Early Detection and Monitoring of Aquatic Invasive Species in Lake Michigan

Darin G. Simpkins Acting AIS Coordinator for Lake Michigan U.S. Fish and Wildlife Service

Laurentian Great Lakes

- Largest Freshwater system in the world
- 21% of world's freshwater 84% of North America's Freshwater
- Provides a variety of unique wetland, near-shore, and deep-water habitats that support a diverse array of plant animal and fish species.
- Wide biological diversity contributes heavily to the regions economy.
- Valued at \$15 billion annually
 - \$7.1 billion related to commercial and sport fisheries alone
 - 85,000 jobs supported 58,000 specifically related to sport fishing



Non – Native Species



- Total number in the Great Lakes > 184 species
- On average, one new species introduced every year (Bright 1998)
- Not every introduction successfully establishes
- Not all will cause negative ecological or economic impacts
- AIS threaten:
 - Native species competition
 - •Ecosystem processes and health nutrient cycling and energy transfer
 - •Economy
 - Economic loss for all Great Lakes AIS > \$5.6 billion annually
 - •\$4.5 billion loss in commercial and sport fisheries alone.

Great Lakes Restoration Initiative (GLRI) Action Plan (2010)



- Determine invasion hotspots
- Develop early detection sampling plans for fishes and macroinvertebrates
 - find rare AIS before it is common
- "By 2014, a basin-wide *surveillance program* with shared sampling protocols and methodologies to provide early detection of nonnative species will be operational."

2012 Amendments of the 1978 Great Lakes Water Quality Agreement between U.S. and Canada

"within two years of entry into force of this agreement, develop and implement an *early detection* and *rapid response* initiative"



Pathways/Vectors of Invasion



- Maritime Commerce ballast water/hull fouling
 - 48% AIS in Lake MI from ballast water transmission
- Hydrologic Connections canals, locks, water diversions, rivers
 - 10% AIS known to have entered Lake MI this way
- Organisms in trade aquaculture, aquarium pets, bait, release of live food fish
 - 20% AIS are known to have entered Lake MI this way.
- Water recreation diving, fishing, & boating gear
- Agency Activities stocking, habitat restoration, rescue, & harbor maintenance activities
- Illegal activities unauthorized introductions

Based on proxies of these vectors (number of ships from international and national ports, hydrologic connections to known sources, and human population size), risk analysis for invasion was conducted for Lake Michigan.

2015 Lake Michigan AIS Vector Risk Analysis

Green Bay FWCO

Invasion Hotspots

- Calumet Harbor, IL
- Chicago Harbor, IL
- Burns Harbor, IN
- Port of Milwaukee, WI
- Port of Green Bay, WI











Fig. 4 Adult Limnoperna fortunei. (http://biolo.bg.fcen.uba.ar/primerapagina.htm

Lake Michigan Basin-wide AIS Surveillance

- eDNA Asian Carp
 - Sample locations prioritized based on liklihood of establishment
 - Sample sites are areas of accumulation
 - Vectors fish mucus, eggs, birds, boats, etc.
- Icthyoplankton Fish Larvae and Zooplankton
 - Light traps
 - Bongo Net Tows
 - Traditonal Gears Juvenile and Adult Fish
 - Electrofishing
 - Experimental Gill nets
 - Paired Fyke nets
 - Minnow traps
- Macroinvertebrates
 - Sediment grab samples
 - Colonization plates/rock bags
- NextGen Sequencing
 - Icthyoplankton
 - Macroinvertebrates









eDNA Sample Locations (2013-2015)



eDNA Sampling Effort for Lake Michigan Tributaries

All results posted at http://www.fws.gov/midwest/fisheries/eDNA/Results-michigan.html

River	State	2013	2014	2015
Muskegon River	MI	150	300	360
Kalamazoo River	MI	200	600	480
St. Joseph River	MI	200	400	520
Grand River	MI	100	200	600
Galien River	MI	-	25	-
Paw Paw River	MI	-	25	-
Fox River	WI	-	400	240
Milwaukee River	WI	-	200	240
Sheboygan River	WI	100	-	-
Sturgeon Bay	WI	150	-	-
Total eDNA samples		900	2150	2440

Larval, Juvenile, and Adult Fish, Zooplankton and Macroinvertebrate AIS Sampling Effort (2013-2015)



Larval, Juvenile, and Adult Fish, Zooplankton and Macroinvertebrate AIS Sampling Effort

		Juvenile and Adult			Larvae		Benthos
Site	State	2013	2014	2015	2014	2015	2015
Arcadia	MI	-	-	31	-	17	10
Benton Harbor	MI	-	-	26	-	16	10
Burns Harbor	IN	66	68	101	-	13	20
Calumet Harbor	IL	-	21	115	-	13	20
Chicago Harbor	IL	-	-	109	-	3	20
Green Bay	WI	8	61	204	318	285	70
Ludington	MI	-	-	18	-	16	10
Manitowoc	WI	-	-	36	-	24	10
Milwaukee							
Harbor	WI	63	73	96	-	16	20
Racine	WI	-	-	35	-	24	10
Saugatuck	MI	-	-	23	-	8	10
Sturgeon Bay	WI	-	-	36	-	24	10
Winthrop							
Harbor	IL	-	-	36	-	24	10
Yearly Total		137	223	866	318	483	230
Overall Total				1226		801	230
Grand Total							2257

Sampling Thoroughness – Species Accumulation Curves



96% of fish species in near-shore zones of Lake Michigan were collected with 866 units of effort in 2015

AIS Early Detection and Monitoring Findings



- No new AIS collected or reported in Lake Michigan
- However new occurrences of previously established AIS have been documented since 2010.
- USGS NAS database lists 67 existing AIS in Lake MI proper
- See http://nas.er.usgs.gov/default.aspx
 - 1 Annelid; 1 Bryozoan; 1 Coelenterate
 - 13 Crustaceans
 - 36 fishes
 - 12 mollusks
 - 3 submersed vascular plants
- Two of these, a crusteacean (Bloody Red Shrimp) and mollusk (New Zealand Mudsnail), have expanded their range.

Bloody Red Shrimp Sightings (2006-2013)

From http://nas.er.usgs.gov/default.aspx



New Zealand Mudsnail Sightings (2006-2015) See http://nas.er.usgs.gov/default.aspx



Questions?



Acknowledgments

Great Lakes Restoration Initiative Great Lakes Water Quality Agreement Wisconsin Department of Natural Resources Michigan Department of Natural Resources Indiana Department of Natural Resources Illinois Department of Natural Resources US Geological Survey University of Notre Dame Central Michigan University The Nature Conservancy Asian Carp Regional Coordination Committee US Fish and Wildlife – Region 3