

Preventing Invasions from Trade in Live Aquatic Organisms

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Preparing people to lead extraordinary lives



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The Nature
Conservancy

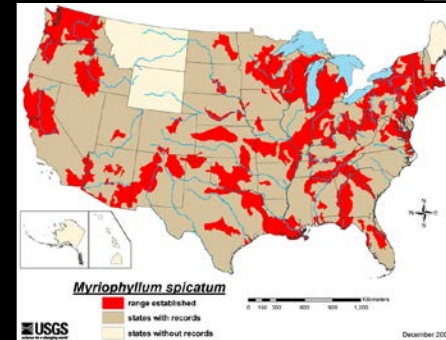


Fisheries and Oceans
Canada

Pêches et Océans
Canada

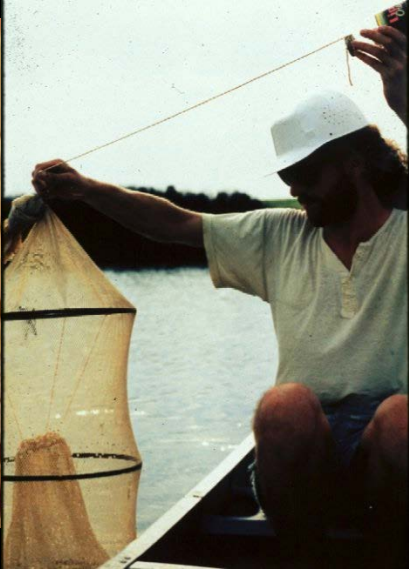
Organisms in Trade

Taxa	Species	
Plants	<i>Cabomba caroliniana</i> (Cabomba)	
	<i>Egeria densa</i> (Brazilian waterweed)	
	<i>Eichornia crassipes</i> (Water hyacinth)	
	<i>Glyceria maxima</i> (Tall mannagrass)	
	<i>Hydrocharis morsus-ranae</i> (European frog-bit)	
	<i>Iris pseudocorus</i> (Yellow iris)	
	<i>Lysimachia numularia</i> (Moneywort)	
	<i>Marsilea quadrifolia</i> (Water shamrock)	
	<i>Mentha aquatica</i> (Water mint)	
	<i>Myosotis scorpioides</i> (Water forget-me-not)	
	<i>Myriophyllum aquaticum</i> (Parrot feather)	
	<i>Myriophyllum spicatum</i> (Eurasian watermilfoil)	
	<i>Najas minor</i> (Lesser naiad)	
	<i>Nymphoides peltata</i> (Yellow floating-heart)	
	<i>Pistia stratiotes</i> (Water lettuce)	
	<i>Potamogeton crispus</i> (Curly-leaved pondweed)	
	<i>Trapa natans</i> (Water chestnut)	
	<i>Typha angustifolia</i> (Narrow-leaved cattail)	
	Fish	<i>Ameiurus melas</i> (Black bullhead)
		<i>Cyprinus carpio</i> (Common carp, koi)
<i>Carassius auratus</i> (Goldfish)		
<i>Gambusia affinis</i> (Mosquitofish)		
<i>Micropterus salmoides</i> (Largemouth bass)		
<i>Misgurnus anguillicaudatus</i> (Oriental weatherloach)		
<i>Notemigonus crysoleucas</i> (Golden shiner)		
<i>Pimephales promelas</i> (Fathead minnow)		
Molluscs	<i>Corbicula fluminea</i> (Asiatic clam)	
Crayfish	<i>Orconectes rusticus</i> (Rusty crayfish)	



Potential for Future Invasions

Taxa	Species
Plants	<i>Aponogeton distachyos</i> (Water hawthorne)
	<i>Houttuynia cordata</i> (Chameleon)
	<i>Marsilea mutica</i> (Water fern)
	<i>Ophiopogon japonicus</i> (Mondo grass)
	<i>Ranunculus lingua</i> (Greater spearwort)
	<i>Salvinia auriculata</i> (Eared watermoss)
Fish	<i>Aristichthys nobilis</i> (Bighead carp)
Amphibia	<i>Xenopus laevis</i> (African clawed frog)



Regulatory Response

Species	IL	IN	MI	MN	NY	OH	ON	PA	WI
Bighead carp (<i>Hypophthalmichthys nobilis</i>)	X	X	X	X	X	X	X	X	X
Bitterling (<i>Rhodeus sericeus</i>)			X						
Black carp (<i>Mylopharyngodon piceus</i>)	X	X	X	X	X	X	X	X	X
Chinese weatherloach (<i>Misgusnus anguillicaudatus</i>)			X						
Eastern banded killifish (<i>Fundulus diaphanus</i>)						X			
Grass carp, triploid (<i>Ctenopharyngodon idella</i>)			X	X	X		X		X
Grass carp, diploid (<i>Ctenopharyngodon idella</i>)						X		X	X
Ide/Orfe (<i>Leuciscus idus</i>)			X						
Mosquitofish, eastern (<i>Gambusia holbrooki</i>)									X
Mosquitofish, western (<i>Gambusia affinis</i>)									X
Piranha (<i>Multiple genera</i>)					X				
Round goby (<i>Neogobius melanostomus</i>)	X	X		X		X	X	X	
Rudd (<i>Scardinius erythrophthalmus</i>)	X	X	X	X		X	X	X	
Ruffe (<i>Gymnocephalus cernuus</i>)	X	X		X		X	X	X	
Sea lamprey (<i>Petromyzon marinus</i>)				X		X			
Silver carp (<i>Hypophthalmichthys molitrix</i>)	X	X	X	X	X	X	X	X	X
Snakehead, giant (<i>Channa micropeltes</i>)									X
Snakehead, northern (<i>Channa argus</i>)	X	X	X	X	X	X	X	X	X
Snakehead family									X
Red shiner (<i>Cyprinella lutrensis</i>)									X
Tench (<i>Tinca tinca</i>)			X						
Three spine stickleback (<i>Gasterosteus aculeatus</i>)						X			
Tilapia (<i>Multiple genera</i>)								X	
Tube-nose goby (<i>Proterorhinus marmoratus</i>)	X	X		X		X	X	X	
Walking catfish (<i>Family Clariidae</i>)	X								
Walking catfish (<i>Clarias batrachus</i>)						X			
White perch (<i>Morone americana</i>)		X		X		X			
Zander (<i>Sander lucioperca</i>)				X					X

Data from Lindsay Chadderton, TNC

Situation for the Great Lakes

- All Great Lakes states are subject to risks from invasive freshwater species in trade
- Protections are only as good as the least effective regulations/enforcement
- Coordination is essential to meet goals of preventing new invaders from arriving

Goals

Research Objectives

Objective 1: Develop risk assessment tools for fishes, plants, mollusks, amphibians, reptiles and crustaceans for the GL Basin.

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Species lists annotated for risk distributed to stakeholders across GL basin, made available online.



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Outcomes

Objective 1: Develop risk assessment tools for fishes, plants, mollusks, amphibians, reptiles and crustaceans for the GL Basin.



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Objective 2: Use tools (Objective 1) to assess invasion risks of species currently in trade in the GL Basin



Species lists annotated for risk distributed to stakeholders across GL basin, made available online.

GL governments have scientifically rigorous and comprehensive information and tools to support coordinated action to manage high risk aquatic species in trade now and in the future.

Objective 1: Risk Assessment Development

1



2



3 Invasion Process

Species Elsewhere

↓
Introduced

↓
Established

↓
Invasive

Gather species data
and look for patterns
explaining success

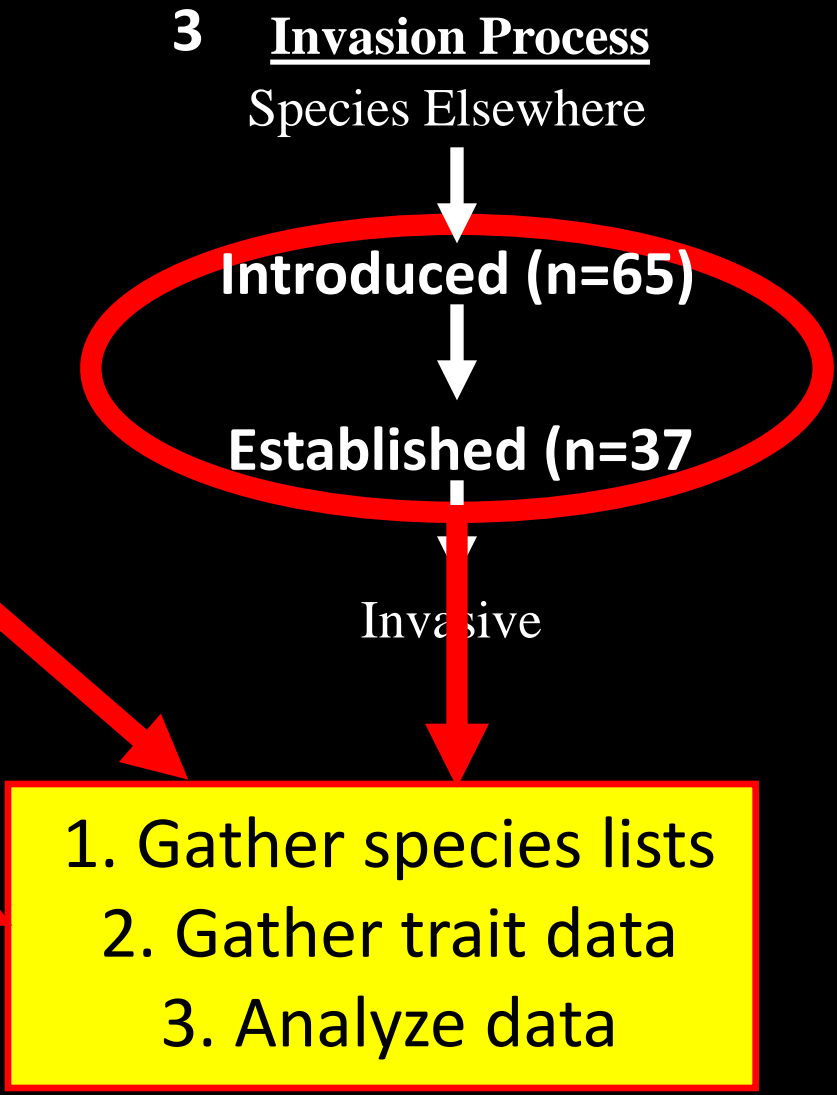
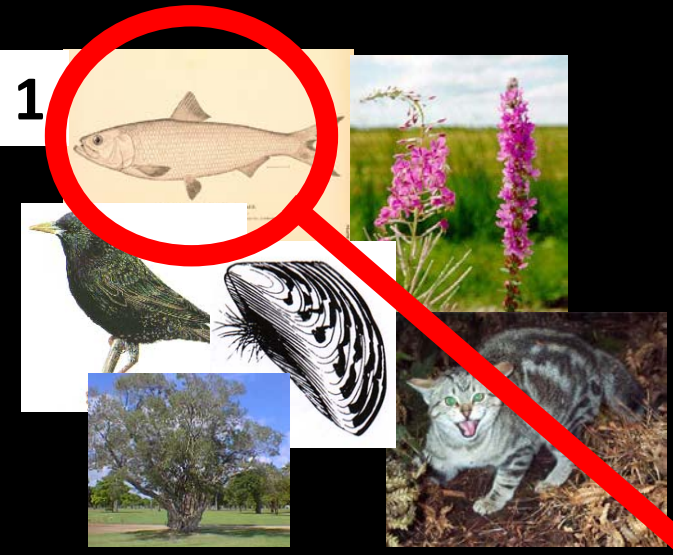
Objective 1: Stakeholder Process

- Worked throughout with *Management Transition Board* to ensure that our work meets the needs of state policy-makers
 - Developing tools is a trade-off between performance/cost/data availability, etc.
 - The most accurate tools are not necessarily the best!
- Training Webinars and meetings for completed tools
- Notre Dame STAIR tools (*Science-based Tools for Assessing Invasion Risk*)

Objectives 1 & 2: Current Status

Risk Assessment Tool	Status of Tool	Species assessed?
<i>STAIRplants</i>	US model and results published, GL paper in preparation, training in fall 2012	Yes
<i>STAIRmollusks</i>	Model complete, training during fall 2013	Yes
<i>STAIRcrayfish</i>	Model complete, training during spring 2014	No
<i>STAIRfish</i>	Model complete, training today during spring 2014	Yes
<i>STAIRherptile</i>	Models under development	No

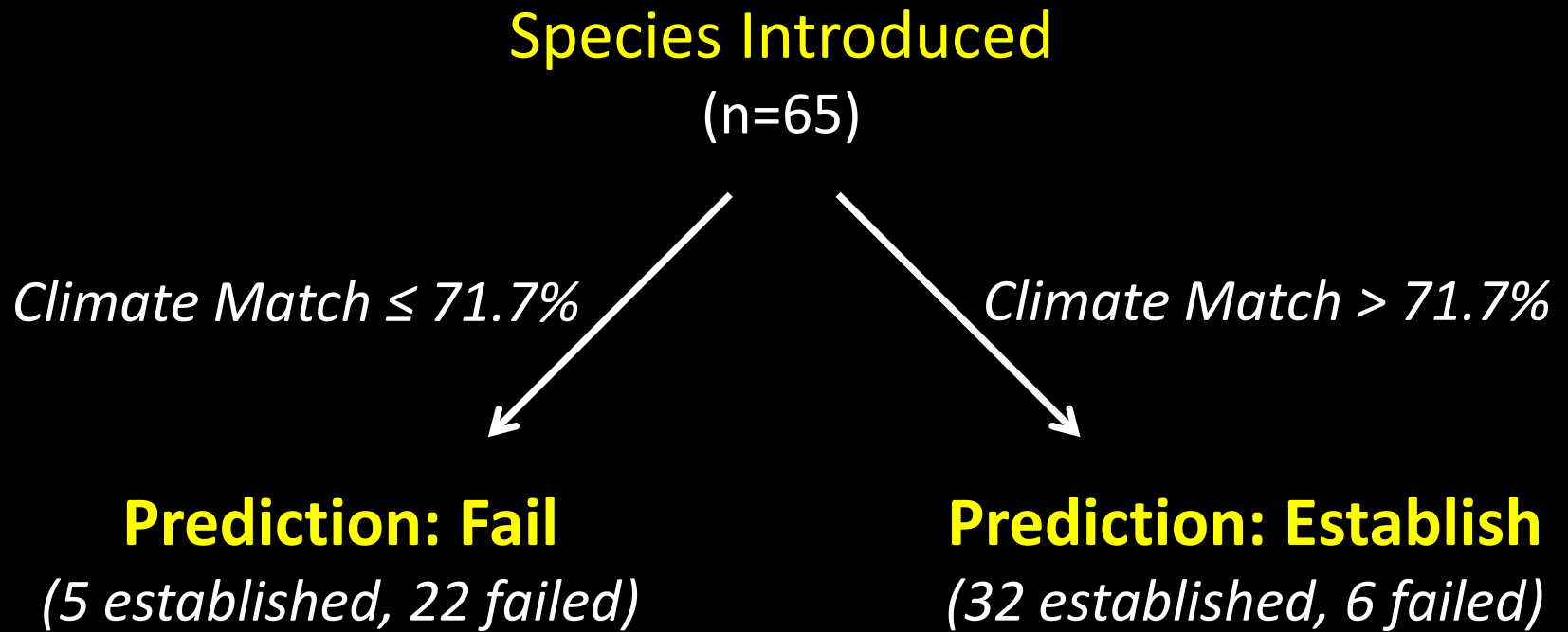
Risk Assessment for Fishes in the Great Lakes



Fishes: Species Lists and Trait Data

<i>Life-history</i>	<i>Habitat preference</i>	<i>Phylogenetic</i>
Body size	Macrohabitat preference	Phylogeny
Egg size	Salinity tolerance	Relatedness
Fecundity	Temperature tolerance	
Larval size		<i>Trophic ecology</i>
Longevity	<i>Invasion risk</i>	Diet breadth
Maturation size	Climate similarity	Trophic guild
Reproductive guild	Prior invasion success	
Spawning frequency		<i>Native range</i>
		Size of range

Fishes: Introduced to Established



Fishes: Established to Invasive

Species Established

(n=37)

Trophic Guild: Other

*Trophic Guild: Piscivore,
Invertivore/Piscivore*

(5 high, 11 low)

Prediction: High Risk

(8 high, 1 low)

Fecundity

< 1,013,000 eggs

Fecundity

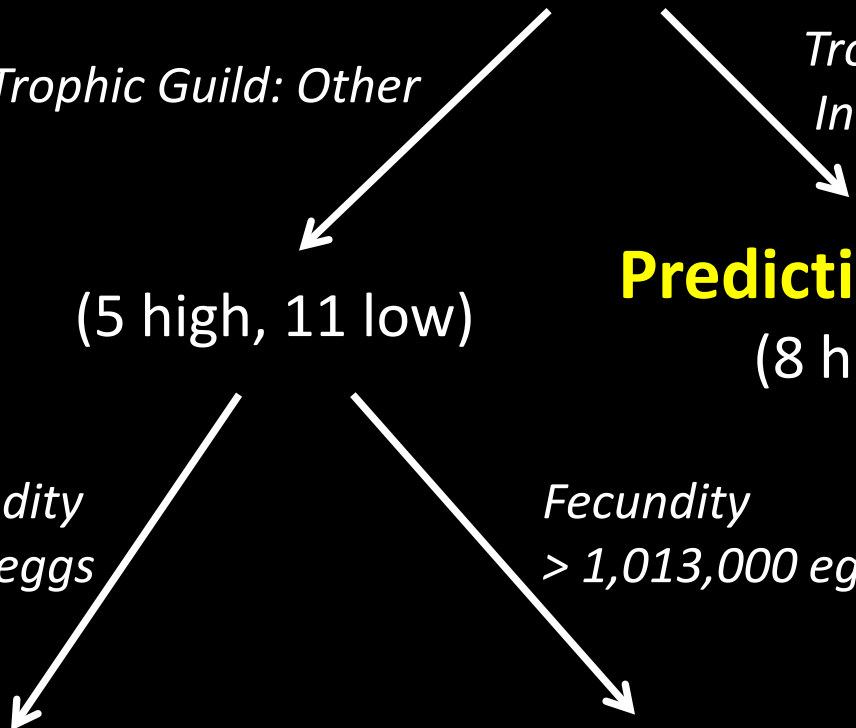
> 1,013,000 eggs

Prediction: Low Risk

(2 high, 11 low)

Prediction: High Risk

(2 high, 0 low)



Plants: GLAqWRA questions and scoring

- 38 questions in 12 categories with scores summed
 - Climate/distribution
 - Invasiveness elsewhere
 - Habitat breadth
 - Potential for spread
 - Generation time
 - Reproductive capacity
 - Competitive ability
 - Impacts to water flow
 - Impacts to water chemistry
 - Impacts to native systems
 - Other negative impacts
 - Response to management
 - AqWRA score
 - Range of possible scores 3 to 91
 - Thresholds can be found to distinguish invaders from others
- History / Biogeography
- Biology / Ecology

New Plant Regulations in IN and IL

Sec. 23. (a) The following are prohibited invasive aquatic plants and are declared pests or pathogens regulated under this section:

- (1) *Azolla pinnata* (mosquito fern).
- (2) *Butomus umbellatus* (flowering rush).
- (3) *Caulerpa taxifolia* (caulerpa or Mediterranean killer algae).
- (4) *Egeria densa* (Brazilian elodea, Brazilian waterweed, Anacharis, or Egeria).
- (5) *Eichhornia azurea* (anchored water hyacinth).
- (6) *Hydrilla verticillata* (Hydrilla or water thyme).
- (7) *Hydrocharis morsus-ranae* (European frogbit or common frogbit).
- (8) *Hygrophilia polysperma* (miramar weed, Indiana swampweed, or hygro).
- (9) *Ipomoea aquatica* (Chinese waterspinach or swamp morning-glory).
- (10) *Iris pseudacorus* (yellow flag iris or tall yellow iris).
- (11) *Lagarosiphon major* (oxygen weed or African elodea).
- (12) *Limnophila sessiliflora* (Asian marshweed or ambulia).
- (13) *Monochoria hastata* (monochoria, arrowleaf, or false pickerelweed).
- (14) *Monochoria vaginalis* (heartshape or false pickerelweed).
- (15) *Myriophyllum aquaticum* (parrot feather or parrot feather watermilfoil).
- (16) *Myriophyllum spicatum* (Eurasian watermilfoil).
- (17) *Najas minor* (brittle naiad or brittle water nymph).
- (18) *Nymphoides peltata* (yellow floating heart).
- (19) *Ottelia alismoides* (duck lettuce).
- (20) *Potamogeton crispus* (curlyleaf pondweed).
- (21) *Sagittaria sagittifolia* (arrowhead).
- (22) *Salvinia auriculata* (giant salvinia).
- (23) *Salvinia biloba* (giant salvinia).
- (24) *Salvinia herzogii* (giant salvinia).
- (25) *Salvinia molesta* (giant salvinia).
- (26) *Sparganium erectum* (exotic bur-reed).
- (27) *Trapa natans* (water chestnut).
- (28) *Typha angustifolia* (narrow-leaf cattail).

Risk Assessment for Reptiles & Amphibians

Alternative Policy: Risk Assessment, remove high risk species from trade

Question: Under such a policy, how much is it worth spending per species to assess risk?



Burmese python

Photo: Skip Snow, National Park Service, Bugwood.org



Nile monitor

Photo: Gary M. Stolz, USFWS, Bugwood.org

African rock python



Photo: South Florida Water Management District

Risk Assessment for Reptiles & Amphibians

Methods:

- Construct risk assessment from readily available data
- Assess the economic outcomes from applying that risk assessment to the US live import trade

Factors Included:

- Number of species in trade
- Value of species in trade
- Rate at which species in trade become invasive
- Cost of invasive species

Risk Assessment for Reptiles & Amphibians

Answer: It is worth paying from \$54,000 - \$141,000 to assess each species within a program of risk assessment

Our risk assessment is basic, but would still allow at least 73% of new species for import



Conclusions

- High performance risk assessment tools can be produced
- Stakeholder engagement has improved our tools and made them more relevant for managers
- Risk assessment tools are an essential component of a regional approach to invasive species prevention
- Coordinated approach is environmentally *and* economically rational