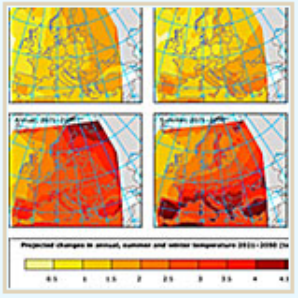
Climate change - a threat to aquatic ecosystems

Climate change – Overview



Click to enlarge

Since the last ice age, around 11,000 years ago, the Earth's climate has remained relatively stable, with global temperatures averaging at about 14°C. However, in the last century climate has started to change rapidly as the Earth's temperature has increased by approximately 0.7°C. Most climate projections reveal that this trend is likely to continue, resulting in an increase in global temperatures of between about 1 and 6°C by the end of this century (IPCC, 2007).

There are many factors that can cause a warming of our climate; for example, more energy from the sun, large natural events such as El Nino or an increased greenhouse effect. Scientists have ruled out the sun and natural variations in our climate as the major causes of the recent warming. There is overwhelming evidence that most of this warming we've seen is due to increased amounts of greenhouse gases in the atmosphere. Greenhouse gases, such as water vapour, carbon dioxide and methane, occur naturally in the atmosphere. But human activities have directly increased the amount of carbon dioxide, methane and some other greenhouse gases. These increases can be through the burning of fossil fuels such as oil and coal, and changes in land use such as chopping down forests for cattle grazing.

Learn more in this video (external)

On top of this we have seen changes in extremes of weather events, such as heatwaves and heavy rainfall. The current changes are very unusual and can not be explained simply as part of any natural cycle, such as El Nino and La Nina, which cause the warming and cooling of the tropical Pacific Ocean, which affects world temperature. Natural cycles can lead to periods with little or no warming and other periods with rapid warming. However, what is important is to look at the longer term trends in temperature, which are rising, and which scientists believe is almost certainly caused by human activity.

CENTER FOR WATER POLICY

SCHOOL OF FRESHWATERSCIENCES

UWM MILWAUKEE

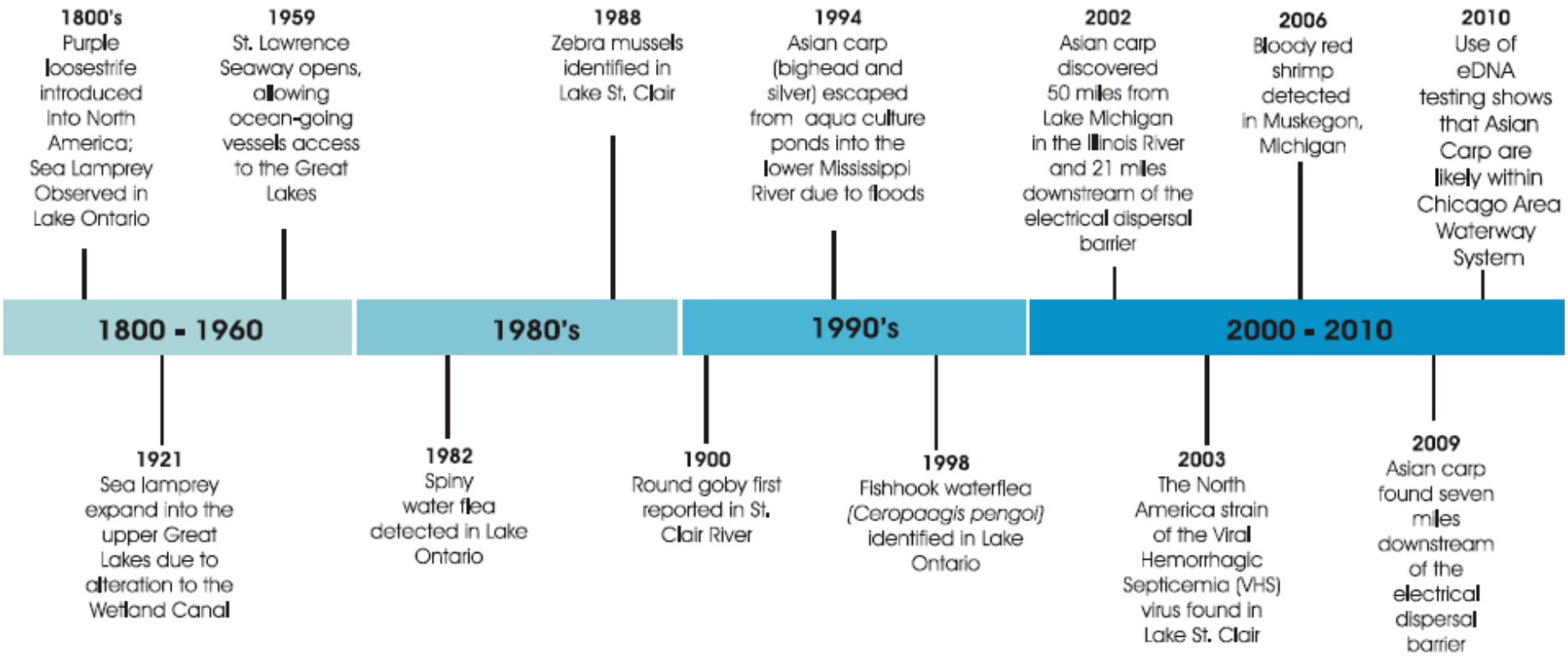
The Great Lakes basin holds the world's largest supply of surface freshwater and is home to over 35 million people. Climate change is predicted to have major impacts on the natural resources of this system, which will exacerbate existing problems and create new challenges. This series of policy briefs explores several impacts of climate change and emphasizes the need for responsible stewardship of our vital water resources.

Climate Change Impacts on Invasive Species in the Great Lakes Basin

More than 180 invasive species are outcompeting native species in many areas of the Great Lakes basin. These invasives are introduced through commercial shipping, canals and waterways, recreational activities, and trading of live organisms (Figure 1). Invasive species damage ecosystem health and have negative impacts on economic growth. They are extremely difficult and costly to eliminate once they have gained a foothold, making prevention the most cost-effective strategy to control their presence. Reducing and managing invasive species is vital to the health of the Great Lakes ecosystem.

Altered fisheries: $9.3billion / year
Extended Growing Season
Reduced Ice Cover
Altered Water Chemistry (<pH)

Timeline of Aquatic Invasive Species in the Great Lakes



GLANSIS GREAT LAKES AQUATIC NONINDIGENOUS SPECIES INFORMATION SYSTEM

Staff | Status | Search | Report | Projects | Prevention | Glossary | Links | Kids

Background

The Great Lakes have a long history of aquatic nonindigenous species (ANS) introductions – both intentional and unintentional. As of 2012, over 180 nonindigenous species have been reported to have reproducing populations in the Great Lakes basin, i.e. lakes Superior, Michigan, Huron, St. Clair, Erie, Ontario, and their connecting channels and water bodies within their respective drainages (Mills et al. 1993, Ricciardi 2001, Ricciardi 2006, Ricciardi unpubl. data). The two most recent ANS reported and verified established in the Great Lakes basin were *Hemimysis anomala* and *Procambarus clarkii* (fact sheet pending review).

The number of Great Lakes aquatic nonindigenous species documented in GLANSIS must be interpreted as a minimum. Identification depends on our ability to find, recognize, verify, and document new species, which is, in turn, dependent on our ability to adequately sample the Great Lakes ecosyste

Species Included in GLANSIS

Species are assessed for inclusion in the database on a case-by-case basis. The present not include waterfowl.

The present database consists of three lists

- a core list of species **nonindigenous** to the Great Lakes basin (not native to any part
- a list of **range expansion** species (native only to a portion of the basin),
- and a **watchlist** (not currently found in the Great Lakes but assessed in the peer-revie literature as of 2010 as likely to invade via current pathways).

GLANSIS GREAT LAKES AQUATIC NONINDIGENOUS SPECIES INFORMATION SYSTEM

Home | Staff | Status | Search | Report | Projects | Prevention | Glossary | Links | Kids

Generate a Non-Indigenous Species List

Select your criteria below

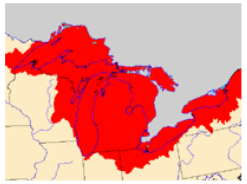
A list of species matching your criteria will be generated.
Species with fact sheets will have links to the fact sheets.

SEARCH HELP

Species Category: Nonindigenous
Group:
Lake (HUC):
Genus:
Species:
Common Name:
Status:
Pathway:
Sort by:
Submit

- All
- Algae
- Annelids-Oligochaetes
- Annelids-Polychaetes
- Bacteria
- Bryozoans
- Coelenterates-Hydrozoans (Hydroids)
- Crustaceans-All
- Crustaceans-Amphipods
- Crustaceans-Cladocerans
- Crustaceans-Copepods
- Crustaceans-Crayfish
- Crustaceans-Mysids
- Fishes
- Insects
- Mollusks-All
- Mollusks-Bivalves (Mussels, clams, oysters)
- Mollusks-Gastropods (Snails)
- Plants
- Platyhelminthes
- Protozoans
- Rotifers
- Viruses

on right)



8108-9719 (734) 741-2235
gon, MI 49441-1098 (231) 759-7824

Great Lakes Aquatic Invasives TCN:

Documenting the Occurrence through Space & Time of Aquatic Non-indigenous Fish, Mollusks, Algae, & Plants Threatening North America's Great Lakes

Ken Cameron
Wisconsin State Herbarium (WIS)
Department of Botany
University of Wisconsin-Madison

kmcameron@wisc.edu

PLANTS	
Genus (2147)	Family
Agrostis (36)	Poaceae*
Alnus (14)	Betulaceae
Alopecurus (16)	Poaceae*
Butomus (1)	Butomaceae
Cabomba (4)	Cabombaceae
Carex (593)	Cyperaceae*
Chenopodium (51)	Chenopodiaceae*
Cirsium (95)	Asteraceae*
Conium (1)	Apiaceae*
Echinochloa (20)	Poaceae*
Egeria (1)	Hydrocharitaceae
Eichhornia (4)	Pontederiaceae
Epilobium (45)	Onagraceae
Frangula (8)	Rhamnaceae*
Glyceria (18)	Poaceae*
Hydrilla (1)	Hydrocharitaceae
Hydrocharis (1)	Hydrocharitaceae
Hygrophila (6)	Acanthaceae
Impatiens (11)	Balsaminaceae
Iris (52)	Iridaceae
Juncus (123)	Juncaceae
Lupinus (165)	Fabaceae*
Lycopus (10)	Lamiaceae*
Lysimachia (42)	Primulaceae
Lythrum (13)	Lythraceae
Marsilea (12)	Marsileaceae
Mentha (13)	Lamiaceae*
Myosotis (12)	Boraginaceae
Myosoton (1)	Caryophyllaceae
Myriophyllum (14)	Haloragaceae
Najas (8)	Najadaceae
Nasturtium (5)	Brassicaceae
Nitellopsis (3)	Characeae (algae)
Nymphoides (7)	Menyanthaceae
Pistia (1)	Araceae
Pluchea (11)	Asteraceae*
Poa (96)	Poaceae*
Polygonum (80)	Polygonaceae*

PLANTS (continued)	
Genus (2147)	Family
Potamogeton (63)	Potamogetonaceae
Puccinellia (31)	Poaceae*
Rorippa (28)	Brassicaceae
Rumex (55)	Polygonaceae*
Salix (170)	Salicaceae*
Solanum (104)	Solanaceae*
Solidago (77)	Asteraceae*
Sparganium (10)	Sparganiaceae
Trapa (2)	Trapaceae
Typha (4)	Typhaceae
Veronica (34)	Scrophulariaceae*

FISH	
Genus (290)	Family
Alburnus (1)	Cyprinidae
Alosa (6)	Clupeidae
Apeltes (1)	Gasterosteidae
Atherina (1)	Atherinidae
Babka (1)	Gobiidae
Benthophilus (1)	Gobiidae
Carassius (1)	Cyprinidae
Channa (2)	Channidae
Clupeonella (1)	Clupeidae
Cottus (33)	Cottidae
Ctenopharyngodon (1)	Cyprinidae
Cyprinella (30)	Cyprinidae
Cyprinus (1)	Cyprinidae
Enneacanthus (3)	Centrarchidae
Esox (4)	Esocidae
Gambusia (24)	Poeciliidae
Gymnocephalus (1)	Percidae
Hypophthalmichthys (2)	Cyprinidae
Knipowitschia (1)	Gobiidae
Lepisosteus (4)	Lepisosteidae
Lepomis (13)	Centrarchidae
Leuciscus (1)	Cyprinidae
Misgurnus (1)	Cobitidae

FISH (continued)	
Genus (290)	Family
Morone (4)	Moronidae
Neogobius (1)	Gobiidae
Notropis (91)	Cyprinidae
Noturus (29)	Ictaluridae
Oncorhynchus (11)	Salmonidae
Osmerus (1)	Osmeridae
Perca (1)	Percidae
Perccottus (1)	Odontobutidae
Petromyzon (1)	Petromyzontidae
Phenacobius (5)	Cyprinidae
Phoxinus (6)	Cyprinidae
Proterorhinus (1)	Gobiidae
Rutilus (1)	Cyprinidae
Salmo (2)	Salmonidae
Scardinius (1)	Cyprinidae

MOLLUSKS	
Genus (113)	Family
Bithynia (1)	Bithyniidae
Cipangopaludina (2)	Viviparidae
Corbicula (1)	Corbiculidae
Dreissena (2)	Dreissenidae
Elimia (50)	Pleuroceridae
Gillia (1)	Hydrobiidae
Lasmigona (9)	Unionidae
Monodacna(1)	Cardiidae
Pisidium (13)	Sphaeriidae
Potamopyrgus (1)	Hydrobiidae
Radix (1)	Lymnaeidae
Sphaerium (20)	Pisidiidae
Valvata (8)	Valvatidae
Viviparus (3)	Viviparidae

*** = Plant family originally targeted by "Tri-trophic" TCN**

Target Genera (black) +
Watchlist Genera (blue)
(# spp. in North America)

= 2,550 Species
in 101 Genera


WIS
copyright reserved
cm
0 1 2 3 4 5 6 7 8 9 10
v 0254231 WIS
Wisconsin: Dane County
Araceae
Pistia stratiotes L.
Retention pond; assoc.: Eichhornia crassipes and Potamogeton nodosus. Banks lined with Phalaris arundinacea, Typha angustifolia, and a shrubby Salix sp.
These were the only water plants noted. [Collected and brought in by G. Coombs. Identified, pressed, labeled, and mounted by T. S. Cochrane as No. 14914.]
07N 09E 06 NW4 NW4
Both Eichhornia and Pistia grow in intermittent clusters all along the perimeter of the north pond. A single small cluster of Pistia was seen in the south pond at the culvert joining the two ponds, and another small cluster of Pistia was noted in a little pool in the wetland outside the second, gated outlet at the southwest corner of the north pond.
City of Middleton- Northern of two retention ponds in Orchid Heights Park, between (0.5 mi. E of) Pheasant Branch Rd. and (0.5 mi. W of) Co. Hwy. Q, 0.5 mi. N of Century Ave. (= Co. Hwy. M).
Collector
Coombs, Guerdon
Coll. No.
14914
22/Sep/2008
Det. Cochrane, Theodore S. 23Sep2008
UNIVERSITY OF WISCONSIN - MADISON HERBARIUM (WIS)

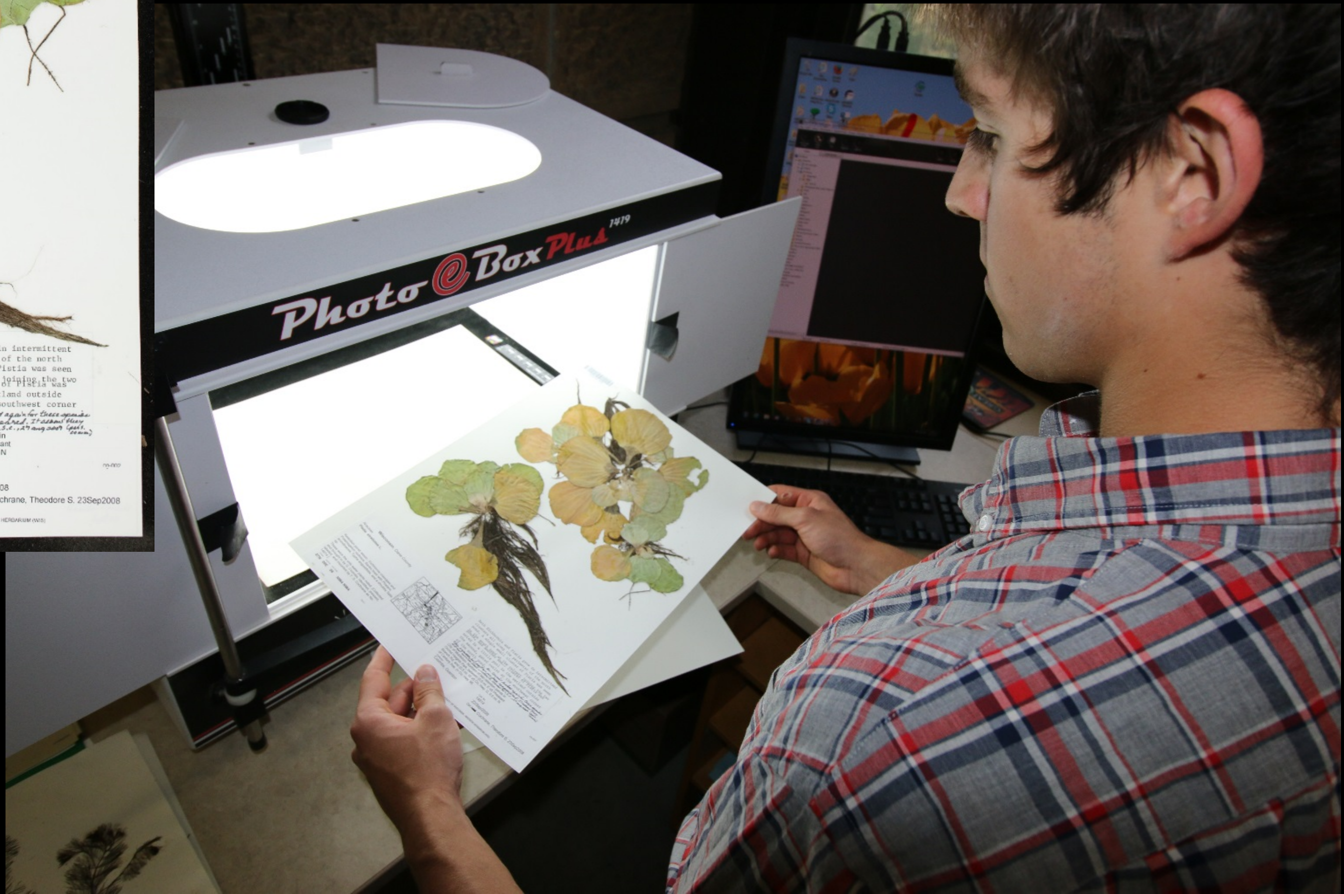



Photo eBox Plus 1419

Details | Comments | Linked Resources

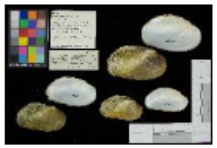
Share 0 Tweet 0

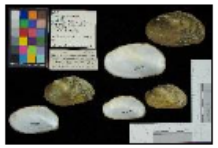
UMMZ : M

University of Michigan Museum of Zoology - Mollusks

Catalog #: UMMZ-MOL-0048617
Taxon: *Lasmigona compressa* (I. Lea, 1829)
Family: Unionidae
Collector:
Locality: United States, Michigan, Jackson, South Branch Kalamazoo River, 4.0 mi. W of Pulaski

Specimen Images


Large Version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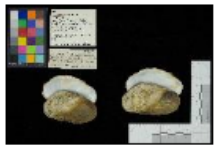
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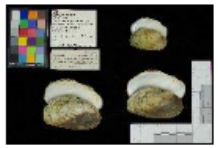
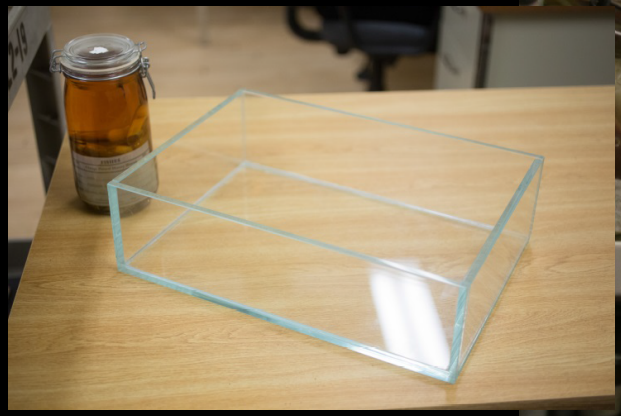

Large Version

Record Id: 7680f405-be34-41e0-8877-c49ef0ab98d6

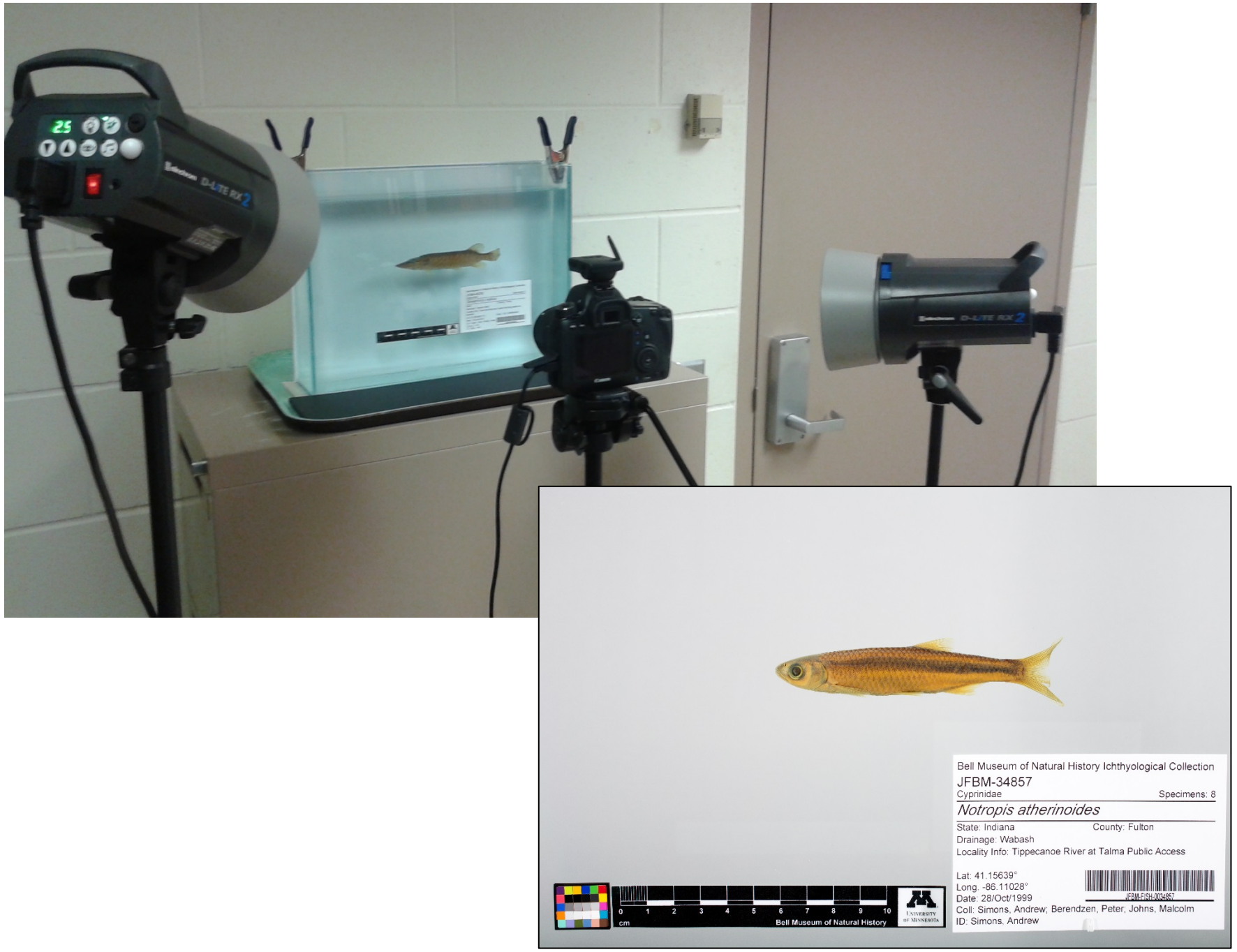
Usage Rights: CC BY-NC-SA (Attribution-NonCommercial-

For additional information on this specimen, please contact
Muse (ptuck@umich.edu)




FMNH 29119 Cichlasoma maculicauda
0 1 2 3 4 5 6 7 8 9 10
cm
copyright reserved
The Field Museum


FMNH 63435 Petromyzon marinus
A
0 1 2
cm
copyright reserved
The Field Museum


Bell Museum of Natural History Ichthyological Collection
JFBM-34857
Cyprinidae
Specimens: 8
Notropis atherinoides
State: Indiana
County: Fulton
Drainage: Wabash
Locality Info: Tippecanoe River at Talma Public Access
Lat: 41.15639°
Long. -86.11028°
Date: 28/Oct/1999
Coll: Simons, Andrew; Berendzen, Peter; Johns, Malcolm
ID: Simons, Andrew
JFBM-FISH-003457
0 1 2 3 4 5 6 7 8 9 10
cm
Bell Museum of Natural History
University of Minnesota

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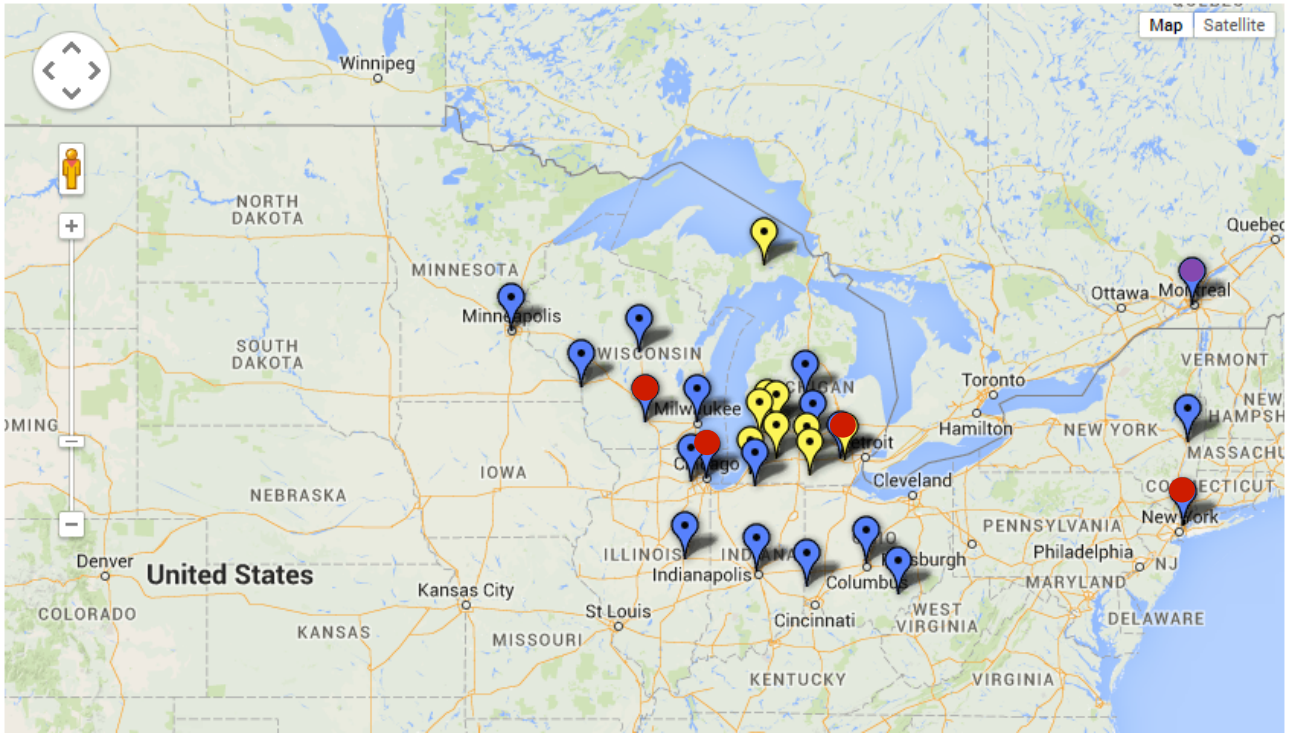
Digitization TCN: Great Lakes Invasives- Collaborator Map



1. Univ of WI-Madison (WIS)
2. Univ of WI-Steven's Point
3. Univ of WI-Milwaukee
4. Univ of WI-LaCrosse
5. University of Minnesota
6. Michigan State Univ

7. Field Museum (F / FMNH)
8. University of Illinois / ILNHS
9. Morton Arboretum ***
10. University of Notre Dame
11. Butler University

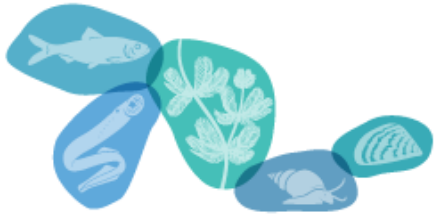
12. Univ of Michigan (MICH)
13. Western Michigan Univ
14. Central Michigan Univ
15. MI Small Herbaria Network ++
16. Miami University
17. Ohio State University
18. Ohio University

19. NY Botanical Garden (NY)
20. New York State Museum

21. Université de Montréal /Canadensys

(22. Arizona State Univ / Symbiota)

http:// GreatLakesInvasives.org



GREAT LAKES
INVASIVES NETWORK

Aquatic Invasives Homepage

- Fish Collections
- Mollusk Collections
- Plant Collections
- Map Search
- Species Lists
- Dynamic Checklist
- Browse Images
- Search Images

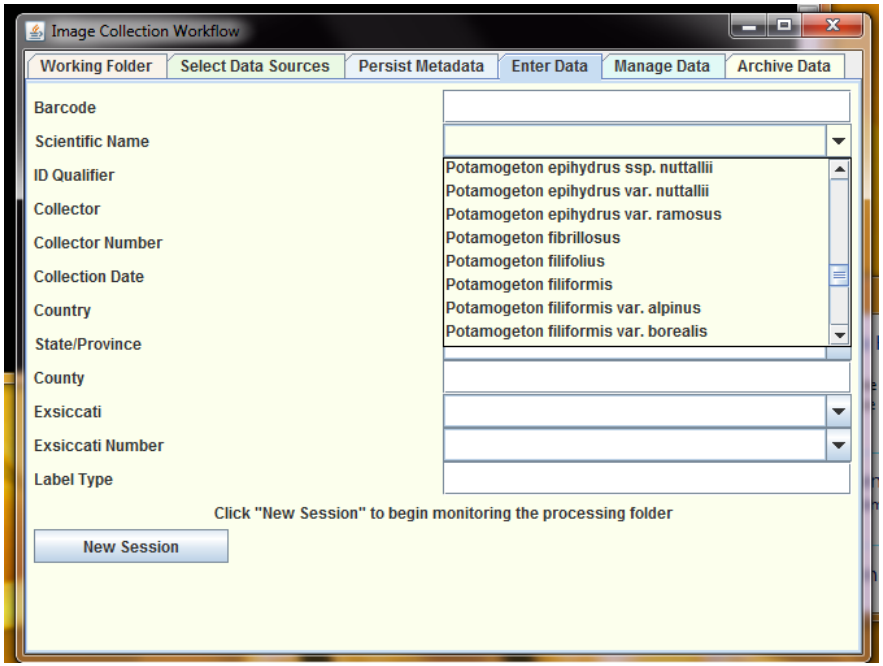
- Log In
- New Account
- Sitemap

One of the greatest threats to the health of North America's Great Lakes is invasion by exotic species, several of which already have had catastrophic impacts on property values, the fisheries, shipping, and tourism industries, and continue to threaten the survival of native species and wetland ecosystems. This bi-national thematic collections network of >20 institutions from eight states and Canada will digitize 1.73 million historical specimens representing 2,550 species of exotic fish, clams, snails, mussels, algae, plants, and their look-alikes documented to occur in the Great Lakes Basin. Others have been placed on watchlists because of their potential to become aquatic invasives.

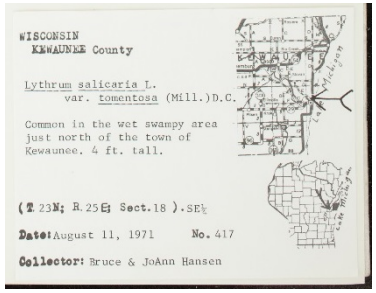
Several initiatives are already in place to alert citizens to the dangers of spreading aquatic invasives among our nation's waterways, but this project will develop complementary scientific and educational tools for scientists, wildlife officers, teachers, and the public who have had little access to images or data derived directly from preserved specimens collected over the past three centuries. This award is made as part of the National Resource for Digitization of Biological Collections through the Advancing Digitization of Biological Collections program and all data resulting from this award will be available through the national resource (iDigBio.org).

Join the network as a regular visitor and please send your feedback to Ken Cameron

1. Skeletal record & image are created *in situ*

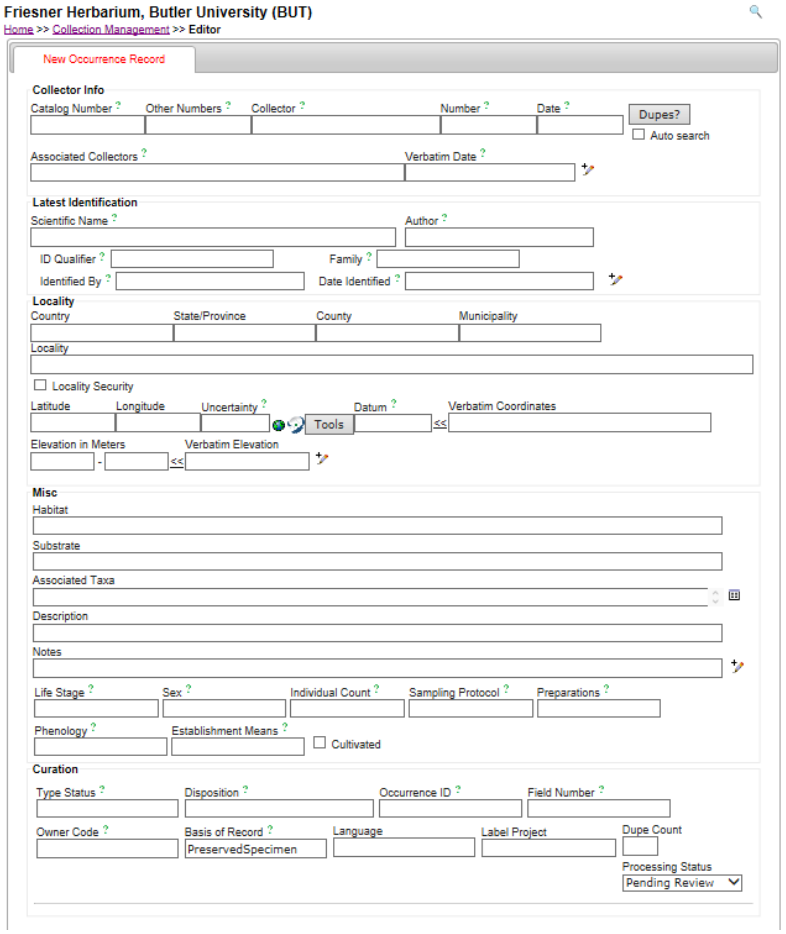


2. Label data is extracted via OCR *ex situ*



ï»¿UNIVERSITY OF WISCONSIN-MADISON (WIS)
v 0047793 WIS
. MAPPED ÃŒ072 FLORA OF WISCONSIN
WISCONSIN KJiWAUNME County
(T. 23N; B. 25 Ei Sect. 18).SE%
August 11, 1971 No. 417
Collector: Bruce & JoAnn Hansen
Lythrum salicaria L.
var. tomentosa
(Mill.)D.C
Common in the wet swampy area just north of the town of Kewaunee. 4 ft. tall.

3. Data is parsed and edited in Symbiota by regional data managers



4. Fed to / ingested by iDigBio

http:// MidwestHerbaria.org

Consortium of Midwest Herbaria

Home | Search Collections | Map Search | Browse Images | Inventories | Interactive Tools | Log In | New Account | Sitemap

Welcome to the Consortium of Midwest Herbaria

While focused around the Great Lakes drainage basin, the region includes the six states that border the western Great Lakes: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. 132 herbaria are listed in Index Herbariorum (Thiers, B. [continuously updated]) from this region; we hope to eventually make data available from a majority of those collections.

The Great Lakes basin includes 84% of North American surface fresh water and includes a mixture of habitat types amidst a landscape that has been highly modified by agricultural and industrial uses and is home to 16% of the US population (US Census Bureau, 2014 estimates). Areas to the south and west of the lakes include lands which form portions of the Mississippi and Ohio River basins; much of this land escaped major glaciation. Plants and communities in the region are diverse, ranging from boreal forest to southern hardwoods, prairies, bogs and fens.

This site is brought to you in collaboration with the Southwestern Environmental Information Network (SEINet).

Plant of the Day

Photo Courtesy of the Forest Preserve District of Dupage County

What is this plant?

Click here to test your knowledge

Français

Canadensys

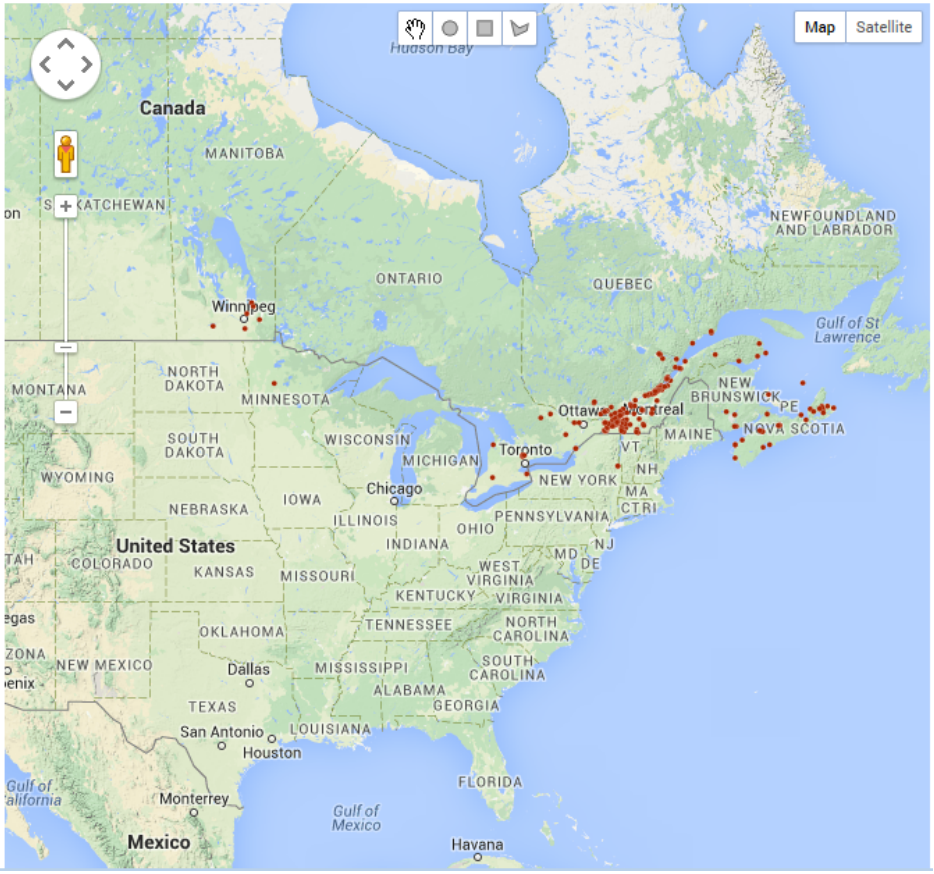
data | community

explorer repository tools vascan

726 Results

Map view | Table view | Stats view

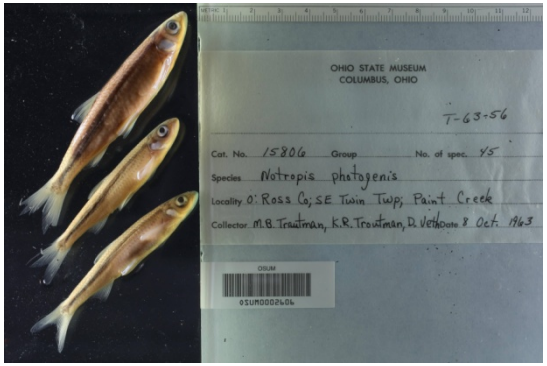
(showing only georeferenced records: 354)



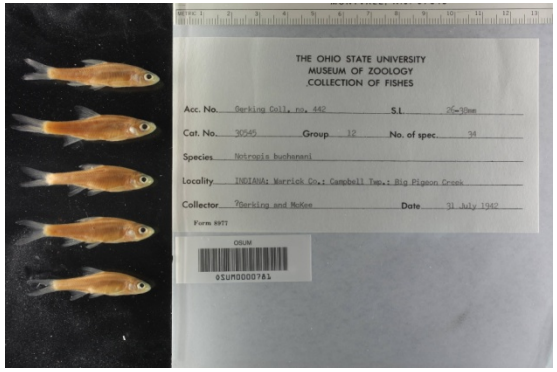
GREAT LAKES INVASIVES NETWORK

Home >> Collections

- [ ] Albion College (ALBC) more info
- [ ] Central Michigan University (CMC) more info
- [ ] Field Museum of Natural History (F) more info
- [x] Green Plant Herbarium (TRT) more info
- [x] Herbarium, Biodiversity Centre of Ontario (OAS) more info
- [x] Herbier du Québec (QUE) – Collection de plantes vasculaires (QUE) more info
- [x] Herbier Louis-Marie (QFA) - Collection de plantes vasculaires (QFA) more info
- [ ] Illinois Natural History Survey (ILLS) more info
- [ ] J. F. Bell Museum of Natural History Herbarium (MIN) more info
- [x] Jardin Botanique de Montréal (JBM) more info
- [x] Marie-Victorin Herbarium (MT) more info

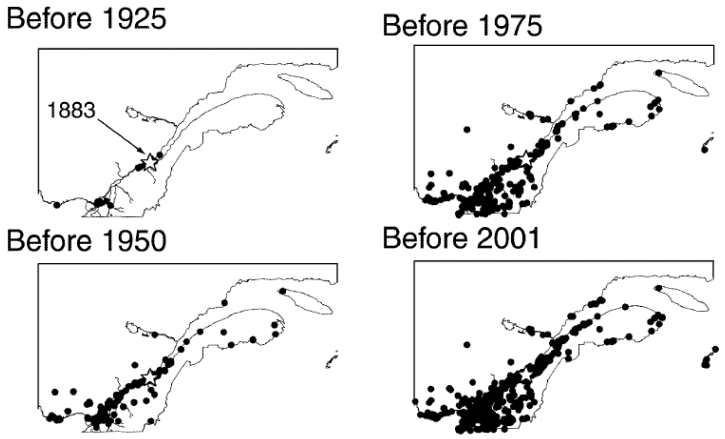


Notropis photogenis (silver shiner)

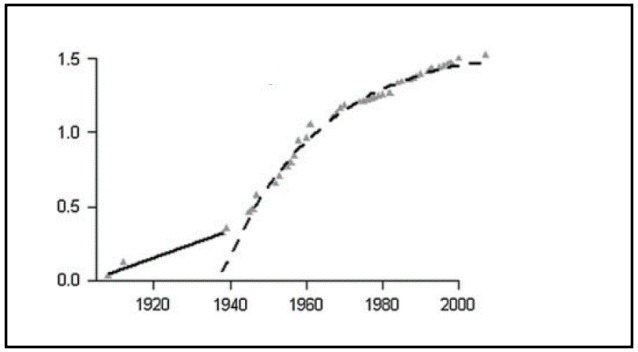


Notropis buchanani (ghost shiner)

Using Specimens to
Recognize the
Good from the Bad



Points of Origin and
Patterns of Invasion
SPATIAL



Invasion Lag Time
TEMPORAL

Occurrence Data
Based on Vouchers!

GREAT LAKES
INVASIVES NETWORK

Species List | Occurrence Records | Maps

Dataset: All Specimen Collections
Taxa: Myriophyllum heterophyllum

1 2 Page 1, records1-100 of 146

Central Michigan University

CMC

Myriophyllum heterophyllum Michx.
CMC00008418 C.E. Whately 170 16 July 2000
United States, Michigan, Charlevoix, Hog Island, Beaver Island, St James township
Full Record Details

Field Museum of Natural History

F

Myriophyllum heterophyllum Michx.
6744553 E. E. Sherff 10 June 1911
U.S.A., Illinois, Cook, Chicago, 41.85000 -87.65000
Full Record Details

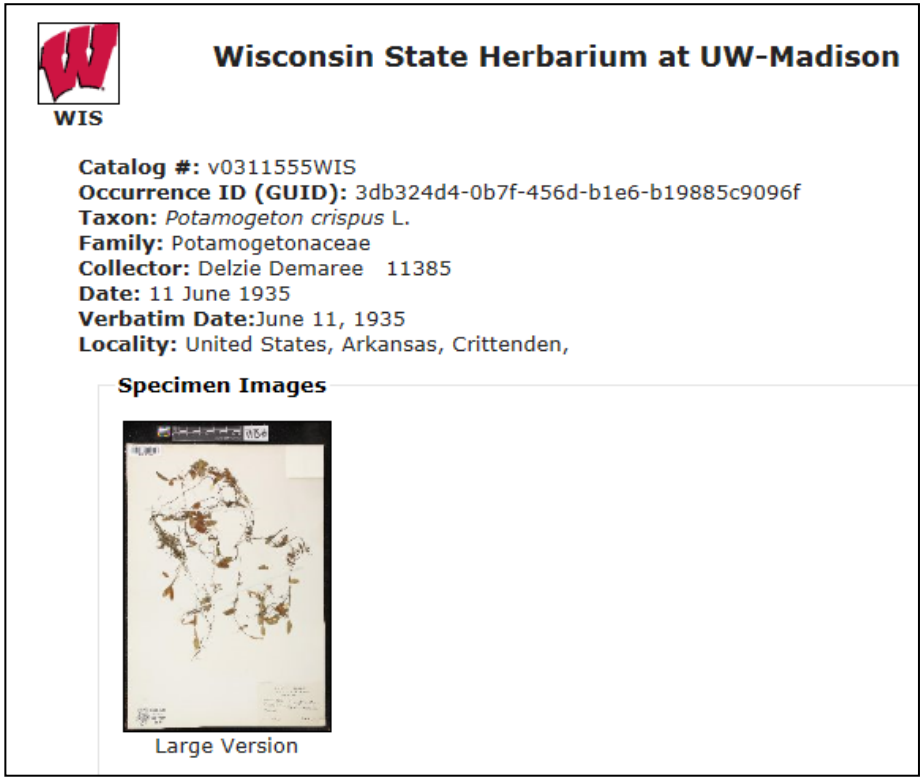
F

Myriophyllum heterophyllum Michx.
467511 G. R. Vasey
U.S.A., Illinois, McHenry, Ringwood, 42.38330 -88.28330
Full Record Details

F

Myriophyllum heterophyllum Michx.
1328585 J. A. Steyermark 40913 16 August 194
U.S.A., Illinois, Cook, 41.83330 -87.85000
Full Record Details

I would like to respectfully report an issue with your herbarium database. I was looking for the oldest specimen of Potamogeton crispus *collected from Arkansas and thought I found it, but upon viewing the image, I noticed it is the wrong species. It is* Potamogeton dimorphus *not* P. crispus.



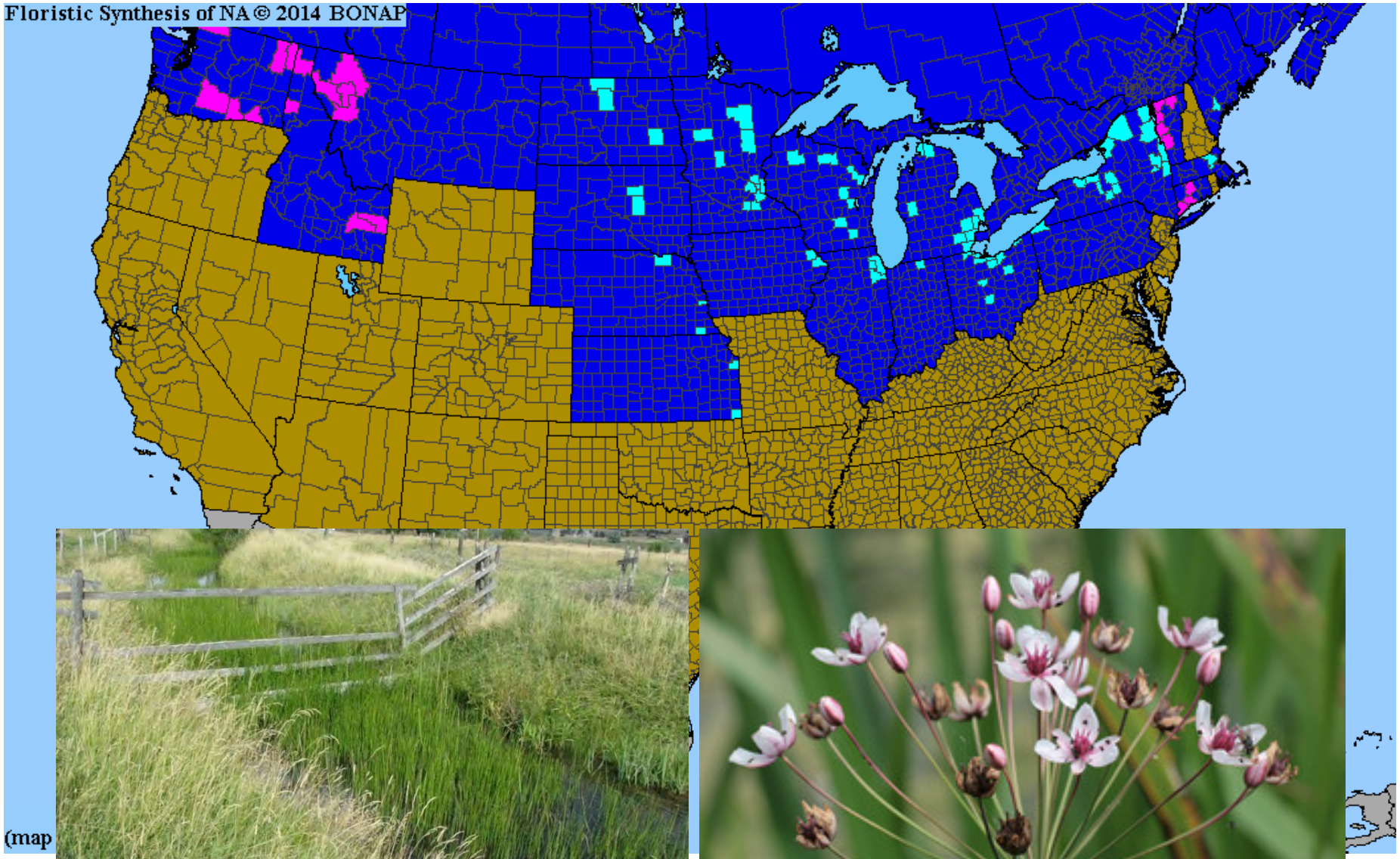
Wisconsin State Herbarium at UW-Madison

WIS

Catalog #: v0311555WIS
Occurrence ID (GUID): 3db324d4-0b7f-456d-b1e6-b19885c9096f
Taxon: *Potamogeton crispus* L.
Family: Potamogetonaceae
Collector: Delzie Demaree 11385
Date: 11 June 1935
Verbatim Date: June 11, 1935
Locality: United States, Arkansas, Crittenden,

Specimen Images

Large Version



(map

Butomus umbellatus

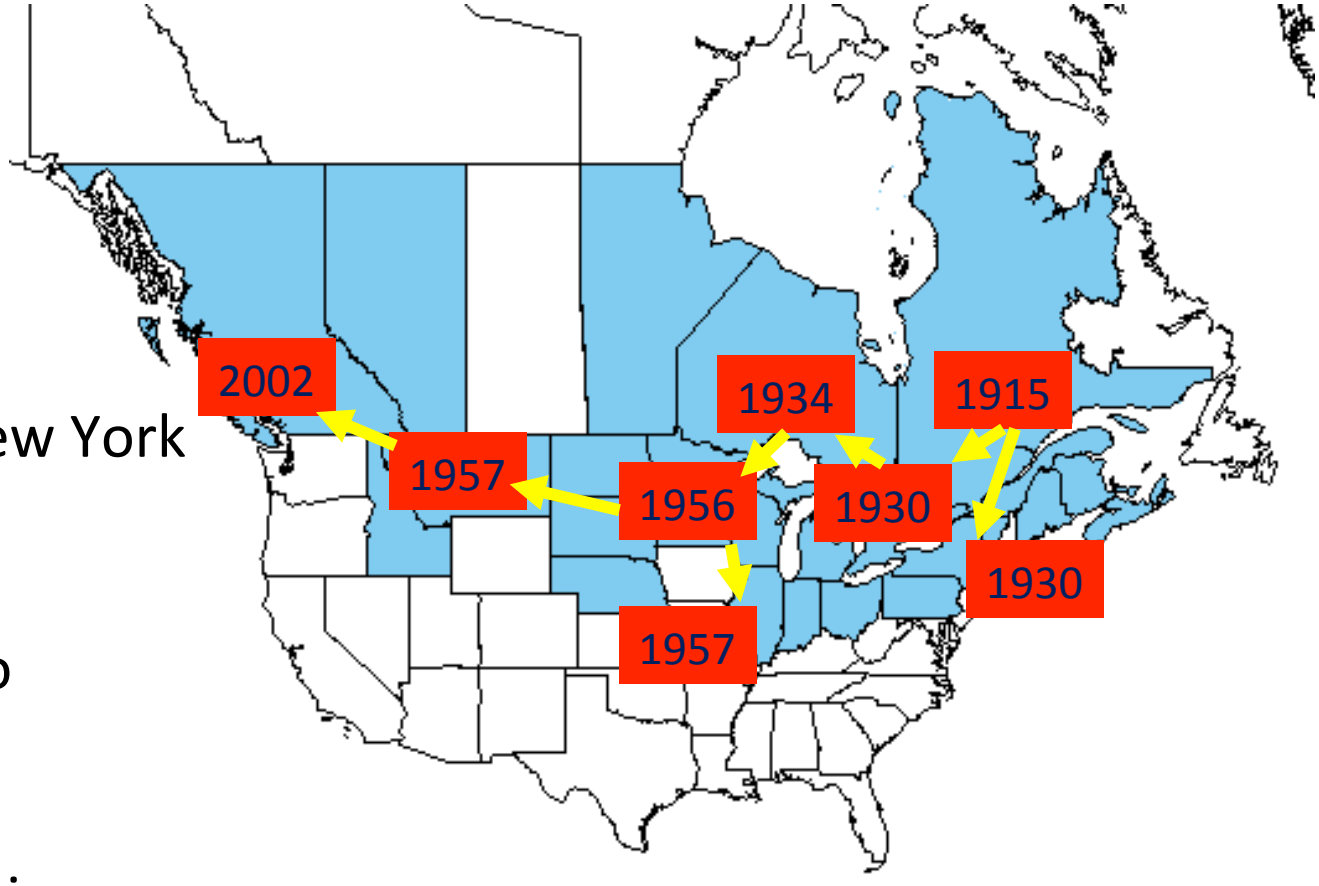
GREAT LAKES
INVASIVES NETWORK

Home >> Collections >> Search Criteria >> **Specimen Records**

Species List | Occurrence Records | Maps

Dataset: All Specimen Collections
Taxa: Butomus umbellatus

1 2 3 Page 1, records1-100 of 245

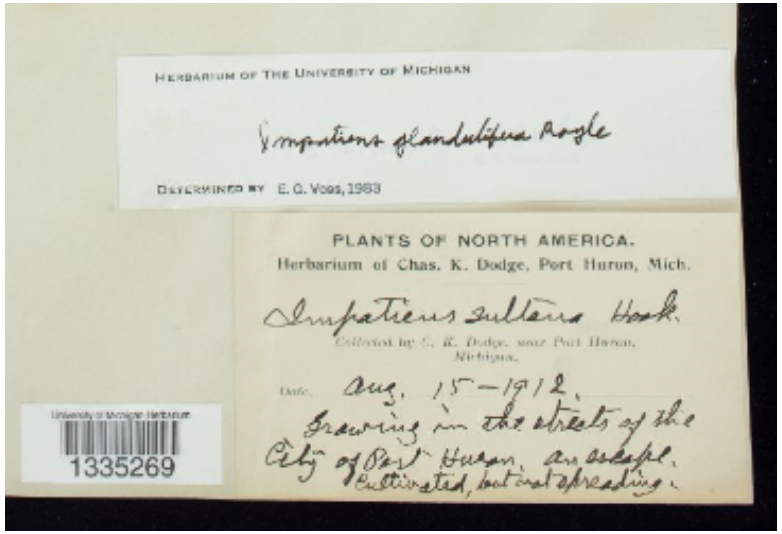


Oldest Specimen

1915 Quebec
1930 Michigan & New York
1934 Ontario
1956 Wisconsin
1957 Illinois & Idaho
1963 Ohio
1975 Vermont
2002 British Colombia

1912 Michigan
1935 British Colombia
1937 Washington
1940 Quebec
1941 Ontario
1946 New Brunswisck
1953 Nova Scotia
1966 California
1984 Michigan (again)
2000 New York & Wisconsin

Impatiens glandulifera



"Growing in the streets of the City of Port Huron. An escape, cultivated, but not spreading"
Aug 1912

Collection	Total Occurrences	Occurrences w/ locality	Occurrences w/ images
CMC	3412	3398	3404
F	5782	3381	0
ILL	5536	0	5497
ILLS	38253	36733	11109
JBM	1286	191	0
JFBM-Fish	2110	2099	2062
MICH	74640	61229	66777
MIN	28953	17	28906
MOR	10219	10060	7351
MSC	7386	0	7384
MT	35383	35358	394
MU *	17547	5	17512
NY	22282	20926	11208
OAS	10230	2	10230
OS	394	0	394
OS-Fish	3522	0	3472
QFA	13321	13289	0
QUE	504	504	0
TRT	18906	18735	0
TRTE	10920	10850	0
UBC	26521	26480	3654
UMMZ-Fish	128	128	48
UMMZ-Mollusk	855	855	414
UWL	604	0	603
UWM *	7255	1715	7225
UWZM-Fish	187	187	0
UWZM-Mollusk	444	444	0
WIN	5745	5745	0
WIS *	86078	65599	86078
TOTALS	**438,406**	**317,930**	**271,347**

PROGRESS TO DATE
18 MONTHS

In the GLI portal:
431,160 plant records
5,947 fish records
1,299 mollusk records

*** Digitization complete**

GREAT LAKES
INVASIVES NETWORK

http:// GreatLakesInvasives.org
http:// MidwestHerbaria.org

iDigBio
Integrated Digitized Biocollections

NSF