, the order of these scales were randomized. No additional individual difference measures were assessed.

6.2. Results and discussion

As in Experiment 3, we calculated the mean truth rating for repeated and new claims and then calculated a NFC score for each participant (Cronbach's $\alpha = 0.858$; $M = 6.45$, $SD = 10.74$). As Fig. 5 shows, we replicated the key patterns from Experiment 3: people were more likely to believe claims that were repeated, and this pattern appeared to be more pronounced for high NFC participants. However, the moderating effect of NFC did not reach significance.

6.2.1. Illusory truth effect and NFC

In a 2 (Claim type: repeated, new) mixed model ANOVA with NFC as a continuous variable, we once again replicated the classic illusory truth effect, $F(1, 87) = 59.95$, $p < .001$, partial $eta^2 = 0.41$, with repeated claims rated more true ($M = 4.18$, $SD = 0.66$) than new claims ($M = 3.44$, $SD = 0.39$). Unlike Experiment 3, there was no main effect of NFC on truth ratings, $F(1, 87) = 0.43$, $p = .513$, partial $eta^2 = 0.01$, and the interaction of NFC and repetition did not reach significance, $F(1, 87) = 0.97$, $p = .327$, partial $eta^2 = 0.01$. We replicated these analyses using a categorical median split NFC classification. The pattern of results was identical, although the interaction of NFC and repetition observed in Experiment 3 was $F(1, 82) = 3.76$, $p = .056$, partial $eta^2 = .04$.[10]

7. Illusory truth effect size analysis

We conducted a mini meta-analysis of Experiments 3 and 4 to more precisely estimate the influence of NFC on the illusory truth effect. Fig. 6 shows a forest plot of all effect size estimates for high and low NFC across the two experiments reported here, by the presence of warnings and collapsed across other between-subjects conditions. We conducted this analysis using the same protocol as described for the meta-analysis of truthiness effects. The total illusory truth effect across all conditions was $d = 1.09$, 95% CI [0.71, 1.47]. The illusory truth effect for participants with high NFC was, $d = 1.40$, 95% CI [0.84, 1.95] and for participants with low NFC, $d = 0.82$, 95% CI [0.30, 1.34], but this difference did not reach significance in the overall analysis, $Q(1) = 2.25$, $p = .134$, $d = 0.58$, 95% CI [−0.18, 1.32].

In an additional analysis we considered the possibility that warnings may mitigate effects of high NFC. Indeed, being warned prior to exposure may reduce the reliance on positive hypothesis testing, leading high NFC participants to elaborate on both the possibility that claims are true and the alternative, that they may indeed be false. To this end, we conducted separate analyses for the warning and no warning conditions to examine under what conditions the influence of NFC was most pronounced. In the warning condition, high NFC participants had an illusory truth effect of $d = 0.74$, 95% CI [0.45, 1.02], compared to low NFC participants, $d = 0.63$, 95% CI [0.29, 0.96], but this difference did not reach significance, $Q(1) = 0.25$, $p = .619$, $d = 0.11$, 95% CI [−0.33, 0.56]. In contrast, in

[9] A cultural fluency manipulation (adapted from Lin, 2019, Experiment 4) was implemented prior to the initial exposure phase. The purpose of this manipulation was to put people in a state of cultural disfluency, which should alert them to pay attention to their environment, or cultural fluency, where they would assume all was right with the world (Oyserman, 2011). Theoretically, the culturally fluent condition would be analogous to being exposed to claims in a familiar environment, while the disfluent condition would be analogous to being exposed to information in an unfamiliar environment. For this purpose, participants were shown photos of a wedding that were either consistent with cultural expectations (e.g., a bride in a white wedding dress, a white wedding cake) or inconsistent with cultural expectations (e.g., a bride in a black wedding dress, a black wedding cake) and asked to rate the quality of each photo (1 = extremely poor quality, 7 = extremely good quality).A 2 (Claim type: repeated, new) × 2 (Cultural fluency manipulation: fluent photos, disfluent photos) mixed model ANOVA with NFC as a continuous variable and cultural fluency as a between-participants factor showed no influence of cultural fluency, with the main effect of cultural fluency and all interactions having $Fs < 0.841$ and $ps > 0.361$. The same results were found when NFC included in this same analysis as a categorical, rather than continuous, variable, with the main effect of cultural fluency and all interactions having $Fs < 0.471$ and $ps > 0.494$.

[10] A total of 5 participants had NFC scale scores exactly the same as the median ($Mdn = 7$), and so were not included in the following analysis. We performed a 2 (NFC: high, low) × 2 (Claim type: repeated, new) mixed model ANOVA. There was a significant illusory truth effect, $F(1, 82) = 84.33$, $p < .001$, partial $eta^2 = 0.51$, with repeated claims rated more true than new statements. As shown on Fig. 5, the interaction of NFC and repetition was, $F(1, 82) = 3.76$, $p = .056$, partial $eta^2 = 0.04$, with high NFC participants showing a truth effect, $F(1, 82) = 59.04$, $p < .001$, partial $eta^2 = 0.42$ (raw mean difference = 0.86, 95% CI [0.64, 1.09]), than low NFC participants showing a truth effect, $F(1, 82) = 27.55$, $p < .001$, partial $eta^2 = 0.25$ (raw mean difference = 0.56, $p < .001$, 95% CI [0.35, 0.78]). There was no main effect of NFC, $F(1, 82) = 1.29$, $p = .260$, partial $eta^2 = 0.02$.

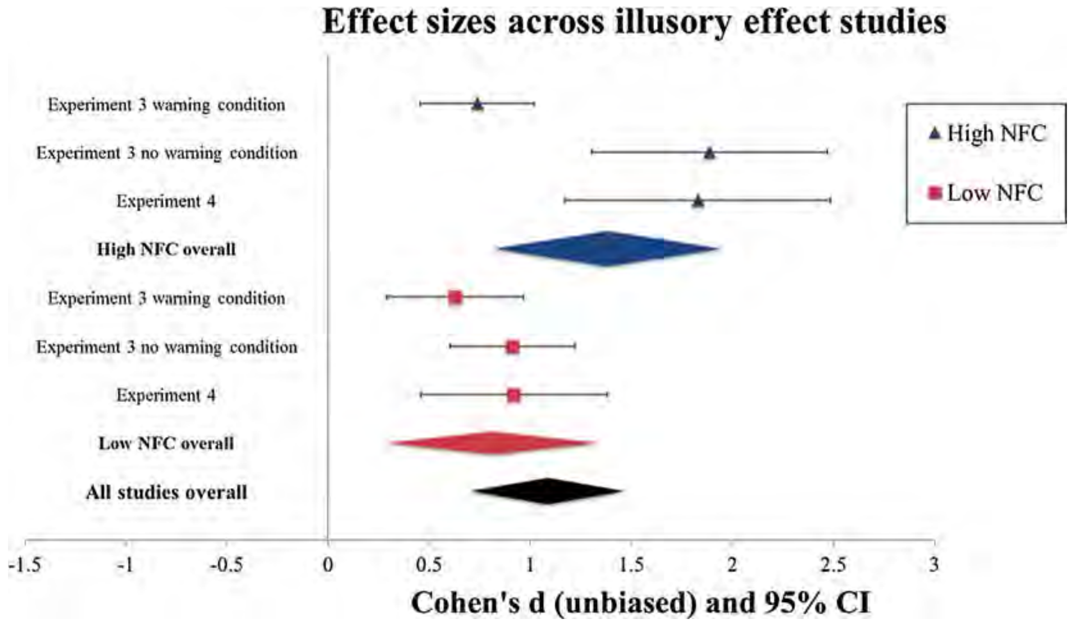


Fig. 6. Effect sizes (*d* unbiased) for the illusory truth effect for high and low NFC across all experiments.

the no warning condition, high NFC participants had a significantly larger illusory truth effect, $d = 1.86$, 95% CI [1.43, 2.30], compared to low NFC participants, $d = 0.91$, 95% CI [0.66, 1.17], $Q(1) = 13.55$, $p < .001$, $d = 0.95$, 95% CI [0.44, 1.45]. Taken together, these data suggest that there is little evidence that NFC moderates the illusory truth effect with standard experimental instructions. However without a warning that one may encounter false information, NFC did indeed moderate the illusory truth effect. These results are of course preliminary and further investigation into the conditions by which NFC may moderate illusory truth is warranted, given the effect of NFC without warnings.

8. General discussion

Across five experiments, we replicated the basic truthiness and illusory truth effects. The influence of NFC—individual differences in people's disposition to enjoy effortful thinking and to spontaneously engage in it, as captured by Cacioppo and Petty (1982) Need for Cognition scale—was less clear. While there was little evidence of any robust moderating effect of NFC on truthiness, there was some evidence that NFC may moderate illusory truth when no experimental warnings are present. While this is the first study to consider the role of individual differences in the truthiness paradigm, the small literature on individual differences in illusory truth squares with our findings. Indeed, the few published studies on individual differences and truth show that the illusory truth effect is robust to variations in age, cognitive ability, need for closure, and critical thinking styles (Brashier et al., 2017; Dekeersmaecker et al., 2019). Dechene and colleagues called for an individual differences approach to illusory truth in their meta-analysis published in 2010. Since then, very little research has addressed this question about individual variation in susceptibility to illusory truth. Dekeersmaecker et al. (2019) highlight the possibility that the lack of published research may be due to a bias against publishing null findings in this area. Our findings on Need for Cognition further add to this emerging literature and suggest several avenues for future research, including a shift towards understanding conditions under which individual differences may emerge.

7.1. Need for Cognition

Overarching patterns often did not reach statistical significance—for truthiness or illusory truth in the individual experiments or in the mini *meta*-analyses (see Amrhein, Greenland, & McShane, 2019). But as noted above, one more reliable pattern did emerge, suggesting that being high on NFC may lead people to be more susceptible to illusory truth when no experimental warning is present. The patterns here are certainly preliminary but suggest an interesting possibility worthy of future research— a proclivity to think more extensively may not protect people from fluency-based biases of truth. Instead, any possible influence of NFC may depend on the specific paradigm and whether people are making immediate or delayed judgments of truth. Our findings highlight the need for more research in this area, but also suggest a more nuanced treatment of the conditions under which any influence of NFC or other individual differences may emerge.

7.2. Moderators and individual differences

To our knowledge, very few studies have considered possible moderators in individual differences on illusory truth and truthiness.

Brashier et al. (2017) examined the moderating role of claim difficulty in the emergence of age differences in susceptibility to illusory truth (see also, Parks & Toth, 2006). This moderator was critical in detecting effects of age on illusory truth; while they found no effects of age with difficult claims, older adults were less susceptible to the illusory truth effect for better known claims—perhaps due to better knowledge application at the time of test (Brashier et al., 2017). It is possible that any effect of NFC may also emerge more robustly for better known claims in both paradigms investigated here. High NFC individuals may be more likely to notice—via a more extensive search— that the photos are non-probative for better-known claims, warding off truthiness. Similarly, the influence of increased elaboration for high NFC may be greater for topics where they have more developed knowledge networks, leading to a larger illusory truth effect (e.g., Boehm, 1994).

Our own findings suggest another important moderator—incidental instructional warnings —that may reduce the possibility that individual differences are detected. We are only aware of one other paper that considered NFC and truth. In that study, instead of simply reading the statements at encoding, participants judged whether or not each statement was true, a kind of incidental warning that would alert participants that some claims are false in the first phase. Boehm (1994) observed no effect of NFC. This finding is consistent with our reanalysis of the warning condition of Jalbert et al.'s (2019, Experiment 1) data, which showed a less reliable effect of NFC than a condition without warning. In our experiments, the NFC effect emerged when people were *not* alerted to think about truth during the encoding phase, a critical methodological difference to the Boehm experiment (see Jalbert, Newman, & Schwarz, 2019, on the effect of instructional warnings). This is also a critical methodological difference to the Dekeersmaecker et al. (2019) studies, which detected no reliable effect of individual difference variables.

There are several reasons to suspect that this standard methodological feature may in fact reduce the possibility of detecting individual differences, at least in the context of NFC. Consistent with the persuasion literature, we assume that high NFC individuals think more about the claims at the time of initial exposure (Briñol & Petty, 2019; Cacioppo et al., 1996). This, in turn, makes the claims more familiar and easier to process when they are encountered again at time 2, especially in comparison to the novel claims presented at the same time (see Unkelbach & Rom, 2017). The claims presented in illusory truth experiments are usually ambiguous and testing their truth value is likely to involve positive hypothesis testing—e.g., do I know of any evidence that supports this claim? This positive testing is less likely when participants are warned that half of the claims are false, which may increase the likelihood of negative hypothesis testing, as observed under other conditions of induced distrust (Mayo, 2017; Mayo, Alfasi, & Schwarz, 2014). As a result, standard experimental warnings and other distrust eliciting variables at the time of initial exposure may curb the otherwise observed increase in illusory truth under high NFC, or in other contexts in which increased elaboration may lead to a larger effect. While preliminary, this finding suggests that understanding individual differences in these truth biases requires attention to context and other situational variables that may moderate any effect of individual difference measures. We explore some of those possibilities in the following section.

The persuasion literature identifies a number of moderators that influence the extent to which high and low NFC individuals differ in their evaluation of presented content. Some variables work to increase differences between high and low NFC on outcome measures. For example, people with high NFC are more convinced by strong, rather than weak arguments, a variable that is rarely manipulated in truth paradigms and may affect the extent to which high NFC individuals draw on positive, rather than negative, testing of truth (e.g., Cacioppo, Petty, & Morris, 1983). Other variables work to reduce differences between high and low NFC. For example, high uncertainty and high self-relevance are sufficient to motivate elaborative thinking even among low NFC individuals, which reduces differences between high and low NFC participants (Smith & Petty, 1996; Ziegler, Diehl, & Ruther, 2002). Conversely, those with high NCF behave more like low NFC participants when they are led to believe they are considering a message intended for those who typically do not engage in effortful thought (Wheeler, Petty, & Bizer, 2005; see also See, Petty, & Evans, 2009). Considering potential moderators across materials, instructions and context will enhance understanding of the role of individual differences, but also provide converging evidence for theory in these paradigms.

7.3. Fluency and truth

Of course it is possible that even after considering the role of potential moderators, very little variance in truthiness and illusory truth is explained by individual difference measures. The illusory truth effect is robust to a variety of conditions which typically attenuate experiential inputs: high knowledge, warnings, and source variations at the time of judgement reduce but do not reverse or eliminate the effect of repetition (Fazio, Brashier, Payne, & Marsh, 2015; Jalbert, Newman, & Schwarz, 2019; Unkelbach & Greifeneder, 2018). Less is known about the truthiness paradigm, but both truth biases are more robust under conditions that highlight relative fluency across items (Dechêne et al., 2009; Newman et al., 2015). When variation in fluency is apparent, it may be a particularly potent input in assessments of truth, in part because ease of processing serves as evidence for several truth-related criteria (e.g., Schwarz, 2015; Schwarz & Newman, 2017). Information that is easy to process is rated as more coherent, credible, compatible with our own general knowledge, more likely to have high social consensus, and better supported by evidence. (Schwarz, 2015; Schwarz & Newman, 2017; see also Unkelbach, Koch, Silva, & Garcia-Marques, 2019). While the present set of studies has focused on assessments of truth, an individual difference approach that considers these other related judgements, which share similar underlying mechanisms, may also inform theory regarding truth.

7.4. Summary

Beyond understanding the role of NFC, an individual difference perspective may be particularly informative in further estimating the magnitude and robustness of fluency effects in assessments of truth. The patterns reported here also point to a more nuanced approach in individual differences that considers the possible moderating role of variables such as delay, instructions, and experimental context—an approach that should further enhance our understanding of fluency-based truth biases.

CRediT authorship contribution statement

Eryn. J. Newman: Conceptualization, Methodology, Software, Data curation, Writing - original draft, Visualization, Formal analysis, Investigation, Supervision, Validation, Writing - review & editing. **Madeline C. Jalbert:** Conceptualization, Methodology, Software, Data curation, Writing - original draft, Visualization, Formal analysis, Investigation, Validation, Writing - review & editing. **Norbert Schwarz:** Conceptualization, Methodology, Writing - original draft, Supervision, Writing - review & editing. **Deva P. Ly:** Software, Data curation, Visualization, Formal analysis, Investigation, Writing - review & editing.

Acknowledgement

Preparation of this article was supported by the Linnie and Michael Katz Endowed Research Fellowship Fund through a fellowship to the second author.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.concog.2019.102866.

References

Abed, E., Fenn, E., & Pezdek, K. (2017). Photographs elevate truth judgments about less well-known people (but not yourself). *Journal of Applied Research in Memory and Cognition, 6*(2), 203–209.
Amrhein, V., Greenland, S., & McShane, B. (2019). March). Scientists rise up against statistical significance. Retrieved from *Nature, 567*, 305–307. https://www.nature.com/articles/d41586-019-00857-9https://doi.org/10.1038/d41586-019-00857-9.
Bacon, F. T. (1979). Credibility of repeated statements: Memory for trivia. *Journal of Experimental Psychology: Human Learning and Memory, 5*, 241–252. https://doi.org/10.1037/0278- 7393.5.3.241.
Begg, I. M., Anas, A., & Farinacci, S. (1992). Dissociation of processes in belief: Source recollection, statement familiarity, and the illusion of truth. *Journal of Experimental Psychology: General, 121*(4), 446.
Bernstein, D. M. (2005). Making sense of memory. *Canadian Journal of Experimental Psychology, 59*(3), 199.
Boehm, L. E. (1994). The validity effect: A search for mediating variables. *Personality and Social Psychology Bulletin, 20*(3), 285–293.
Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2009). *Introduction to meta-analysis.* West Sussex, England: John Wiley & Sons.
Bornstein, B. H. (2004). The impact of different types of expert scientific testimony on mock jurors' liability verdicts. *Psychology, Crime & Law, 10*(4), 429–446.
Brashier, N. M., Umanath, S., Cabeza, R., & Marsh, E. J. (2017). Competing cues: Older adults rely on knowledge in the face of fluency. *Psychology and Aging, 32*(4), 331.
Briñol, P., & Petty, R. E. (2019). The impact of individual differences on attitudes and attitude change. In D. Albarracin, & B. T. Johnson (Vol. Eds.), *The handbook of attitudes: Vol. 1*, (pp. 520–556). New York: Routledge.
Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of Personality and Social Psychology, 42*(1), 116.
Cacioppo, J. T., Petty, R. E., Feinstein, J., & Jarvis, W. B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin, 119*, 197–253.
Cacioppo, J. T., Petty, R. E., & Feng Kao, C. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment, 48*(3), 306–307.
Cacioppo, J. T., Petty, R. E., & Morris, K. J. (1983). Effects of need for cognition on message evaluation, recall, and persuasion. *Journal of Personality and Social Psychology, 45*(4), 805.
Cardwell, B. A., Henkel, L. A., Garry, M., Newman, E. J., & Foster, J. L. (2016). Nonprobative photos rapidly lead people to believe claims about their own (and other people's) pasts. *Memory & Cognition, 44*, 883–896.
Cardwell, B. A., Newman, E. J., Garry, M., Mantonakis, A., & Beckett, R. (2017). Photos that increase feelings of learning promote positive evaluations. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 43*(6), 944.
Cho, H., & Schwarz, N. (2006). *If I don't understand it, it must be new: Processing fluency and perceived product innovativeness.* ACR North American Advances.
Dechêne, A., Stahl, C., Hansen, J., & Wänke, M. (2009). Mix me a list: Context moderates the truth effect and the mere-exposure effect. *Journal of Experimental Social Psychology, 45*(5), 1117–1122.
Dechêne, A., Stahl, C., Hansen, J., & Wänke, M. (2010). The truth about the truth: A meta-analytic review of the truth effect. *Personality and Social Psychology Review, 14*, 238–257.
Dekeersmaecker, J., Dunning, D., Pennycook, G., Rand, D. G., Sanchez, C., Unkelbach, C., & Roets, A. (2019). Investigating the robustness of the illusory truth effect across individual differences in cognitive ability, need for cognitive closure, and cognitive style. *Personality and Social Psychology Bulletin*.
Fazio, L. K., Brashier, N. M., Payne, B. K., & Marsh, E. J. (2015). Knowledge does not protect against illusory truth. *Journal of Experimental Psychology: General, 144*, 993–1002.
Fenn, E., Newman, E. J., Pezdek, K., & Garry, M. (2013). The effect of nonprobative photographs on truthiness persists over time. *Acta Psychologica, 144*(1), 207–211.
Garcia-Marques, T., Silva, R. R., & Mello, J. (2016). Judging the truth-value of a statement in and out of a deep processing context. *Social Cognition, 34*(1), 40–54.
Graham, L. M. (2007). Need for cognition and false memory in the Deese–Roediger–McDermott paradigm. *Personality and Individual Differences, 42*(3), 409–418.
Greifeneder, R., Bless, H., & Pham, M. T. (2011). When do people rely on affective and cognitive feelings in judgment? A review. *Personality and Social Psychology Review, 15*(2), 107–141.
Greifeneder, R., & Schwarz, N. (2014). *Metacognitive processes and subjective experiences.* New York: Guilford Press314–327.
Hansen, J., & Wanke, M. (2010). Truth from language and truth from fit: The impact of linguistic concreteness and level of construal on subjective truth. *Personality and Social Psychology Bulletin, 36*, 1576–1588. https://doi.org/10.1177/0146167210386238.
Hasher, L., Goldstein, D., & Toppino, T. (1977). Frequency and the conference of referential validity. *Journal of Verbal Learning and Verbal Behavior, 16*, 107–112.
Jalbert, M., Newman, E. J., & Schwarz, N. (2019). Only half of what I'll tell you is true: How experimental procedures lead to an underestimation of the truth effect. Working paper, USC Mind & Society Center.
Jalbert, M., Newman, E., & Schwarz, N. (2019). Trivia claim norming: Methods report and data. *ResearchGate*. https://doi.org/10.6084/m9.figshare.9975602.
Kelley, C. M., & Lindsay, D. S. (1993). Remembering mistaken for knowing: Ease of retrieval as a basis for confidence in answers to general knowledge questions. *Journal of Memory and Language, 32*, 1–24. https://doi.org/10.1006/jmla.1993.1001.
LaTour, K. A., LaTour, M. S., & Brainerd, C. (2014). Fuzzy trace theory and "smart" false memories: Implications for advertising. *Journal of Advertising, 43*(1), 3–17.

Leding, J. K. (2011). Need for cognition and false recall. *Personality and Individual Differences, 51*(1), 68–72.
Lin, Arieli, & Oyserman (2018). Cultural fluency means all is okay, cultural disfluency implies otherwise. Unpublished manuscript.
Masson, M.E., Loftus, G.R., 2003. Using confidence intervals for graphically based data interpretation. Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale 57(3), 203. Chicago.
Mayo, R. (2017). Cognition is a matter of trust: Distrust tunes cognitive processes. *European review of social psychology: Vol. 26*, (pp. 283–327). Routledge.
Mayo, R., Alfasi, D., & Schwarz, N. (2014). Distrust and the positive test heuristic: Dispositional and situated social distrust improves performance on the Wason Rule Discovery Task. *Journal of Experimental Psychology: General, 143*(3), 985.
McAuliff, B. D., & Kovera, M. B. (2008). Juror need for cognition and sensitivity to methodological flaws in expert evidence 1. *Journal of Applied Social Psychology, 38*(2), 385–408.
Nadarevic, L., & Aßfalg, A. (2017). Unveiling the truth: Warnings reduce the repetition-based truth effect. *Psychological Research Psychologische Forschung, 81*(4), 814–826.
Nelson, T. O., & Narens, L. (1980). Norms of 300 general-information questions: Accuracy of recall, latency of recall, and feeling-of-knowing ratings. *Journal of Verbal Learning & Verbal Behavior, 19*, 338–368. https://doi.org/10.1016/S0022-5371(80)90266-2.
Newman, E. J & Zhang, L. (in press). Truthiness: How non-probative photos shape belief. In R. Greifeneder, M. Jaffé, E. J. Newman, & N. Schwarz (Eds.). The psychology of fake news: Accepting, sharing, and correcting misinformation. London, UK: Routledge.
Newman, E. J., Azad, T., Lindsay, D. S., & Garry, M. (2018). Evidence that photos promote rosiness for claims about the future. *Memory & Cognition, 46*(8), 1223–1233.
Newman, E. J., Garry, M., Bernstein, D. M., Kantner, J., & Lindsay, D. S. (2012). Nonprobative photos (or words) promote truthiness. *Psychonomic Bulletin & Review, 19*, 969–974. https://doi.org/10.3758/s13423-012-0292-0.
Newman, E. J., Garry, M., Unkelbach, C., Bernstein, D. M., Lindsay, D. S., & Nash, R. A. (2015). Truthiness and falsiness of trivia claims depend on judgmental contexts. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41*, 1337–1348. https://doi.org/10.1037/xlm0000099.
Oyserman, D. (2011). Culture as situated cognition: Cultural mindsets, cultural fluency, and meaning making. *European Review of Social Psychology, 22*(1), 164–214.
Parks, C. M., & Toth, J. P. (2006). Fluency, familiarity, aging, and the illusion of truth. *Aging, Neuropsychology, and Cognition, 13*(2), 225–253.
Petty, R. E., DeMarree, K. G., Briñol, P., Horcajo, J., & Strathman, A. J. (2008). Need for cognition can magnify or attenuate priming effects in social judgment. *Personality and Social Psychology Bulletin, 34*(7), 900–912.
Reber, R., & Schwarz, N. (1999). Effects of perceptual fluency on judgments of truth. *Consciousness and Cognition, 8*, 338–342.
Reinhard, M. A. (2010). Need for cognition and the process of lie detection. *Journal of Experimental Social Psychology, 46*(6), 961–971.
Schwarz, N. (2015). Metacognition. In E. Borgida, & J. A. Bargh (Eds.). *APA handbook of personality and social psychology: Attitudes and social cognition*. Washington, DC: APA.
Schwarz, N., & Jalbert, M. (in press). When (fake) news feels true: Intuitions of truth and the acceptance and correction of misinformation. In R. Greifeneder, M. Jaffé, E. J. Newman, & N. Schwarz (Eds.). The psychology of fake news: Accepting, sharing, and correcting misinformation. London, UK: Routledge.
Schwarz, N., & Newman, E. J. (2017). *Psychological Science Agenda| August 2017*. Chicago: Psychological Science.
See, Y. H. M., Petty, R. E., & Evans, L. M. (2009). The impact of perceived message complexity and need for cognition on information processing and attitudes. *Journal of Research in Personality, 43*, 880–889.
Smith, S. M., & Petty, R. E. (1996). Message framing and persuasion: A message processing analysis. *Personality and Social Psychology Bulletin, 22*(3), 257–268.
Stanislaw, H., & Todorov, N. (1999). Calculation of signal detection theory measures. *Behavior Research Methods, Instruments, & Computers, 31*(1), 137–149.
Unkelbach, C. (2007). Reversing the truth effect: Learning the interpretation of processing fluency in judgments of truth. *Psychological Science, 20*, 135–138. https://doi.org/10.1037/0278- 7393.33.1.219.
Unkelbach, C., & Greifeneder, R. (2018). Experiential fluency and declarative advice jointly inform judgments of truth. *Journal of Experimental Social Psychology, 79*, 78–86.
Unkelbach, C., & Rom, S. C. (2017). A referential theory of the repetition-induced truth effect. *Cognition, 160*, 110–126.
Unkelbach, C., Koch, A., Silva, R. R., & Garcia-Marques, T. (2019). Truth by Repetition: Explanations and Implications. *Current Directions in Psychological Science, 28*(3), 247–253.
Wegener, D. T., Clark, J. K., & Petty, R. E. (2019). Cognitive and metacognitive processes in attitude formation and change. In D. Albarracin, & B. T. Johnson (Vol. Eds.), *The handbook of attitudes: Vol. 1*, (pp. 291–331). New York: Routledge.
Wegener, D. T., & Petty, R. E. (1997). The flexible correction model: The role of naive theories of bias in bias correction. In M. P. Zanna (Vol. Ed.), *Advances in experimental social psychology: Vol. 29*, (pp. 141–208). San Diego: Academic Press.
Wheeler, S. C., Petty, R. E., & Bizer, G. Y. (2005). Self-schema matching and attitude change: Situational and dispositional determinants of message elaboration. *Journal of Consumer Research, 31*(4), 787–797.
Whittlesea, B. W. A. (1993). Illusions of familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 1235–1253. https://doi.org/10.1037/0278-7393.19.6.1235.
Wootan, S. S., & Leding, J. K. (2015). Need for cognition and false memory: Can one's natural processing style be manipulated by external factors? *The American Journal of Psychology, 128*(4), 459–468.
Ziegler, R., Diehl, M., & Ruther, A. (2002). Multiple source characteristics and persuasion: Source inconsistency as a determinant of message scrutiny. *Personality and Social Psychology Bulletin, 28*(4), 496–508.

MNRD Non-Local Beings Report

Attachment 10

Assessing Potential Non-Economic Loss & Damage from Climate Change

Partnership with the Bad River Band of the Lake Superior Chippewa Indians

January 2018


Attachment 10 to MNRD Non-Local Beings Report

Acknowledgements

Chi miigwech to the Bad River Tribal Council, interview participants, and especially Edith Leoso and Devon Brock-Montgomery at the Bad River Natural Resources Department.

This research was funded by the Dow Sustainability Fellows Program, the Dow Distinguished Seed Award, and a University of Michigan School of Information (UMSI) Community Engagement Grant. Thanks to faculty advisor Dr. Stuart Kirsch (University of Michigan Department of Anthropology) and Olivia Serdeczny (Climate Analytics) for advice and support.

Research Team Members

Stephanie Dooper, School of Education
Katie Proudman, School of Social Work
Adam Osielski, School of Law
Sarah Swanz, School of Information
Ansha Zaman, School of Environment and Sustainability

Graduate Students at the University of Michigan, Ann Arbor

Table of Contents

Executive Summary

Purpose and Methodology

Under the United Nations Framework Convention on Climate Change (UNFCCC), *non-economic loss and damage* (NELD) has emerged as a new concept to capture the full extent of

meaning. Factors such as loss of cultural heritage and loss of identity are not always addressed in planning documents, and yet their potential loss can make a permanent impact on the well-being of a community.

This study examines potential non-economic loss and damage from changes to the environment affecting the Bad River Band of the Lake Superior Tribe of Chippewa Indians, a Native American community in northern Wisconsin.
within the community and is intended to inform the community's climate action planning. The assessment also adds to the international policy-making discourse surrounding NELD.

We conducted 20 semi-structured ethnographic interviews of a cross-section of tribal members in order to assess participants' overall connection to the environment, their involvement in traditional practices, and the impact of potential cultural loss due to climate change.

Findings

- *Cultural Importance of Selected Species*: Participants described the cultural value of resources such as wild rice, walleye, maple and birch trees, medicinal plants, and deer, and how these resources play a role in building community, passing on traditions, as well as connecting to the land and their Native ancestry.
- *Relationship to the Environment*: Many tribal members were keenly aware of the interconnectedness of species and the importance of protecting every species from harm. The community's relationship to the environment is grounded in values of reciprocity and commitment to stewardship. Treaty rights play an important role in reinforcing this connection.
- *Potential Impacts of Adverse Environmental Events*: With reduced availability of ceremonial natural resources, tribal members may be unable to carry on cultural traditions. Loss of existing food resources may accelerate the substitution of traditional foods with store-bought foods and lead to added physical health risks. Loss of traditional lifestyles also has mental health implications.
- *Adaptation and Resilience*: Participants revealed a willingness to modify behavior (such as travelling to the ceded territories or substituting species) in order to continue valued practices. Others spoke instead of the ability to effect change through collective action (e.g., organized advocacy). The responses to the threat of environmental change were

Implications for Bad River Band

- monitoring plans can help account for the risks to cultural heritage from climate change. The material is particularly useful in communicating to non-tribal members (e.g., collaborators such as federal and state agencies) the incommensurable value of these natural resources.
- Aside from accounting for climate change risk to cultural practices, the collected narratives can help determine climate change adaptation and mitigation approaches in accordance with how the community values the resource. To make this determination, it is important to ascertain whether it is the species or the practice that is more important to the community.
- The study also highlights tribal strengths in its rich oral tradition and its history of resilience in the face of forced assimilation and ongoing discrimination.

Implications for Future NELD Research

- Aside from environmental stressors, marginalized communities face issues of social inequality. As in the case of the Bad River Band, socio-economic challenges are entangled with environmental challenges. They play a role in determining the community's response to climate change. To understand the impact of NELD, researchers must take a holistic view of the community and not study environmental impacts in isolation.
- Different cultures have different rules about sharing traditional knowledge with outsiders. NELD researchers from outside the community must be sensitive to this dynamic.
- Community natural resource management practices may not align with different management practices in use by state and federal governments. NELD researchers must recognize such different management practices in order to effectively account for ongoing community efforts to avoid potential losses.
- This study relied on qualitative data and collaborative research methods. Such research requires adequate time and patience to gain consent and build trust with the community.

  time investment and partnership building.

“These people wanted to get into an argument about how much the crop was worth in dollars and cents, and I said that’s not even a legitimate question. Because it concerns a lot more: our culture, our lifestyle, our spirituality. So, it’s priceless. We can’t put a price on it. We won’t. It’s not for sale.”

Introduction

Most climate change research focuses on measuring potential economic loss from changes in the environment. There is growing recognition in the international community that economic assessments do not capture the full extent of potential loss or damage from climate change and other environmental stressors. The concept of *non-economic loss and damage* includes adverse health impacts, reduction in biodiversity, loss of indigenous knowledge, cultural heritage, loss of identity or sense of place resulting from the destruction of culturally important landscapes or built sites. These factors are not effectively addressed in national or international policy frameworks, although researchers and policy-makers have begun to evaluate their importance.

We set out to learn about potential non-economic loss and damage that may be experienced by members of the Bad River Band of Lake Superior Chippewa, a Native American community in northern Wisconsin. This paper reports on our research, cataloging certain natural resources of particular cultural importance to the Bad River Band and describing the implications of our research for both the Bad River Band and future researchers of non-economic loss and damage.

Background

What is Non-Economic Loss and Damage (NELD)?

In the face of environmental stressors and climate change, there can be losses that are both material and non-material; some that can be assessed through economic valuations, and others that are harder to measure and quantify through market metrics. For instance, in the event of

the land due to relocation of the community cannot. If the crop and the arable land lost in the

s culture, lifestyle, spirituality, or sense of place, then attaching a monetary value can be meaningless or defeat the purpose (e.g., a friendship bought is not a friendship). These factors are not always addressed in planning documents, and yet their potential loss can make a permanent difference to the well-being of a community.

Under the United Nations Framework Convention on Climate Change (UNFCCC), *non-economic loss and damage* (NELD) has emerged as a new concept in the negotiations to address this issue.[1]

in monetary terms. These are irreplaceable resources that often hold a high symbolic value and are central to the social cohesion of a community. They are often left out of climate risk

[2] Even though they might be vital to those who suffer the losses, they can go unnoticed. Failure to measure and account

Accounting for these potential losses can re-prioritize the monitoring of natural resources and improve adaption and mitigation planning.

In 2013, the 19th UNFCCC Conference of Parties (COP19) established the Warsaw International Mechanism (WIM) to address losses and damages associated with climate change.[3] In subsequent years, an initial work plan was approved for the WIM Executive Committee and NELD became part of this work plan.[4] In terms of NELD, the work plan includes enhancing understanding by gathering of data and knowledge on non-economic losses. Thus the international policy process on NELD is still evolving. As institutional arrangements are made to address NELD under the UNFCCC, it has become increasingly crucial that sound research on the topic guide the policy process.

(i) conceptualization of NELD and (ii) case studies of NELD. The conceptual studies have

There is no universal unit that can be used to express NELD items and the value placed on these items are highly context dependent.[5] Various qualitative and semi-quantitative strategies to assess NELD have been suggested (e.g., risk indices, multi-criteria decision analysis).[6] Valuation methodologies (such as contingent valuation) and their limitations are discussed.[7] To date, a case study showing empirical evidence

---

[1] Serdeczny, O., Waters, E., & Chan, S. (2016). *Non-Economic Loss and Damage in the Context of Climate Change. German Development Institute.* Retrieved from https://www.die-gdi.de/uploads/media/DP_3.2016.pdf.

[2] Morrissey, J., & Oliver-Smith, A. (2013). Perspectives on non-economic loss and damage: Understanding values at risk from climate change. *Loss and Damage in Vulnerable Countries Initiative Report* (K. Warner & S. Kreft, Eds.).Retrieved from http://loss-and-damage.net/download/7308.pdf.

[3] UNFCCC. (2013). *Report of the Conference of the Parties on its nineteenth session, held in Warsaw from 11 to 23 November 2013. Addendum. Part two: Action taken by the Conference of the Parties at its nineteenth session.* Retrieved from http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf.

[4] UNFCCC. (2014). *Report of the Executive Committee of the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts.* Retrieved from http://unfccc.int/resource/docs/2014/sb/eng/04.pdf.

[5] *E.g.,* Serdeczny, *et al*. (2016).

[6] Fankhauser, S., Dietz, S., & Gradwell, P. (2014). *Non-economic losses in the context of the UNFCCC work programme on loss and damage (policy paper)*. London School of Economics, Centre for Climate Change Economics and Policy, Grantham Research Institute on Climate Change and the Environment. Retrieved from http://eprints.lse.ac.uk/64554/1/Fankhauser

[7] Morrissey, *et al*. (2013).

of NELD has been carried out in eight villages in Bangladesh.[8] A recent study comparing NELD in Japan and Bangladesh has also been conducted to show failure to adequately account for NELD in disaster risk reduction strategies and climate change adaptation reports.[9]

Our research contributes to this growing body of literature by using qualitative methods to assess potential non-economic loss and damage among the Bad River Band of the Lake Superior Tribe of Chippewa Indians.
to others, case studies such as ours create recognition of the presence of NELD in diverse communities and help develop rules to assess NELD.

Bad River Band of Lake Superior Chippewa Indians

Our partner, the Bad River Band of Lake Superior Chippewa Indians, is a federally-recognized Native American tribe with approximately 8,000 registered members, including about 1,700 members living on the reservation. They are part of the much larger Lake Superior Ojibwe group of over 300,000 in the United States and Canada and are related to the Anishinaabe group of North American indigenous peoples that also includes the Ottawa, Potawatomi, and Algonquin peoples.[10] They are part of the Anishinaabe group of North American indigenous peoples that also includes the Ottawa, Potawatomi, and Algonquin peoples.

The reservation of the Bad River Band covers 125,000 acres of land in northwestern Wisconsin on the southern shore of Lake Superior (*Gitchi Gami*), the largest freshwater lake in the world, as well as two hundred acres on the northern tip of Madeline Island (*Moningwunakauning*), the longtime cultural center of the Ojibwe. Over 90% of this land remains undeveloped, including 40 miles of shoreline along Lake Superior. The Kakagon Sloughs, wetlands covering 16,000 acres, have been designated a National Natural Landmark and Wetland of International Importance under the Ramsar Convention on Wetlands. These wetlands contain the largest area of natural wild rice beds in the Great Lakes basin, which have been a source of physical and spiritual sustenance for generations of Ojibwe.

Through a series of treaties in the mid-1800s between the United States and the Ojibwe bands, the Ojibwe ceded lands in Northern Michigan, Wisconsin, and Minnesota to the federal
[11] Efforts

---

[8] Andrei, S., Rabbani, G., & Khan, H. I. (2015). *Non-economic loss and damage caused by climatic stressors in selected coastal districts of Bangladesh*. Bangladesh: Bangladesh Centre for Advanced Studies. Supported by the Asian Development Bank. Retrieved from http://www.icccad.net/wp-content/uploads/2016/02/ADB-Study-on-Non-Economic-Losses-and-Damages-Report_Final-Version-Reduced-File-Size.compressed1.pdf.

[9] Chiba, Y., Shaw, R., & Prabhakar, S. (2017). *Climate change-related non-economic loss and damage in Bangladesh and Japan*. International Journal of Climate Change Strategies and Management. Retrieved from: doi:10.1108/IJCCSM-05-2016-0065.

[10] Chippewa and Ojibwe generally are used interchangeably.

[11] Bad River Band. (2006). *History: A Brief Bad River History*. The Bad River Band of Lake Superior Chippewa Tribe. Retrieved from: http://www.badriver-nsn.gov/history.

to resist being forcibly removed further west culminated in the Treaty of 1854, which established permanent reservations in the region, including what is now the Bad River Reservation. It is important to note that—unlike many other tribes—the Bad River Band selected their reservation

Europeans. Accordingly, the Band's connection to its reservation lands (and the ceded territories)

outside of its historical territory.

For decades, the rights of the Ojibwe people were systematically abused. Efforts like the General Allotment Act of 1887 (the Dawes Act), as well as the Treaty of 1854 itself, broke up reservation lands, allotting small parcels to Native Americans deemed suitably "civilized" and selling off the remainder to white settlers. Forced assimilation efforts, along with boarding and mission schools, disrupted traditional ways of life, the effects of which continue today. The rights to hunt,

denied, often forcibly.[12]

Walleye War."

their treaty rights.
demonstrated the importance of preserving access to these natural resources and maintaining Ojibwe rights and cultural practices.[13] It was also during this time that the Great Lakes Indian Fish & Wildlife Commission (GLIFWC) was established to manage and protect the off-reservation treaty rights on behalf of its eleven-member Ojibwe tribes.

The many natural resources found on the reservation are vital to the teachings, practices, lifestyles, and livelihoods of members of the Bad River Band.[14] According to tribal teachings, the Great Spirit told the Band's ancestors, who lived on the Atlantic Coast, to move to the place where "the food grows on water." After a series of stops along the St. Lawrence River, they settled in the Great Lakes region where they found wild rice—or *manomin*, the "food that grows on water"—along the lakes and rivers. They continue to harvest the wild rice for sustenance and as food used in ceremonies, feasts, and other gatherings.

---

[12] Nesper, L. (2002). T*he Walleye War: the struggle for Ojibwe spearfishing and treaty rights*. Lincoln: University of Nebraska Press.

[13] Loew, Patty, and James Thannum. "After the Storm: Ojibwe Treaty Rights Twenty-Five Years after the Voigt Decision." *The American Indian Quarterly*, vol. 35, no. 2, Mar. 2011, pp. 161–91.

[14] Bad River Band. (2011, July 11). *Bad River Band of the Lake Superior Tribe of Chippewa Water Quality Standards*. Retrieved from http://www.badriver-nsn.gov/tribal-operations/natural-resources/announcement-a-alerts-natural-resources/291-announcements-natural-resources.

According to the tribe’s teachings, water (*nibi*) is the lifeblood of the earth and connects the past, present, and future generations. In addition to wild rice, the water provides other resources such as walleye (*ogaa*), lake sturgeon (*name*
Furthermore, tribal members traditionally hunt deer, gather nuts and berries, tap maple trees for sugar, and harvest birch bark for canoes and handicrafts.

Respect for Mother Earth, which incorporates a deep respect for the natural systems that sustain the tribe’s culture, are important components of the tribe’
gathering practices. Accordingly, before taking something from Mother Earth, tribal members typically will offer loose tobacco (*asemaa*) in gratitude. Moreover, this respect means not taking from the Earth more than you need and ensuring that the land and water will be there for future generations. This is sometimes referred to as the Seventh Generation Principle, pursuant to which a decision made today should consider the affect it might have on seven generations into the future.

Environmental Threats on the Bad River Reservation

The Reservation has a humid, continental climate with distinct seasons which sustains different habitat types—coastal habitats, inland aquatic habitats, and upland habitats. Of particular interest among the coastal habitats, the Kakagon and Bad River Sloughs consists of diverse plant species and extensive wild rice beds.

Changing lake levels, more frequent and intense storms, and vector-borne diseases could affect coastal habitats and result in loss of wild rice beds, loss of breeding

habitat and food for migratory birds. Increased water temperatures could affect inland aquatic habitats and result in a

such as the non-endemic sea lamprey; and an increase in habitat suitability for invasive species such as Atlantic salmon carp and non-endemic plants such as narrow-leaved cattails.[15] Higher air temperature and changes in precipitation patterns could affect upland habitats and may cause the replacement of tree species such as birch and maple by tree species from forests further south. These natural resources not only have subsistence and ecological value, but are also culturally important to the Bad River Band and other Ojibwe bands in the region.

[15] Minnesota Sea Grant. (n.d.). Lake Superior’s Non-Native Species (100). Retrieved November 07, 2017, from http://www.seagrant.umn.edu/ais/superior_nonnatives.

In addition to these climate change risks, other environmental threats have included a controversial open-pit iron-ore mine proposal in the Penokee-Gogebic Range located upriver, as

Band Tribal Council declined to renew the easement for Enbridge Line 5, an aging pipeline that continues to carry over 500,000 barrels of crude oil per day across the reservation and nearby lands. Moreover, many threats, such as concentrated animal feeding operations (CAFOs), to Bad River's water and air come from nearby communities.

Scope and Methodology

W
a Native American community facing environmental threats. We made initial contact with the
T
of Lake Superior Chippewa in March 2017. We traveled to the Bad River Reservation in April 2017, to meet with them, receive their feedback on the project, and seek approval to engage with community members. We were committed to creating a project that was culturally appropriate, relevant, and would add value to the Bad River Band's current efforts in climate change adaptation and cultural preservation. Our project proposal (Appendix A) was presented to the Bad River Tribal Council and approved in late April 2017.

The data collection and interview structure were developed to assess participants' overall connection to the environment and past and current involvement in traditional practices. Such practices include wild rice harvesting, hunting, gathering, and other practices that involve the use of natural resources on the reservation and within the ceded territories. The Bad River Reservation Seventh Generation Climate Change Monitoring Plan was referenced to identify
. The demographics
This form
asked participants to differentiate between practices they had done previously and what they are currently involved in. It also guided our interview questions. The anonymized responses have been aggregated in Appendix E.

Before initiating any interviews, we went through the University of Michigan Institutional Review Board (IRB) process to ensure that our work conformed to federal, state, and university policies regarding the protection of human research subjects.
would not require ongoing IRB oversight since it involved minimal-risk, noninvasive data

August 27.
During this period, we facilitated semi-structured interviews with members of the Bad River Band. The Interview Guidelines (Appendix B) were used to ensure that facilitation was culturally sensitive and maintained a consistent approach. Each of the interview participants reviewed a project overview and signed a consent form (Appendix C). Participants were free to stop the interview at any time and were provided small gifts (<$20) in gratitude for their participation.

We worked in conjunction with tribal leadership, T
River Natural Resources Department to identify individuals who were willing to participate in our study.

We recorded interviews with 20 participants. Participants were a mix of men and women, elders and non-elders, all of whom lived on the reservation or within a 10-mile radius. Interviews were typically 30-60 minutes long and were video or audio recorded. We held the majority of the interviews in the Chief Blackbird Building (also known as the Administration Building), and occasionally interviewed participants in their homes or the Elderly Center.

Along with interviews, we attended community events and met with professionals working in the

reservation and with the Great Lakes Indian Fish & Wildlife Commission.

In addition to collecting information about traditional practices, the semi-structured interview sought to measure current or potential personal, family, or cultural loss and damage due to climate change and environmental stress. Our questions (Appendix B) were open-ended and were designed to allow the interviewee to respond freely based on their knowledge and experience. These questions were structured to capture participants' relationship to the land, to understand how or if climate change is affecting their daily lives, and to discover the degree to which climate change impacts their culture. Follow-up questions were based on responses provided by the participant. In this way, the interview format was an open structure that was largely guided by the interviewee.

Throughout this process, the privacy and autonomy of our research participants and the Bad River Band was of utmost importance. All audio and video recordings are being returned in full to the T

The use of the terms "tribal member" or "tribal elder" throughout specify an individual perspective or experience by an enrolled member of the Bad River Band of Lake Superior Chippewa. The use of the word "community" throughout the paper is meant to describe the tribal members living on or near Band River Reservation.
Bad River Band and we use the term "tribe" to refer to a connection to the larger Ojibwe and Anishinaabe identities and beliefs.

Findings

participants and coded the interviews accordingly. Table 1 provides a list of themes and their descriptions.
interviewee responses illustrated these themes.

Table 1: Overview of codes used in analyzing interview content

THEME	DESCRIPTION
Cultural Importance of Wild Rice	Migration story, how rice is used and shared, ceremonies for self, family, or community
Cultural Importance of Fish	Species: walleye, brook trout, perch
Cultural Importance of Trees	Species: birch, maple, ash, cedar; Practices: basket-weaving, canoe-making, use of knocking sticks, sugaring
Cultural Importance of Plants	Medicinal and edible, roots and berries, sage, sweet grass
Cultural Importance of Game	Species: deer, rabbit
Cultural Importance of Other Species	Additional uncategorized species: duck, swan, owl, eagle, turtle, muskrat, mosquito, clam, wolf
Relationship to the Environment	Reciprocity, connection of all species to one another, stewardship of the land, ties to waterways, specific ties to Bad River Reservation, giving tobacco in gratitude
Treaty Rights	Sovereignty, access to off-reservation resources, politics, social justice
Cultural Impact of Adverse Event	Sense of loss or loss of teachings due to mining, pipelines, non-sustainable harvesting, or climate change or environmental stressors
Other Impacts of Adverse Events	Economic, physical health, mental health, subsistence living, food sovereignty
Adaptation & Resilience	Perceived ability to adapt to changes and adverse events

Cultural Importance of Selected Species

Wild Rice

Wild rice (*manomin*, meaning "good seed" or "good berry") is a sacred food for Anishinaabe people. As shared by one elder, "it's one of the signs that were given to the people in dreams and visions on the migration journey. They were told they would be home when they came to the place where food grows on water." (Participant 3). The prophecy of the food that grows on water (rice) is an important teaching indicating why the Ojibwe people settled in the Great Lakes region. Wild rice therefore represents not only a food source for tribal members, but also a connection to the land, to *Gitchi Manidoo* (the Great Spirit or Creator), and to their native ancestry
community:

- You have to understand that rice is a staple food source here. It's done at
, funerals, birthdays,
holidays – there's always wild rice. (Participant 12).
- Rice is more than food. It's that belonging to the earth, that we all belong to. And it's giving something to us through the Lord, the Creator to sustain us. (Participant 9).
- The value of being able to go out and harvest it [wild rice]. When you're there, you feel your ancestors that were there before you. Knowing that is very important to me. (Participant 16).

Tribal members described the rice beds as sacred and important to protect. They also connected the health and well-being of the community to the health of the rice beds:

- The wild rice has always been very important to us as part of our being, as part of not just food for our bodies, but food for our souls. (Participant 9).
- To me it [wild rice] just represents life…perseverance in a historical

over time. Elders described traditional practices of drying, scorching, and dancing on the rice to remove the husk. While harvesting processes have changed to include machines, the ceremonial traditions of the rice harvest have been largely preserved. Such traditions include the seasonal
fering of tobacco to the spirits in the Kakagon Sloughs, and the annual *manomin* powwow. Participants explained these traditions as follows:

- You don't go out there and just start harvesting. You put your *asemaa*, your tobacco, in the water and you offer prayers. When you bring in the

(Participant 3).

- Before we harvest, we put out a dish to the spirits that are in the sloughs, that are all around us. [This is] for protection and safety of what we're harvesting, for water, and to say we are grateful for that abundance of food that was given to the Anishinaabe. Wild rice is the reason my people are here in this area. (Participant 1).

Based on water levels and decreased abundance of wild rice, the Tribal Council made the

living memory. Tribal members described the harvest ban as a challenging experience for the community. They recognized the value in allowing the rice beds to replenish, but tribal members

the amount of rice they had at ordinary meals. Some members were able to go to the ceded

and nutritional value of rice grown in the Kakagon and Bad River Sloughs compared to other sources.

Fish

practices, including hook-and-line, netting, and spearing. While the walleye is the widely-preferred species with a cultural importance approaching that of wild rice, interviewees also

geon, trout, and carp.

Walleye is a sacred food for Anishinaabe people. Like wild rice, it is used in ceremonies and was historically an abundant resource. Walleye have *tapetum lucidum*

that make them easier to see when spear

The physical attributes of the walleye are incorporated into tribal teachings and explain the origin of cultural practices:

> Walleye in particular has a really important story with us and they're
>
> And that's not by any coincidence. We were always told that's why; they are giving themselves to us that way. W
>
> s why. (Participant 10).

Trees

Trees play a prominent role in the culture of the Ojibwe people, providing resources for a variety

species play a prominent role in the lives of the tribal members, such as maple, birch, ash, and cedar.

Maple sugaring provides an ingredient for cooking and an opportunity for tribal members to bond with family members and friends. One tribal member described sugaring with her family: "Doing that with my children is probably the most important thing . . . . I think going through that process with them, from the starting moment of giving that tobacco, and then explaining to them the story of maple sugaring and how we got to doing it." (Participant 7). Many members noted that maple syrup is often used for gifting among tribal members and is also a required part of certain ceremonies.

Birch and ash have many uses for the Ojibwe, providing the raw materials for making baskets, lacrosse sticks, toboggans, snowshoes, burial urns, bowls, and other craft items. Many traditional stories involve birch, and birch canoe-making is an ancient traditional practice that has been passed down from generation to generation. When considering the loss of access to birch on Bad River Reservation, one participant described:

> [Without birch,] our young people . . . may never fully experience what
>
> on one of our rivers, in one of our lakes here like our Anishinaabe people have done for thousands of years. I really don't think that's replaceable in any way shape or form, those feelings that you get from doing that . . . . It's our chance to rekindle or maintain that relationship we have with the *manidoog*, with the spirits. (Participant 10).

Cedar also plays a central role in the harvesting of wild rice because it is lightweight and especially useful as a ricing stick. Even while members use modern boats to harvest in the sloughs, they continue to use traditional cedar ricing sticks to knock the rice (to separate the grains from the stalks).

Plants

Tribal members spoke of gathering a variety of plants, berries, and nuts, including strawberries, blackberries, raspberries, potatoes, wintergreen, yellowroot, and mushrooms. The cultural importance of plants can be seen in the fact that some months of the year are named according to the harvest occurring at that time. *Odemiini-giizis* ("Strawberry Moon"), for example, begins in the month of June, and represents the harvest of strawberries. Likewise, *Iskigamizige-giizis* (Sugarbushing Moon) season begins in April and *Manoominike-giizis* (Ricing Moon) in late August.

“It’s not the resources that are dependent on us, it’s the other way around. I think too many people forget that nowadays.”

The Ojibwe name for Bad River, *Mashkiki Ziibi* means “Medicine River,” referring to the abundance of medicinal plants that grow on its banks. These plants have medicinal and spiritual uses that go beyond the nutritional value they might offer.

Some tribal members spoke of the medicinal value of plants such as yellow root. One participant recalled from her childhood: “I can remember my grandma—she had this bag of roots. She used to hang them behind her door in her bedroom. If you had a sore throat, she would go break off a piece of it . . . . You would chew it for a while.” (Participant 13). Another participant spoke of the need to pass on knowledge of plants to her children and grandchildren:

> If we can’t harvest the deer because of chronic wasting [disease], or the
>
> coming and you can’t eat the birds, so then you better know your plants. Because perhaps what you’re going to have to survive on in the future would be what you can grow, if you can’t eat the hooved, the winged, or that which is in the water. And it’s just skills and knowledge that I think they need for the future. (Participant 4).

Game

Historically, hunting practices have included hunting (with bow or gun), trapping, and snaring. Anishinaabe people have long hunted deer, moose, fox, bear, and other mammals. Traditionally, these mammals were sources of food, clothing (tanned hides), and tools (bones and antlers). Our interviews predominantly focused on deer hunting.

The meat of white-tailed deer is considered a sacred, traditional food and is included in ceremonies. It is also an important lean, healthy food source.
when a young hunter ge game. The ceremony is symbolic of a young person becoming an adult hunter and provider for their family and community:

- W . I do those ceremonies. That’s

  the adult hunters. (Participant 3).
- Young men, young hunters, they become men too, by being providers for their community
  generosity in our community…you’re not allowed to eat any of the deer. You give it all out to the community, your family, your extended family, and you feed your people, literally. (Participant 10).

The act of hunting is also an important recreational and communal pastime. Tribal members feel a sense of connection to their hunting partners and to their ancestors that hunted and trapped in the woods before them: “One of the things I enjoyed about hunting, besides providing food on the table, was having that chance to go out with my relatives . . . . I wouldn’t go hunting alone,

. . . walking through the woods, I always thought about the ones before me, walking that same ground.” (Participant 16).

Other Species

Certain species of birds are also culturally important to the Ojibwe. The swan, in particular, was described as being connected to wild rice and having a role in signaling the start of spring: “They

spring.” (Participant 11). The swan is also honored as part of a traditional swan dance. Likewise, both the turtle and the muskrat are featured in the Ojibwe creation story. Explained one interviewee, “Supposedly the turtle is how we originated here—on the backs of a turtle—and a

established where [the Apostle Islands] are today.” (Participant 15).

Another respondent explained that the turtle was also used to help the Ojibwe track time: “Originally, Anishinaabe people did not have an alphabet and a written language. They’d take the shell of the snapping turtle, and there are thirteen sections on the back of the snapping turtle. And you’d use that as a calendar, and you could tell the story of what you’d be doing during each one of those moons.” (Participant 3).

One member also described the importance played by the wolf in Anishinaabe teachings: “[T]he wolf has a lot to do with native prophecy. If the wild places no longer exist, the wolf has no place to retreat. If the wolf passes out of existence, then pretty soon Anishinaabe and all other humans will soon follow. That’s a part of our prophecy.” (Participant 3).

Relationship to the Environment

overall. They described notions of the interconnectedness of all species, reciprocity, stewardship

Interconnectedness of All Species

Many tribal members are keenly aware of the interconnectedness of species in the environment and the resultant harm that would occur if one or more species were harmed or lost. One tribal member shared, “I think that anytime a species leaves for whatever reason, there are effects, because I believe everything is connected . . . .” (Participant 5).
“We are all connected, how could we not be? You walk on it [the land] every day . . . . You breathe the air, drink the water, you walk on the ground everyday.” (Participant 17).

One participant shared her perspective on the relationship among species:

> Everything is connected . . . it is the perch, and only the perch, that the Atlantic elliptical clam is reliant on to release its egg . . . . [The egg] doesn't attach to the gills of the walleye or the gills of other species, except for the perch . . . . When the egg of the Atlantic elliptical clam decides to hatch, it hatches and drops. And that's where it stays for the rest of its life. . . . [The] clam stays in the bed of the river . . . and it keeps the bed in place. And in keeping the bed in place, it keeps the channel of the river in place . . . [which means] there is the exact amount of water that is needed for wild rice to grow. Without that little Atlantic elliptical clam, without the perch, we don't have wild rice. (Participant 12).

Another participant highlighted this interconnection, drawing special attention to the diminished role of humans: "We are very pitiful people. We depend on everything here in creation to help us survive and live a good way of life. If we weren'
It's not the resources that are dependent on us, it's the other way around. I think too many people forget that nowadays." (Participant 10).

Reciprocity

This understanding of interconnectedness and the role that all species play in a healthy environment extends to humans. Tribal members are instructed not to take more than they need and that their actions impact the natural world. For example, when harvesting wild rice, some seeds naturally fall back into the rice beds, thereby helping reseed the beds and providing food for invertebrates, birds, mammals, and other wildlife. This is part of their teachings about how to harvest wild rice: "And then you're also harvesting for those little birds that are out there that are also helping too. You're knocking rice off into the water. You're seeding, too. It's a big process of reciprocity." (Participant 10). This reciprocity means "[b]e mindful of what you take . . . and what you give back—that's the most important part." (Participant 8).

This
is done by offering tobacco before taking anything from the land or water. "There are a lot of ceremonies and rituals involved in that way of life . . . . You don't just go out there and start harvesting. You put your tobacco in the water and offer prayers." (Participant 3). Similarly, a female elder described the value of being able to interact with resources in their natural environment: "Having it [natural resources] right there available to you, being able to touch it, put your tobacco by it and thank it for everything it's done.
in our culture and among our people." (Participant 12).

practice of sharing the harvest with family and members of the wider community. According to one tribal member, "You're out there and you're not just harvesting for yourself: I mean, you're harvesting for your extended kinship, your clan systems, your aunts, uncles, your way extended relatives, your community in general." (Participant 10). Sharing and being a provider is an important part of identity: "Someone that can take care of his or her people. To take that away, that would be very detrimental to the foundation of who we are." (Participant 10).

Stewardship of the Land

The community's relationship to the environment grounded in values of reciprocity leads to a strong commitment to land stewardship. Given the history and importance of treaty rights in the ceded territories, land stewardship extends beyond the Bad River Reservation:

> We are the caretakers of these areas [in northern Wisconsin, Michigan, and Minnesota] and we know that. Because of our unique sovereign status and our ability to protect things at a higher level. Here on the reservation we have a long, rich history of protecting different areas and we continue to do so to make sure that it's not just the water that's protected. (Participant 10).

Other members described particular activities that demonstrated the importance of stewardship,

demanding pipeline operators prevent spills, regulating harvesting practices to let rice reseed, forts, noting that "if you look on Google Earth, you can see the outline of our reservation, distinctly, because there's nothing but trees on it." (Participant 12).

Participants communicated a contrast of the values found in Anishinaabe teachings with those demonstrated by modern society. They shared that "at the very foundations of our spirituality, we're taught to live in harmony and balance with the four orders of creation, Mother Earth, and also never to take more than what you need, so that you don't over-exploit those resources in excess, for money like corporate interests do." (Participant 3).

Specific Ties to Bad River Reservation

form the foundation of many members' connection to the environment. Among the

were the Kakagon Sloughs, Waverly Beach, Madigan Beach, Bad River Falls, the shores of Lake Superior, and burial grounds on the reservation. Just as common, however, were general ties to the reservation that were not linked We noted how many members cited the waterways or "the water" when asked what part of the reservation they would most like to protect because there was a recognition that the "quality of water determines the quality of life." (Participant 15).

“We come from a long line of oral history...and it has been prophesied that when we can’t rice anymore then our people will perish.”

Many others felt their connection to the reservation through the taste of wild rice or practice of harvesting it. One person described giving wild rice to tribal members newly released from prison:

> [Wild rice] is one of the things that is given to every person that has come out because they have gone several years sometimes without eating it. That brings them to tears, just the taste of the food. When I saw someone do that, I asked, what makes you cry about this and they said, ‘It’s the connection. This taste reminds me of home.’ (Participant 12).

Treaty Rights

Treaty rights play an important role in the lives of members of the Bad River Band and reinforce the connection to the environment and to their identity as Native Americans. As stated by one tribal member, “That ability to harvest in these areas is very important because it rekindles our relationship with everything in creation.” (Participant 10). Tribal members access the ceded

the reservation itself.

Looming in tribal memory is a period known as the Sandy Lake Tragedy, when hundreds of Ojibwe died of starvation and disease in 1850–1851 after federal agents failed to make the annuity distribution required by treaty. The Sandy Lake Tragedy ended the attempted removal west and strengthened Ojibwe resolve to remain in their traditional homeland. The resulting Treaty of 1854 established the reservations and continued use of the ceded territories. The Sandy Lake Tragedy and other failures to uphold treaty obligations demonstrated that the tribe’s survival could not depend on non-Natives. Accordingly, having independent food sources and exercising treaty rights in the ceded territories promote food sovereignty and self-reliance. As one participant noted, “I think [treaty rights] is something that has to be really protected. . . . We have always gone through a lot of strife just trying to get clean water.” (Participant 9).

independence of the Band River Band and their particular sovereign status within the United States. It is a reminder that the tribe has never relinquished ties to its ancestral land and that its history on the North American continent goes back much farther than the arrival of Europeans.

Treaty rights have also been used as a mechanism for conservation within the reservation, the ceded territories, and beyond, as is illustrated by the following statements:

- We have reserved treaty rights especially here, and close by where we live and I feel that there would probably have been a lot more environmental destruction if our treaty rights had not been upheld. It is because of that we were able to lobby for Clean Water Act authority, Clean Air Act authority, because of our treaty rights. We have been successful, not the tribe necessarily, but tribal members, in bringing attention to issues such as [mining companies] injecting acid into the White Pine Mine that was only a half mile from Lake Superior, or injecting sulfuric acid into the earth. (Participant 14).

- [W]e've got rights all the way down the northern third of the state, so these treaty rights will protect everybody here. Because if we threaten to take them to court because our treaty rights are violated, we've got a case. The treaty rights protect the environment, not just for Native people, but for everyone, at least those that live in the ceded territories. So we get a lot of support from non-Native people, especially from groups like Sierra Club, Nature Conservancy, and other environmental groups, as well as individuals. (Participant 3).

Potential Impacts of Adverse Environmental Events

pollutants, pathogens, invasive plants, mining, and the pipelines that run through the reservation.

As described below, the potential impacts of these threats can be divided into impacts on culture and impacts on health.

Cultural Impacts

The importance that the Bad River Band places on natural resources means that loss of (or diminished access to) these resources poses a distinct threat to tribal members' lifestyle and cultural identity. Such loss would impact several aspects of the community's culture, including its sense of place, the availability of resources for traditional practices, oral tradition and teachings, and aspects of the Ojibwe language.

Migration Story

s migration story and prophecies from the Creator. The potential loss of these resources has an impact on beliefs, tribal identities, and sense of place on Bad River Reservation:

- Then comes the story about what our creation story is and actually how we came to be here, because of the food on the water. It brings a whole different dynamic into the emotional part. The uncertainty. Because we don't know. This is new for us. No wild rice? Wow, that's a scary thought. I don't know. I don'
emotional time. (Participant 7).

- I do not believe that's what the Creator has set out for us. I believe that the Ojibwe are strategically placed along the Great Lakes. . . . It would be like losing faith, watching it happen. What would we do? We would be falling apart. We wouldn't be connected to that creation story. (Participant 19).

- We come from a long line of oral history . . . and it has been prophesied that when we can't rice anymore then our people will perish. (Participant 17).

Ceremonial Foods, Materials, and Practices

Ojibwe people are traditionally hunters and gatherers. The harvesting of wild rice, sugaring,

adverse events. When considering the impact of diminished resources, it includes the possible

The abundance of rice on the reservation has changed over time. Elders described navigating with boats through narrower, denser channels in the rice sloughs when they were younger. The channels are now much wider, which is an indication that the volume of rice has decreased. One participant also noted that the increase in humidity has impacted her ability to dry out the rice in the sun. When drying the rice now, she has been required to stay at home and monitor the rice closely to cover and uncover it based on humidity. These changes in seasonal climate and subsequent adjustment to drying methods only occurred during the last 4-5 ricing seasons (Participant 5).

Seasonal changes have also impacted maple sugaring. Tribal members described periods of unseasonably warm periods in late winter. The warm temperatures initiate the running of the maple sap and tapping now begins earlier than in the past. The time available to tap trees has shortened from four weeks to two weeks. In some cases, the warm temperatures were followed by cold temperatures, damaging the sap. These changes impact amount of sap, the tree tapping schedule, and the viscosity and quality of the maple syrup.

T

become obsolete:

> **“Much like you go to the hospital when you’re sick, many of our people take to the woods because they know that’s what’s going to help them.”**

> It’s always concerning when you can’t rely on a species anymore, especially like walleye or something. . . . We would adjust, again,
>
> would be deeply impacted. t light up like walleye. There’s a reason we spear for walleye. (Participant 7).

Vulnerable species are also used for the creation of art and other traditional tools and objects. This includes but is not limited to baskets, textiles, ceremonial regalia, beading, canoes, lacrosse sticks, and snowshoes. One local artisan expressed her concern that she may not be able to hand-harvest the black ash she uses to make baskets and other ceremonial objects if the black ash trees were to die out. (Participant 5). Her concern is well founded: the Bad River Reservation Natural Resources Department expects that emerald ash borer, a non-native insect that is highly destructive to North American species of ash, will reach the Bad River Reservation in twenty to thirty years.

Teaching Younger Generations

to the next generation. These opportunities to learn about the natural world around them and to share tribal beliefs and Anishinaabe identity are lost when substituting with store-bought food. The following passages demonstrate the importance of passing on knowledge and the emphasis on providing experiences for young people to build connections with the natural world and to learn tribal teachings:

- [Young people] may never be able to fully experience what it is like to

  rivers or lakes here like our Anishinaabe people have done for thousands of years. I really don’t think that’s replaceable in any way, shape or form… that harvesting aspect is really ceremonial to us in a way. It’s our chance to rekindle or maintain that relationship we have with the manidoog or the spirits. (Participant 10).

- What is that life going to be like for them [younger generations]? They won’t be able to do what we’re doing . . . . Those things make you Anishinaabe. What does that make you if you aren’t practicing them or attuned to them? (Participant 17).

- When we tell those stories then, and we don't have that tree to say, 'And that's the birch tree right there. And this is the birch.' And showing pieces of the tree, of the bark, to our little people, our young people, then they don't know what the heck we are talking about and it isn'
longer. And that's really sad.
helped us through so many years to be able to live a good life is no longer available for our little people, our young people to see, and hold and smell and stand there and peel all the bark off . . . that's what I used to do as a kid. It'
when we're telling a story and saying, 'and then he got into this birch bark canoe' and you're like, 'what is a birch bark canoe?' 'Well, come to the museum and I'll show you that birch bark canoe right now'. . . and that's the only way they're going to be able to see it. (Participant 12).

Language

The traditional practices of hunting and gathering are interconnected with the Ojibwe language (*Anishinaabemowin*).

the month parallels the historical timing of harvest which could be impacted by climate change. If climate change results in reduced snowfall or different snow patterns, what does it mean for the *Onaabdin-Giizis* (Snowcrust Moon), that occurs in March? Participants communicated the interconnection between key Ojibwe descriptors and changes in the environment:

- When we lose that ability to identify things, we also lose the language that goes along with that too. Our language is very descriptive so we have different ways to describe, you know different types of cedar…All the intricate words that would go along with that would be lost too. So I kind of look at it like a chain reaction. (Participant 10).

- If you see more and more people getting back into the language well maybe there's a chance they can get back into that craft too. But if those plants are gone, then what does that mean? Because a lot of the language, the roots are tied to describing that plant or that animal or that part of nature that connects that person to that thing or activity. So, if that plant is gone, or if that tree is gone, or if that species gone, then what does that mean for the word and then what does that mean for the language and then how do we connect to nature? (Participant 5).

medicinal plants, game), community members used descriptors such as "scared," "devastated," "shock," and "sadness." These descriptors indicate the magnitude of the potential non-economic loss and damage related to culture, traditional practices, and teachings.

Physical Health and Mental Health

Additional consequences of adverse environmental events only partly captured by economic metrics include impacts on physical and mental health. As described by a tribal member, "for the community here, if there's an abrupt end to resources, like wild rice, it would be economically devastating to them, spiritually devastating, and emotionally devastating" (Participant 12).

Changes in lifestyle, increased access to modern food amenities, and the introduction of food

changes:

> Maple syrup and wild rice and so on are actually our health foods. These people who live at the poverty level and eat these commodities and all of these starches and everything, are no longer healthy. . . . When I think of my grandfather's generation and even beyond that, those old guys used to pack their deer out of the woods. They didn't drag them out. They'd put them on their back and pack them. They were strong enough to do that . . . . You eat a diet of wild game and different foods that you gather out of the forest. . . . The diet of native people has changed. All people, really. (Participant 3)

Potential loss of these food resources due to climate change or other environmental damage will accelerate the substitution of traditional foods with store-bought food and lead to additional health risks.

There are also health risks related to water quality, pollutants, and introduction of other pathogens. For example, chronic wasting disease (CWD) has been found in deer species in southern Wisconsin and may arrive north. As described by tribal member, there are "very few studies on how that [CWD] affects the human system too…it used to be if you shoot a deer it would be good for you, now if you shoot a deer it may not be good for you" (Participant 10).

Tribal members suggested that loss of land, species, and traditional lifestyles also have mental health implications. One tribal elder shared that "elders are experiencing grief related to the loss of rice. They try to bring elders out [to the rice beds] but they don't go because they don't want to see what has changed" (Participant 11). Another elder described that the "loss of a resource is just the same as the loss of one of your relatives…it's deeper than thinking of them as resources in that way. It means a part of your teachings, a part of your culture, is not going to be there." (Participant 14). This description of grief and loss indicates a deep social-emotional connection

Tribal members shared that healthy living and overcoming social issues related to historical trauma, poverty, incarceration, and drug and alcohol use can be achieved by maintaining a proper relationship with the environment:

All of our seasonal practices are directly tied to *Mino-bimaadiziwin*, or the good way of living. You know, we're not just talking about our health as it pertains to staying away from diabetes and blood pressure and what not, but we're also referring to mental health and maintaining sobriety.

things—addictions, drugs, and alcohol. . . . Because a long time ago when our people would get sick, everything that we ever needed was in the woods. . . . Much like you go to the hospital when you're sick, many of our people take to the woods because they know that's what's going to help them. (Participant 10).

Adaptation and Resilience

When asked about potential threats to cultural practices that might arise from climate change, nearly all interviewees responded with examples that exhibited adaptation and resilience. Several interviewees revealed these traits through a personal willingness to modify behavior (such as travelling to the ceded territories or substituting species) in order to continue valued practices. Others spoke instead of the ability to effect change through some manner of collective action (e.g., organized advocacy, actions of the tribal council). For many, adaptation and resilience are traits possessed by the Ojibwe people. These characteristics are revealed through traditional stories and teachings.

Willingness to Travel

Common among many respondents was a willingness to travel in order to continue to participate in traditional activities such as harvesting wild rice and maple sugaring. Where particular species

interviewees indicated that they would search of
locally unavailable. Many people have already done so and described traveling to the ceded territories to harvest wild rice.

However, tribal members perceive that there are economic barriers to accessing natural resources in the ceded territories, as noted here:

> If it's not your livelihood, you're not going to go way out of your way to get it unless you're using it to make a living or really need it for ceremonial purposes. . . . Say I wanted to harvest birch bark, but did not want to solely rely on the reservation, I would be willing to go into the National Forest to harvest my bark. But for a lot of people that is very
>
> woods or National Forest to harvest. (Participant 1).

One anticipated effect of climate change is that various species decline or shift in range, particularly boreal species, such as paper birch or spruces. For Bad River Band members, the risk is that prized species shift entirely away from reservation and ceded territories. Such a change would impact the ability of the tribal members to harvest culturally important resources within

Species Substitution

While particular species of plants and animals are centrally important to Ojibwe teachings and cultural practices, some respondents displayed a willingness to substitute another species for those whose existence may one day be in jeopardy. One participant considered tapping birch trees for sugar if maples were to disappear. The source of his willingness is the importance he places on the practice rather than the product. Although this participant does buy sugar at the store, the process of making sugar from scratch and sharing the experience with his children is as important as the ultimate product (Participant 7).

Another participant expressed a preference for the black ash tree in making crafts, but noted that other species may be acceptable. Adapting to changes in the availability of species means attempting to understand lessons that nature might be trying to teach her, "maybe there is another tree out there that really wants to be woven with or to be used." (Participant 5). Similarly, one

used (Participant 14).

Collective Action

Tribal members spoke of taking collective action that demonstrated their adaption and resilience. At times, such collective action manifests itself as advocacy or other cooperative effort. One participant told the story of the 1996 response to efforts by a Canadian mining company to transport a trainload of sulphuric acid across the Bad River Reservation, and how "our Bad River *Ogichidaag*, our warrior society, went down and blockaded the tracks for 28 days and brought [the mining company] to the negotiating table." (Participant 3).

Many tribal members spoke of their role as a protector of the environment even beyond the reservation and ceded territories: "[Being a protector is] not even just for the entire ceded territory, [but also] the U.S. as a whole. We had members from Bad River go up to Standing Rock,[16] and that's way beyond ceded territory." (Participant 18). Participants emphasized the importance of being united in protecting and maintaining the quality and longevity of the land. Another participant shared her experience at the People's Climate March in Washington D.C. in April 2017, saying, "It was amazing. . . To be one of the folks that was right there, and engaged and directing, it was pretty powerful. . . I wanted other people to feel that, especially in my community." (Participant 17).

At other times, resilience is demonstrated through actions taken by the Bad River Tribal Council, the Department of Natural Resources, or other tribal leaders. Examples include the council's decision to suspend wild rice harvesting in 2007 and 2012, efforts by the Department of Natural

Identity as Resilient and Adaptive People

Many interviewees grounded their responses to the threat of environmental change in an understanding of the Ojibwe people as resilient and adaptive communities. This self-

(e.g., the migration story), and from a shared understanding of historical events impacting the Bad River Band (e.g., the Walleye Wars, pipeline protests, etc.). The following quotes provide examples of this identity:

- Our people are extremely adaptable. We've adapted to a lot of different things, and we're survivors. We've survived a lot of things in our history of Anishinaabe. We've survived attempted relocation, assimilation. People have survived massacres, you know? And we've overcome all of that. We're still here. (Participant 10).

[16] From April 2016 to February 2017, protestors gathered near the Standing Rock Indian Reservation to protest the threat posed by the Dakota Access Pipeline to the Standing Rock Sioux's water supply and burial grounds.

- Like most nomadic people, we exhaust the resource until it gets so bad we can't survive, and then we just pick up and move to a new more resourceful area. (Participant 15).

- They never said that it was forever, that we would make our home there. What they said is for many many many years, that we would make our home here. Because of the rice. That [disappearance of wild rice] is sort of an indicator that we may have to continue to move. . . . If something

  (Participant 12).

- Originally, the people lived in the western Great Lakes area until hard times fell upon them, and they migrated all the way to the great salt water barrier, the Atlantic Ocean. They lived there for strings of lives until hard times fell upon them again. So in dreams and visions they were given signs to follow and told to prepare for a migration. (Participant 3).

Implications for Bad River Band

To monitor climate change impacts on these resources, the Bad River Band developed its Seventh Generation Climate Change Monitoring Plan in 2016, keeping in mind the physical, biological, and cultural impacts of climate change and the cost of the monitoring. This section

natural resources planning.

External Communication and Outreach

The Bad River Band's existing Climate Change Monitoring Plan accounts for the cultural importance of certain species by prioritizing monitoring measures for these species. Our

, the Monitoring Plan,

magnitude of their importance to the community. W
or stories from members of the community will help to explain potential risks to cultural heritage from climate change when collaborating with federal and state agencies and non-governmental organizations to address environmental issues. In addition, the material is particularly useful in communicating with non-tribal members and the general public who are uninformed about the culture of the Bad River Band.
recordings in social media, website, or other campaigns addressing environmental issues of concern to the community.

Determining Adaptation and Mitigation Approaches

As the Bad River Band continues to develop its climate adaptation and mitigation planning, our

For example, some potential cultural impacts may be avoidable through adaptation—by changing practices or substituting species. However, adaptation may be inappropriate or even traumatic, especially if the adaptation would necessitate amending the traditional teachings. In that case, the focus should be on mitigating—to the extent possible—the effects of any potential losses.

To make this determination, it is important to ascertain whether it is the species or the practice that is more important to the community. For example, is it walleye or is it the practice of

itself, then efforts to stock walleye may not be as important to the community as generalized efforts to maintain water quality. Or, if the walleye itself is culturally important, then efforts to maintain the stock should be continued. Different community members we spoke to had different perspectives on such questions.

be unimaginable. Wild rice, for example, is so foundational to the band's migration history and tribal members' sense of belonging that substitution, even if possible, would not be suitable. In such a case, mitigation measures (such as temporary suspension of harvesting to allow the crop to regenerate) may be the best way to limit cultural losses. Accordingly, it is important to identify whether species substitution is both practicable and suitable in order to determine which measure is best.

Given the view expressed by some members that invasive species have been put here for a purpose, one adaptation measure might be to develop a relationship with those living further south to better understand what species might be migrating northward and how they might be integrated into existing Ojibwe tradition over time. Likewise, building a relationship with communities living further north might enable continuing access to desired cultural resources that have migrated beyond the reservation and ceded territories. The latter option is complicated by the international border between the United States and Canada, but simultaneously made easier by existing cultural bonds with other Ojibwe bands found on the northern shores of the Great Lakes.

Other existing or suggested adaptation measures that were suggested by interviewees included the following:

- Traveling to the ceded territories to harvest;
- Offering subsidies or van-shares to support tribal members wanting to travel to the ceded territories to harvest;
- Building a seed bank of culturally important plants (already under way); and
- Stockpiling culturally important resources (e.g., cedar for ricing sticks).

Inclusive Decision-making Process

mitigation requires more research than this report provides. In particular, it calls for including

as tribal members. The remainder came from federal and tribal government agencies and non-governmental organizations. Such an approach would not seem to capture the spectrum of viewpoints held by Bad River Band members.

In our sample, members varied in their opinions about what cultural practices were important to preserve, and these opinions were largely based on whether or not the members themselves practiced the traditional method. The Bad River Band is not homogenous, and each participant provided a unique perspective on acceptable adaptation measures. While for Participant 14,

differing perspectives would need to be taken into account by planners and decision-makers.

In addition, although we interviewed some tribal members who live in nearby Ashland, we did not capture many views of tribal members who live off the reservation, who make up the majority of the Bad River Band. Whether adaptation and mitigation planning should address the needs of all tribal members or only those living within the reservation boundaries is an important question we cannot answer given the scope and limitations of the project and our status as non-members.

Tribal Strengths to Harness

The Bad River Band has two key strengths that it can harness to strengthen any adaptation or mitigation measure it undertakes.

First, it has a long history of resiliency in the face of challenges such as attempted removal, forced assimilation, and ongoing discrimination. Tribal members take pride in their identity as a resilient and adaptive people and communicated a sense of hopefulness and engagement. This spirit manifests itself in a willingness to challenge mining or pipeline companies or to assert their treaty rights individually or collectively.

Second, the Bad River Band has a rich oral tradition. Traditional subsistence practices, along with the exercise of treaty rights, help reinforce the tribal connection to the land, water and fauna. Without these activities, there is a risk that oral teachings will not be passed on or will become fossilized. It was evident to us that oral tradition alone cannot replace direct experiences with the environment and that continuing to promote the traditional ways of life helps keep tribal traditions alive. Oral traditions also help give meaning to changes in the environment so that such changes are not experienced as a loss. Teaching the Ojibwe language and the youth outdoor programs seem to be effective steps towards creating and reinforcing ties to the environment.

Implications for Future NELD Research

facing environmental threats. W
evaluating NELD, but we hope our successes and failures can be studied by other researchers in undertaking their own research. We have noted here some of the complexities we encountered when doing our work.

Defining the Community

The Bad River Band is a part of a much larger Ojibwe group—one of the largest indigenous groups in North America. The Bad River Band maintains close cultural and familial ties with other Ojibwe throughout Michigan, Minnesota, Ontario, and Quebec, especially the Red Cliff Band of Lake Superior Chippewa, whose reservation is approximately 55 miles away.

Given the reservation system in the United States, and the resulting separate tribal governments, it made sense to us to limit our research to the Bad River Band. The Band has its own independent Natural Resources Department and its own obligation to combat climate change. No matter how much its members might have culturally in common with other Anishinaabe tribes, it is an independent political entity.

Nevertheless, the Band'
appropriate cultural group to evaluate. Bad River Band members share cultural practices, such as ricing, and cultural beliefs, such as the oral history of the migration, with other Ojibwe. Additional interviews might shed light on whether Bad River Band members are more or less sensitive to environmental changes than others in this larger group. Would members of the Lac du Flambeau Band, for example, be equally impacted by the loss of sugar maple trees? A comparative study of Ojibwe across many bands would identify any differences, as well as reinforce which practices are culturally meaningful. In addition, other Ojibwe may have different adaptation and mitigation strategies that would be culturally appropriate for the Bad River Band to adopt.

Working with a Native American Community

The Bad River Band are a minority population within Wisconsin and the United States. Only about 1,500 tribal members live on the Bad River Reservation; the majority live off the reservation. Historic and current discriminatory policies by government entities have oppressed Native American lifestyles, livelihoods, and identity
poverty, high unemployment rates, addiction, and incarceration impact Bad River and other Native American communities. Discrimination against Native Americans remains pervasive and there continues to be distrust between the tribe and the state and federal governments.

This discrimination leads to their voices being marginalized and consequently policy decisions do not incorporate their views. The majority non-Native population may be dismissive of Native American concerns about protection of the environment or may deem traditional practices obsolete and unworthy of preservation. The value of NELD research itself may not be accepted given this discrimination.

Moreover, poverty can mean that tribal members are themselves a big threat to resource conservation. For example, we were told that some tribal members had recently been cutting down and selling birch saplings to non-Native communities to make ends meet. (Participants 1, 20). This has had a noticeable impact on the birch population and also means that there will be fewer large birch trees in the future suitable for making birch bark canoes. There is currently a moratorium on cutting down birch trees (with exceptions for permitted religious or cultural purposes) that will continue until healthy birch populations return, but these accounts are evidence that economic forces may be harming tribal practices as much as or more than environmental forces. Losses from these forces interact with potential non-economic losses from climate change and complicate any NELD analysis.

In addition to these social and economic challenges, the Bad River Band faces environmental threats from mining, pipelines, and invasive species that currently threaten its water and natural resources, making climate change appear to be a less pressing problem. Social issues such as poverty, addiction, and incarceration can compromise their ability to effectively prioritize enforcement and conservation.

Sharing Knowledge with NELD Researchers

None of our research team was Native American and we relied on the willingness of participants to share their knowledge with us. In addition to normal reservations about speaking with

. NELD researchers from outside the community must be sensitive to this dynamic when eliciting information to include in climate planning.

Different cultures have different rules about sharing traditional knowledge with outsiders. During the long period of forced assimilation, many Native Americans practiced their traditional ways in secret. Moreover, their traditional knowledge has been exploited and used against them in the past. As a result, many are still understandably reluctant to share traditional knowledge with outsiders. Some practices, such as the Midewiwin sometimes called the Grand Medicine Society, are secret to all outsiders, Native and non-Native alike, and only Native Americans may become initiates.

The cultural practices that are kept secret are most likely to be the cultural practices that the group cares about most. However, if outsiders in federal and state government, for example, are

when developing climate change strategies that may affect the group. The burden should be on outsiders to make genuine ef are going to make policy choices that affect the community. Without learning about the migration story, for example, non-tribal members may not appreciate that wild rice is as important culturally as it is economically and may incorrectly assume that it can be substituted with store-bought rice.

Differing Worldview

Early on, we had considered holding a focus group that would be given a list of species and asked to rank their cultural importance to the Bad River Band using a Likert Scale. This ranking, we thought, could then be used, in conjunction with customary economic and environmental assessments, to prioritize or re-prioritize climate change mitigation tasks. Due to logistical and time constraints, we did not hold the focus group. We were also leery that a ranking would allow an outsider to convert qualitative information into quantitative data and thereby allow the assignment of a dollar value to the numeric ranking. For example, loss and damage at the highest end of the scale would be recompensed at $1 million, and the next level down at $500,000, and so on. This would have defeated the purpose of studying non-economic loss and damage, which

Moreover, it is worth thinking about whether such a focus group could have worked with this community. Many participants spoke of the interconnectedness of all species—human, animal, and plant—and their ties to the air, land, and water
articulate preferences for one species over another, given this understanding that changes to one will have a ripple effect on others.

Approaches to invasive species offer another example of differing world view, as Ojibwe beliefs might differ from normative natural resource management practices. The Ojibwe language does not include a word for invasive species. Instead, non-native species are considered gifts from the Creator and it is important to understand the Creator's purpose for that species (Participants 12, 19). For example, rather than trying to pull up non-native cattails that threaten wild rice, the community has explored other ways of using the cattails, perhaps as bio-fuel, as a food source, in weaving, or as decoration. Or, perhaps the species serves as a protector or a warning species (also known as "sentinel species") of the fragility of the rice beds.

This dif
resource management practices in use by state and federal governments. It can also lead to miscommunication. A failure to tear up cattails to save the rice beds may not be the result of indifference, but a fundamentally different view of the role of non-native species in the ecosystem.

Indeed, the different worldview reinforces the need for more understanding of potential non-economic losses to communities who do not share the notion that monetary damages are an adequate recompense for their loss:

> We prize clean water, fresh air
> and so on, even more than money or materialism. It is a much different way of thinking. The Anishinaabe worldview is much different than that of the industrialized world. We think in terms of the sacred circle: it has no beginning and no end. (Participant 3).

In the quote that opens this report responding to a question about the monetary value of wild rice ("It's priceless. We can't put a price on it. We won't. It's not for sale."), the tribal elder forcefully asserts that the Bad River Band *cannot* quantify the value of wild rice in monetary terms and *will not* do so. The Band'
maintain a way of life in the face of assimilation pressures.

Relying on Qualitative Data

Our observations and open-ended responses to semi-structured interviews represent qualitative data. Qualitative results rely on the interviewer's approach to shaping the interview and directing the participant. The results also rely on the coder's interpretation of the responses, which can seem more subjective and less credible or reliable than quantitative data. The strength of qualitative data is in capturing the variety, individuality, and vividness of the descriptions that can become sterile when transformed into quantitative data through coding. Qualitative data seems better suited to capturing the emotional impact of cultural loss or change brought about by environmental stressors.

We collected our information using collaborative research methods. We partnered with the community in creating our questionnaire, structuring our interviews, identifying and scheduling participants, and clarifying the objective of the research. Collaborative research work such as this requires time and patience to gain consent and build trust with the community. This is especially important in marginalized communities.

NELD research with similar methodologies cannot be done properly in a short amount of time. This type of research may take longer to complete than environmental or economic assessments,

economic impact in legal and regulatory regimes reinforces the preference for quantitative data at the expense of qualitative data that may better express the potential non-economic loss and damage to cultural heritage that is at risk.

Conclusion

Through this study, we explored the Bad River Band's relationship to the environment in an effort to better understand what potential cultural losses they may face in the event of climate change or other environmental transformations. The narratives we collected point to the community'
walleye, and maple, as well as the role these resources play in creating familial and social bonds and maintaining a social identity. The loss of these resources is unimaginable for some tribal members, and could mean loss of intergenerational ties, loss of language, and cultural disintegration. Strong themes of resilience and willingness to adapt in the face of threats to these resources also ran across the narratives. The Bad River Band has a long history of resilience in the face of discrimination, disenfranchisement, and dispossession; such resilience, in combination with the Band's deep ties to the land, may make it better equipped to resist or adapt to the threats posed by climate change.

The importance our participants placed on these natural resources strengthens the idea that some climate change losses may be incommensurable. While the valuation of these resources is

effective climate change decision-making. Studies such as this can form the basis for determining climate change adaptation and mitigation strategies, can inform external policymaking, and can be used to identify sources of resiliency within the community. Studies such as this also add to the larger body of academic work that is documenting these non-economic losses for different communities in an effort to gain recognition for such losses in international policy frameworks.

Appendices

Appendix A – Project Proposal to Tribal Council
Appendix B – Interview Guidelines/Questions
Appendix C – Project Overview and Consent Form
Appendix D – Demographic Form
Appendix E – Aggregated Demographic Data

Appendix A

Preliminary Research Proposal to the
Bad River Band of Lake Superior Chippewa

Background Statement

Most climate change research and assessments focus on measuring the potential economic loss from changes in the environment. We want to focus on the potential non-economic losses from climate change or other environmental stressors. These are items that cannot be monetized -- factors like adverse health impacts, reduction in biodiversity, loss of knowledge and language, as well as the loss of identity or sense of place resulting from changes in culturally important landscapes or built sites.

These factors are characterized by the fact that their potential loss makes a substantial and permanent difference to the well-being of those affected. These factors are not effectively addressed in national or international policy frameworks, although researchers and policy-makers have begun to recognize their importance.

Goals/Objectives

The aim of this project is develop a framework to assess potential non-economic loss and damage from climate change. The framework will be informed through the collection of stories from people that actively experience and understand the impacts of climate change on their daily lives. These measures of non-economic loss and damage can then to be used to develop or prioritize adaptation measures that minimize these losses. At a minimum, the framework and assessment will help inform policymakers of the importance of these cultural and social factors to climate change adaptation planning and effectiveness.

Team Introduction

The project team represents graduate students from five University of Michigan - Ann Arbor schools. The following is a list of team members and our faculty advisor. We have included more detailed bios in Appendix.

Katie Proudman, Social Work
Stephanie Dooper, Higher Education
Adam Osielski, Law
Sarah Swanz, Information
Ansha Zaman, Natural Resource Management & Environmental Science
Dr. Stuart Kirsch, Faculty Advisor, Department of Anthropology, LS&A

We have received funding for this project through the Dow Sustainability Fellowship program, operated through University of Michigan Graham Sustainability Institute. Nonetheless. this is a student-directed and self-determined project. We have devised the project objective and scope ourselves. We plan to share our final report with the Graham Institute at a year-end presentation, but we will consult with tribal leadership before any presentation of sensitive materials.

Methodology

With your guidance, we would like to learn about the potential impact of climate change and environmental stressors from members of the community. We can do so through a variety of methods: survey of community leaders and experts, focus group meetings, attending community meetings, and/or one-on-one interviews with community members.

We have attached the topics of our potential questions in the Appendix. These are semi-structured questions that allow participants to respond freely based on their knowledge and experience. Anyone is free to decline to be interviewed. We can offer food for focus groups and small gifts (<$20) as thank-yous for participation.

We would not record (audio or video) any interview without the participant's consent and each participant is free to stop the interview at any time. We would not take photographs or videos of any places, ceremonies, or activities that you direct us not to. Any recordings we do take would be shared with you.

Due to our own academic schedules, we are free to visit the Bad River Reservation for about six weeks from mid-July to the end of August. We will work with you to plan our visits.

During the fall, we would work on analyzing the data we acquired and writing up our report. We expect to complete our report by mid-November.

Possible Deliverables to Community

- Archive of oral histories to record and showcase how the landscape of Bad River reservation and watershed is evolving due to climate change. This could be videos to post on your website or the Great Lakes Commons website (http://www.greatlakescommons.org). Or we can set up a private archive available only to tribal members if you do not want to make it public. We can also help catalog existing recordings.
- Add value to Bad River Band's ongoing climate adaptation and mitigation planning. We can align our questions with the objectives of the Seventh Generation Climate Change Monitoring Plan. We would agree to comply with your data sharing or confidentiality policy.
- We understand that some teenagers are working video production. We would be happy to have them along if they wanted to learn more. We can also offer photography or basic computer lessons to them.
- We will provide you with regular updates on our activities as often as you instruct and we consult with tribal leadership before publication of our final report.

Miigwech - Thank you, we look forward to hearing from you.

Interview Guidelines

Climate Change NELD Project

The following outlines sample questions for the facilitation of the Climate NELD interviews and oral histories. The document is for internal use by University of Michigan Climate NELD team and was developed in partnership with Bad River Tribal leadership, Tribal Heritage Office and Department of Natural Resources.

Pre-recording

- Receive Project Overview and sign Participation Consent
- Complete Participant Demographics Form
- Ensure that participant understand that their participation is voluntary.

Sample Interview Questions *(subject to change based on interview content)*

Background

- Please tell us your name and age.
- How long have you lived on Bad River Reservation?
- Did you grow up on the reservation?
- What is your current job / role in the community?
- Have you seen any changes to the environment -- the land, the water, the weather, plants and animals -- during your lifetime?
- Have you lost or altered any experiences or connections to the environment as a result these changes

Species Checklist

- Do you eat wild rice? Do you know how to harvest wild rice?
  - If the wild rice did not grow, how would you feel about that?
  - Tell us how you felt during the year(s) when you were not able to harvest wild rice.
  - How important is it that your ricing sticks are made of cedar from the reservation or ceded territory?
- Do you eat walleye? Do you know how to fish? What type of fishing (gun, net, spear)? What species do you catch?
  - If there were no more walleye to be caught here, how would you feel about that?
- Do you eat maple sugar or syrup harvested from Bad River? Do you know how to harvest sugar?
  - If the sugaring trees moved north, where would you get your sugar/syrup?
  - How is the season? How many taps do you get? Changes to methods over time?
- Do you harvest birch bark, or, purchase/receive gifts of birch bark items made from local artisans?
  - If the birch tree wasn't able to grow here anymore, how would you feel about that?
- Do you [insert from checklist as appropriate]? Do you know how to [harvest, fish, hunt]?
- If there were no more [deer, sweetgrass, etc], how would you feel about that?
- What values do you find and develop through these activities?
  - Do you have any memories that illustrate this?

Open-Ended Questions

- How far would you be willing to travel to get wild rice or maple sugar/syrup if the plant life moved north, *beyond the ceded territories*?
- What things in the environment are most important to you? How do you protect them?
- What are places (one place) on the reservation you would like to keep pristine? Why?
- How much would Bad River have to change for it to longer feel like Bad River to you?
- Do you think you would ever move away from Bad River? What would that mean to you?

Appendix C

Climate Change Student Project Overview

Introduction to Climate Change Project

We are a team of students from University of Michigan who are studying how changes to the environment might impact your way of life. Changes to the environment -- or climate change -- might mean changes in temperature and rain and snow levels, changes in the availability of fish and game, changes in plants or crops , or changes in water quality. The Bad River Band has long been looking at these changes and developed a Seventh Generation Climate Change Monitoring Plan.

We have developed the research project in partnership with the Tribal Heritage Protection Office and Department of Natural Resources. Our project was approved by the Bad River Tribal Council in April 2017.

What is Non-Economic Loss from Climate Change?

Most climate change research focuses on measuring the potential economic loss from changes in the environment -- the money a fisherman might lose if there are no more fish in the lake. We want to focus on the potential non-economic losses from climate change or other environmental stressors. These are things that you cannot put a dollar amount on -- things like knowledge and language or the loss of identity or a sense of place that comes from changes in culturally important landscapes. These factors are not always addressed in planning documents, and yet their potential loss can make a permanent difference to the wellbeing of a community.

What are we asking from you?

- We would like to collect stories from people like you through focus groups or interviews and ask you questions about your relationship to the environment and how it has changed.
- We would like to speak with you for about an hour. You do not have to answer all of our questions and you are free to end the interview at any time. We understand there might be information you do not wish to share with non-tribal members.
- With your permission, we would like to make a recording of our conversation. The recording will help us with our analysis after our time at Bad River Reservation. We will archive our interviews with the Tribal Heritage Protection Office and you will be able to access them there at any time.

If you would like to participate, we will ask you to complete the consent form on the other side.

Consent Form

The aim of this project is develop a framework to assess potential non-economic loss and damage from climate change. The framework will be informed through the collection of stories from people that actively experience and understand the impacts of climate change on their daily lives. We would like to ask you questions about your relationship to the environment and how it has changed.

We would like to speak with you for about an hour. With your permission, we would like to make a video recording of our conversation. You do not have to answer all of our questions and you are free to end the interview at any time.

The Bad River Band of Lake Superior Chippewa will keep the recording and will have the rights to use, reproduce, and publish the recording for any lawful purpose according to its policies.

What we have learned from you may become part of our written report, but we will not publish any report without first obtaining the approval from tribal leadership.

If you would like to participate in our study, please sign below to indicate that you understand:

(1) The general topic of the questions that will be asked

(2) That your story will be recorded

(3) How your story will be used by the researchers

______________________________   ____________________

Name (printed)   Date

____

Name (signed)

Interviewer Name: ____________________

If you have any questions about this project, please contact any of the following:

- Edith Leoso, the Tribal Heritage Protection Officer, [redacted]
- Devon Brock-Montgomery, the Climate Change Coordinator, [redacted]
- Stephanie Dooper, Student Researcher, [redacted]

Participant Demographic Form

Climate Change NELD Project

We ask that you complete this form so that we get an impression of the people participating in our focus groups or individual interviews. Your individual information will not be shared outside the research group. Summary information from all participants may be used in our final report. Thank you for your participation.

1). What is your gender?

□ Female □ Male □ Two Spirit □ Gender non-conforming

2). What is your age?

□ 16-17 □ 30-39 □ 50-59
□ 18-29 □ 40-49 □ 60 and over

3). Tribal Membership

□ Bad River Band □ Other (Please specify:__________) □ Non-member

4). Are you currently living on Bad River Reservation?

□ Yes | □ No
If no, please indicate location or approximate distance from the reservation: ______________________________

5). How many months per year are you on reservation?

□ More than 6 months □ Summer Only □ Weekends Only
□ Fishing Season □ Rice Season □ Only for Ceremonial Events

6). Do you participate in any of the following? Check **all** that apply.

Have Done Before	Still Currently Do (within past 12 months)
□ Hunt (gun)	□ Hunt (gun)
□ Hunt (bow)	□ Hunt (bow)
□ Fish (hook and line)	□ Fish (hook and line)
□ Fish (netting)	□ Fish (netting)
□ Fish (spearing)	□ Fish (spearing)
□ Trapping	□ Trapping
□ Maple sugaring	□ Maple sugaring
□ Gathering balsam boughs	□ Gathering balsam boughs
□ Gathering sweetgrass	□ Gathering sweetgrass
□ Collecting berries/roots	□ Collecting berries/roots
□ Wild Rice (manomin) harvesting	□ Wild Rice (manomin) harvesting
□ Harvesting plants for medicinal use	□ Harvesting plants for medicinal use
□ Harvesting edible plants	□ Harvesting edible plants
□ Birch bark harvesting	□ Birch bark harvesting

Appendix E

Table 1. Demographics of interview participants.

Demographic categories surveyed	Number of respondents
Gender	
Male	8
Female	11
Age	
18-29	3
30-39	3
40-49	3
50-59	1
60 and over	9
Tribal Membership	
Bad River Band	19
Are you currently living on Bad River Reservation?	
Yes	16
No	3
How many months per year do you live on or near Bad River Reservation?	
More than 6 months	19

Table 2. Overview of past and current participation in traditional practices.

Traditional practices surveyed	Number of respondents: Practiced in the past	Number of respondents: Current practices (last 12 months)
Hunt (gun)	14	6
Hunt (bow)	1	0
Fish (hook and line)	16	10
Fish (netting)	16	9
Fish (spearing)	13	7
Trapping	6	2
Maple Sugaring	17	10
Gathering balsam boughs	10	4
Gathering sweetgrass	9	8
Collecting berries/roots	17	12
Wild rice harvesting	17	9
Harvesting plants for medicinal use	17	12
Harvesting edible plants	14	10
Birch bark harvesting	13	8