Looking Forward: Risk Assessment Tools to Identify Future Invaders Before They Arrive

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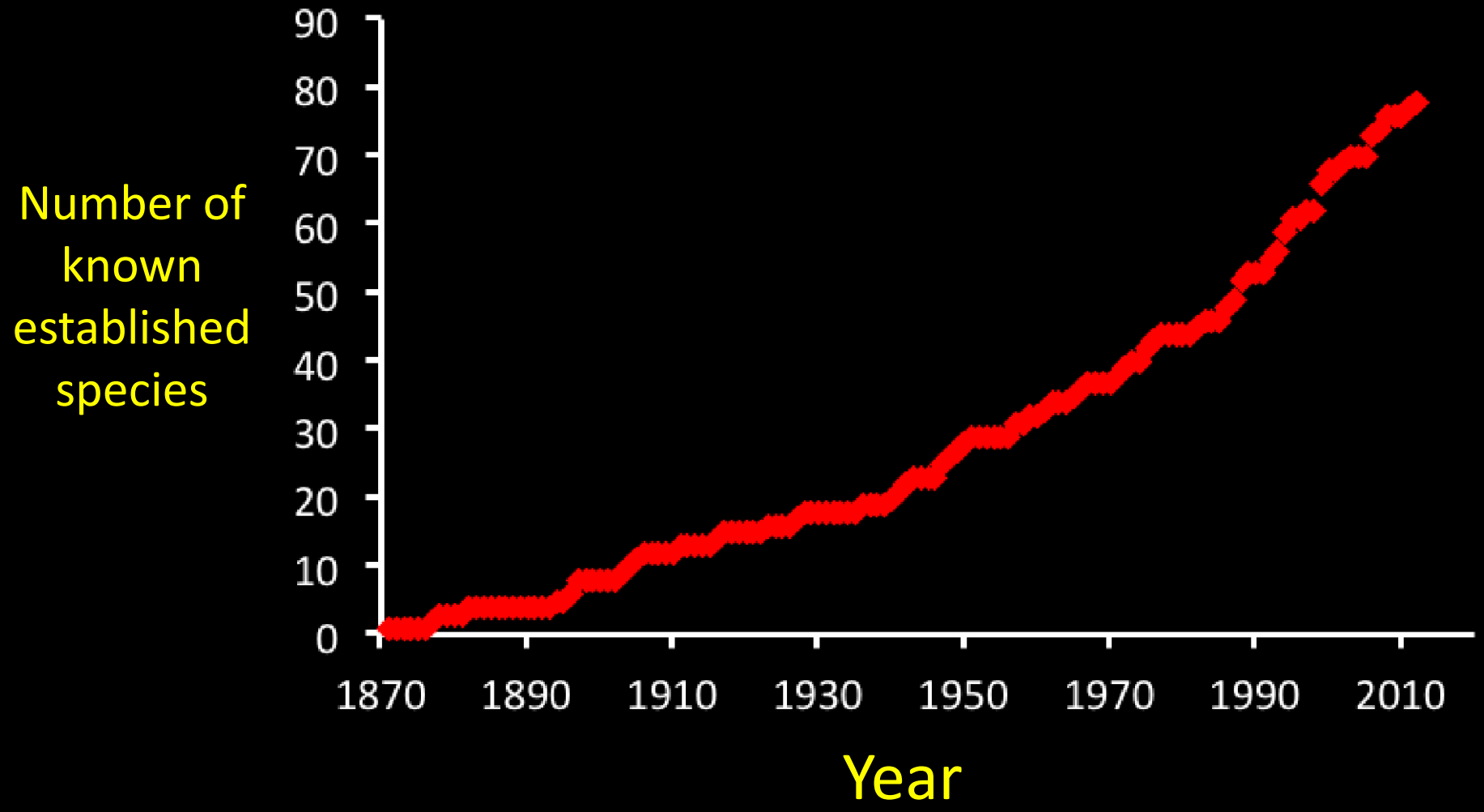
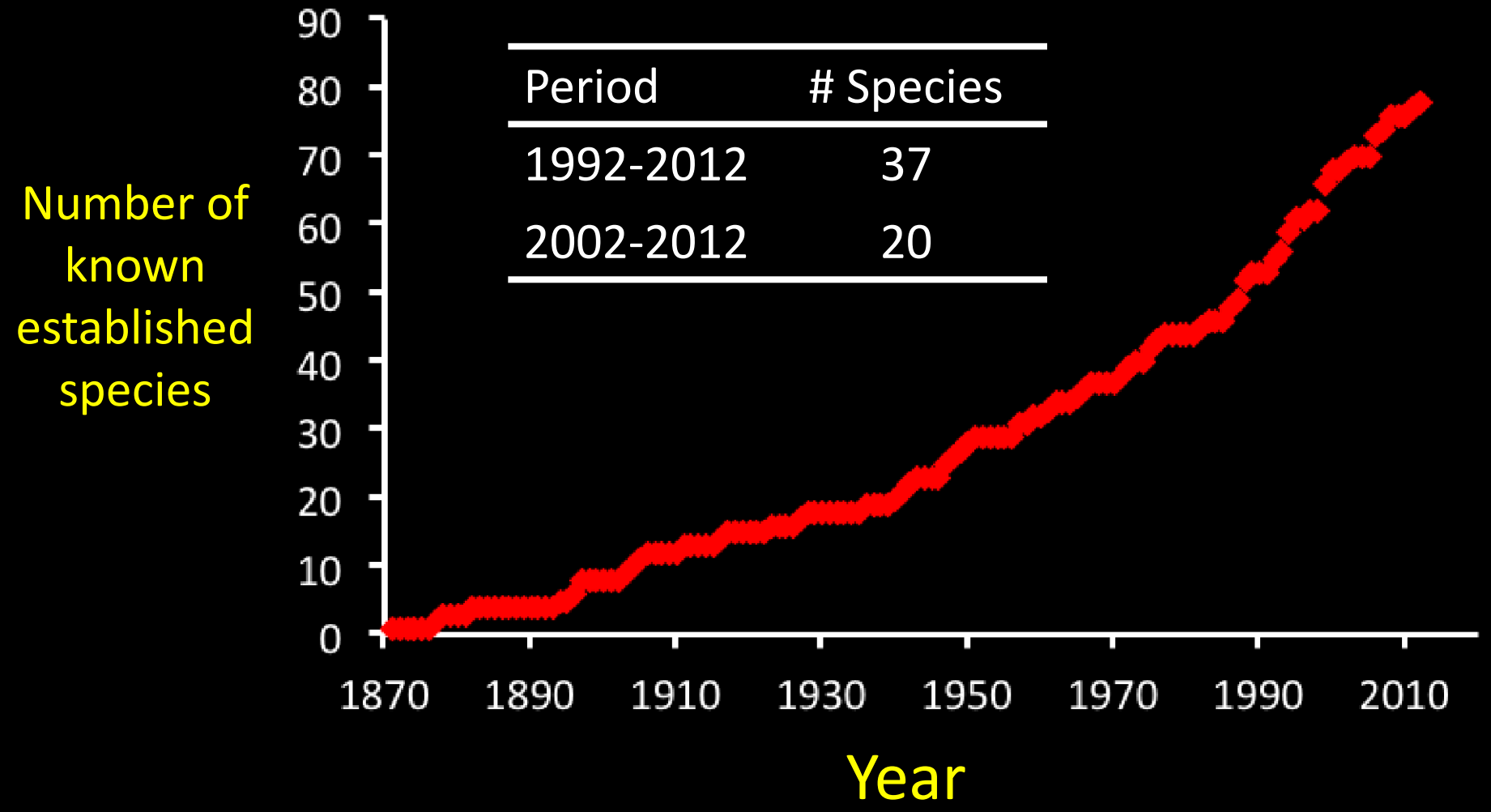
Established Non-native Aquatic Species in IL



Data from Abigail Jacobs, M.S. Student at Loyola

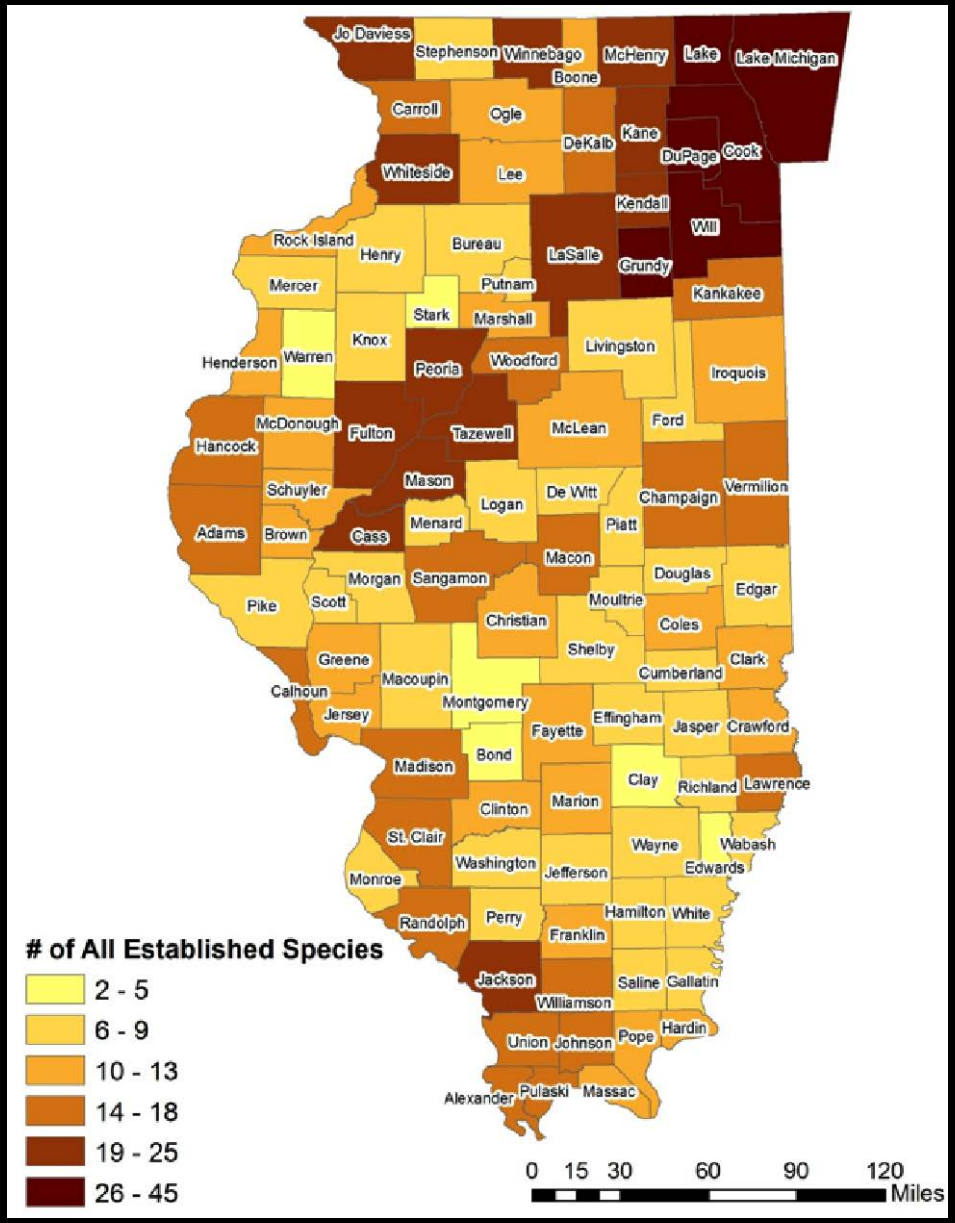
Established Non-native Aquatic Species in IL



Period	# Species
1992-2012	37
2002-2012	20

Data from Abigail Jacobs, M.S. Student at Loyola

Geography of Established Species



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Taxonomy of Established Species

Taxa	Number of Records	Number of Species
Algae	11	5
Plants	4,551	31
Coelenterates	3	2
Crustaceans	286	10
Mollusks	2,269	7
Fishes	15,939	23
TOTAL	23,059	78

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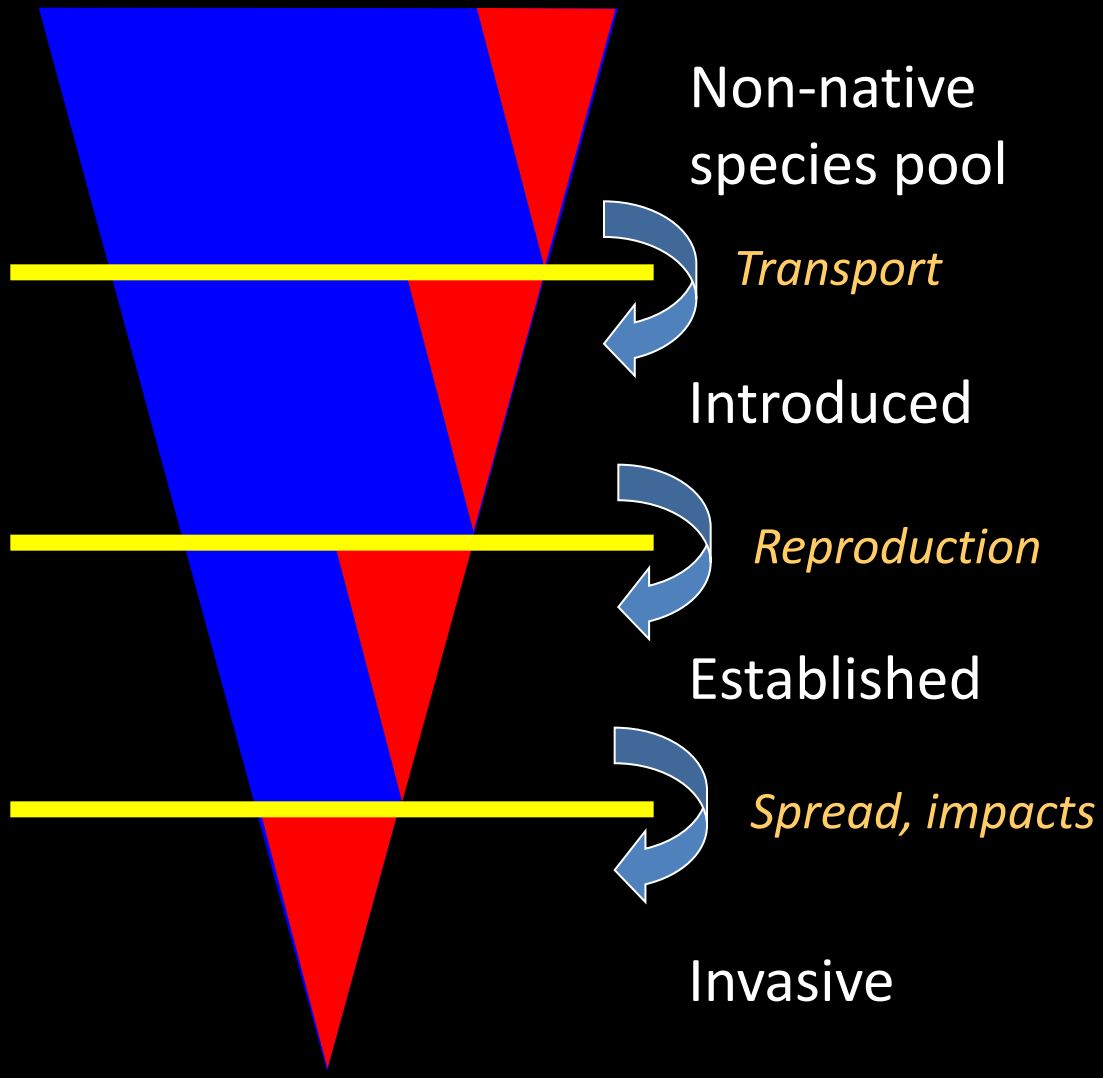
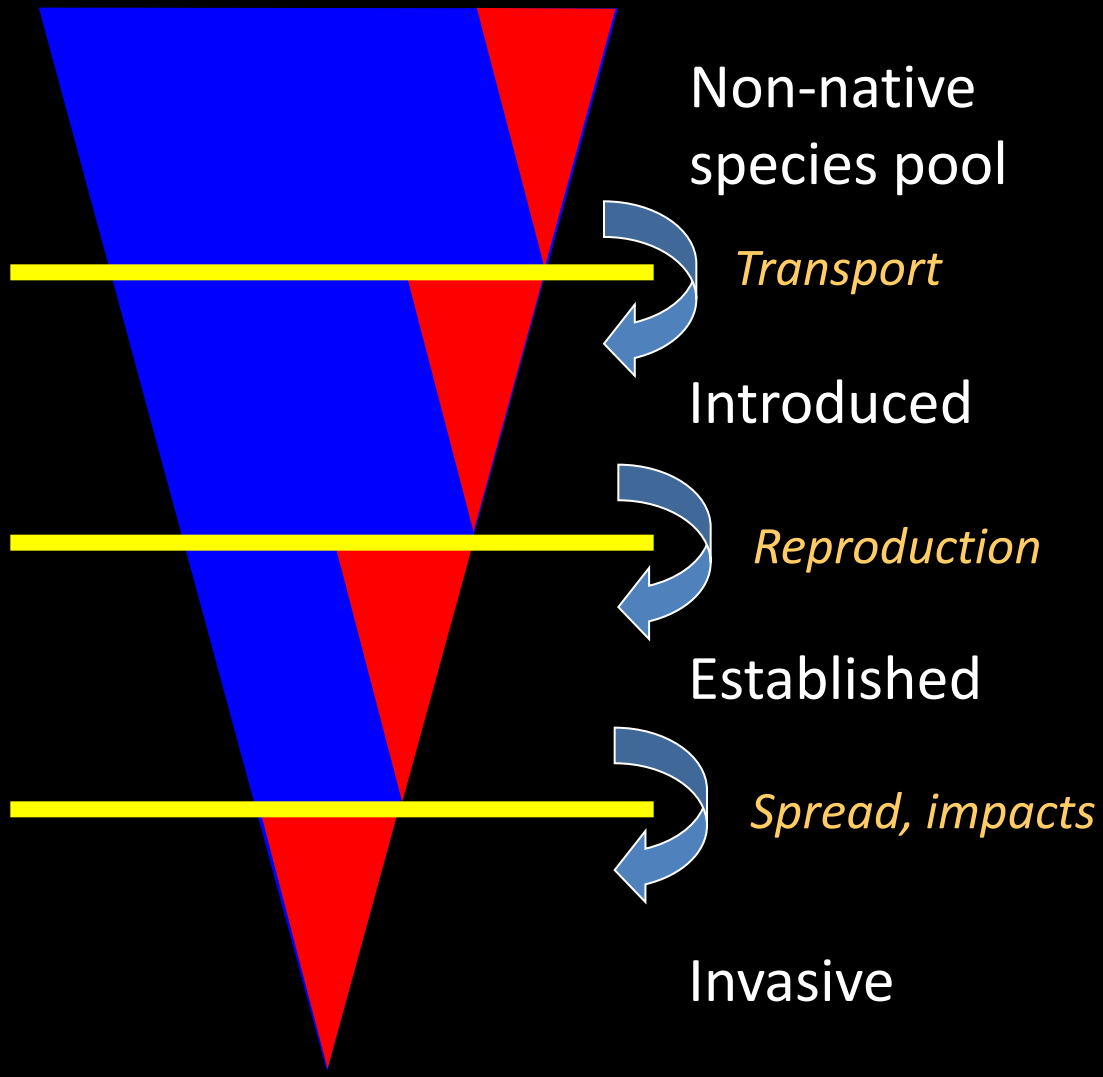
Invasion Sequence



Options for Management

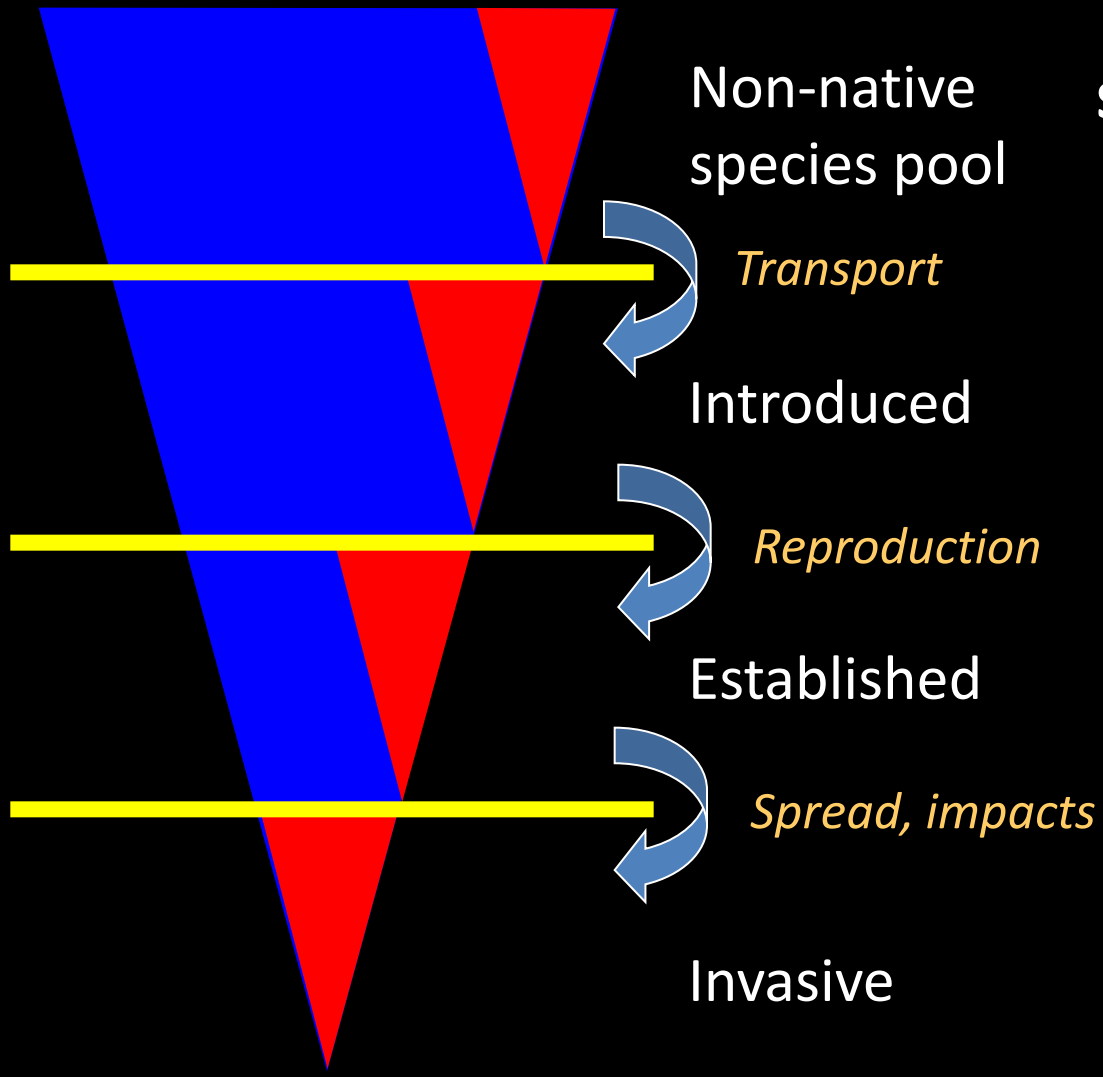


Prevention

Early detection/ rapid response

Control, management, adaptation

Risk Assessment



Goal of Risk Assessment is to identify high risk species before they are introduced

Prevention

Early detection/ rapid response

Control, management, adaptation

Great Lakes Policy Response

- Shared resource, but little co-ordination for management and policy
- All jurisdictions remain at risk from almost all invaders

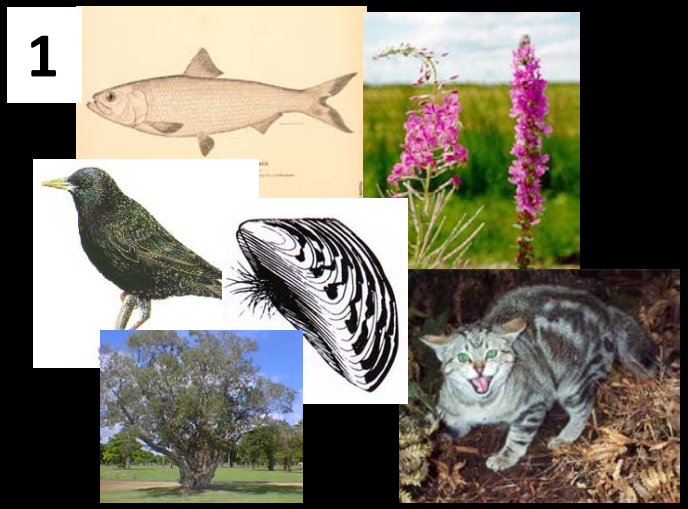
Species	IL	IN	MI	MN	NY	OH	ON	PA	WI
Bighead carp *(Hypophthalmichthys nobilis)*	X	X	X	X	X	X	X	X	X
Bitterling *(Rhodeus sericeus)*			X						
Black carp *(Mylopharyngodon piceus)*	X	X	X	X	X	X	X	X	X
Chinese weatherloach *(Misgusnus anguillicaudatus)*			X						
Eastern banded killifish *(Fundulus diaphanus)*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

Organisms in Trade Risk Assessment Project

Research Objectives	Communication (Objective 3)	Outcomes
Objective 1: Develop risk assessment tools for fishes, plants, mollusks, amphibians, reptiles and crustaceans for the GL Basin.	Produce and make freely available text and online versions of risk assessment tools. Conduct workshops in their use and application.	**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 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.	

Risk Assessment for Fishes in the Great Lakes

1



2

3 **Invasion Process**

Species Elsewhere

↓

Introduced

↓

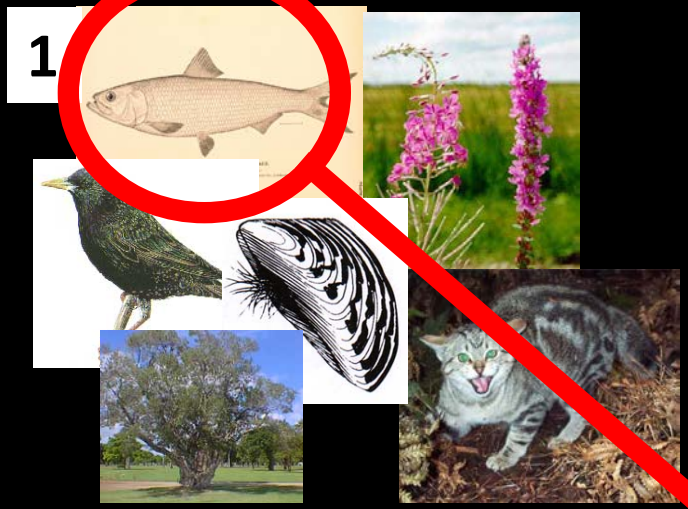
Established

↓

Invasive

Introduced to Established

1



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Species Elsewhere

↓

Introduced

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Established

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Invasive

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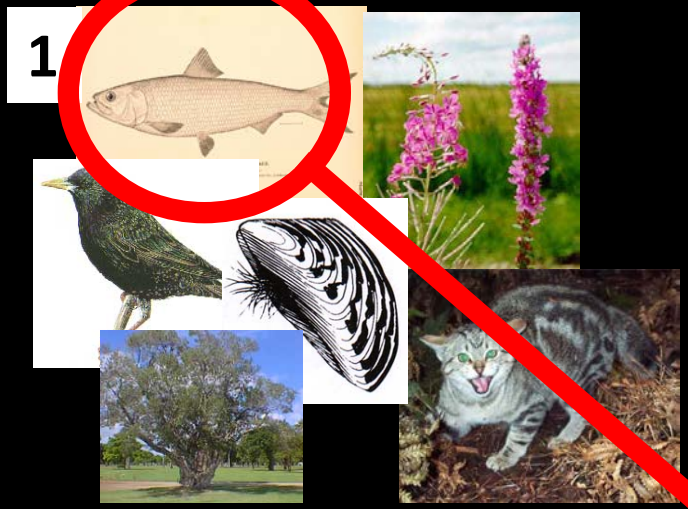
1. Gather species lists
2. Gather trait data
3. Analyze data

Established to Invasive

1



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Species Elsewhere

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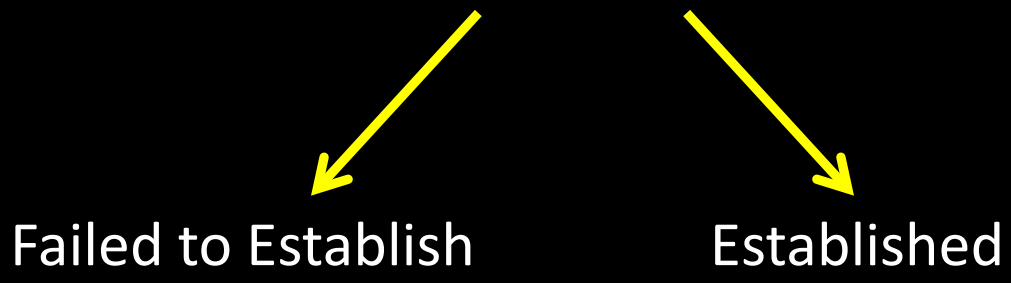
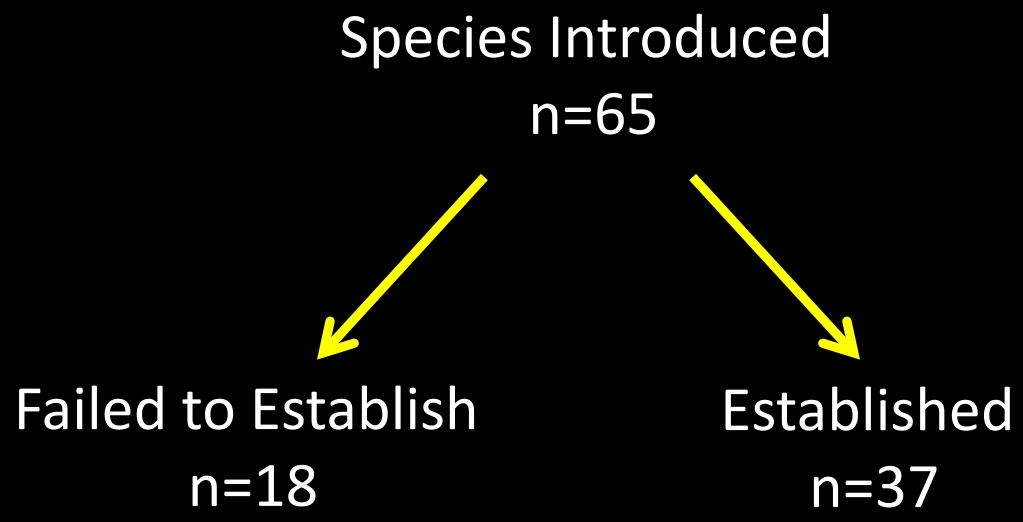
Gather Species Lists: Introduced to Established



1. Gather Species Lists: Introduced to Established



2. Gather Trait Data

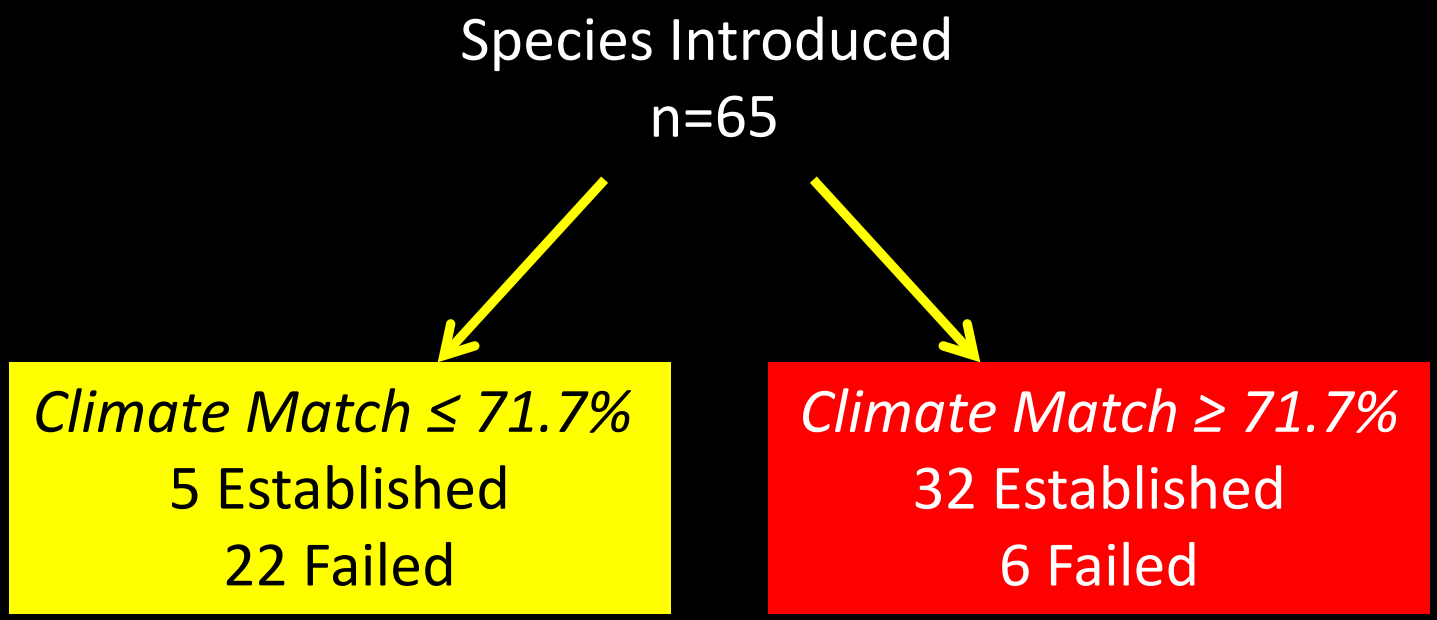
Life History	Body size
	Egg size
	Fecundity
	Larval size
	Longevity
	Maturation size
	Reproductive guild
	Spawning frequency
Habitat preference	Macrohabitat preference
	Salinity tolerance
	Temperature tolerance
Invasion risk	Climate similarity
	Prior invasion success
Phylogenetic	Phylogeny
	Relatedness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

3. Analyze Data: Introduced to Established

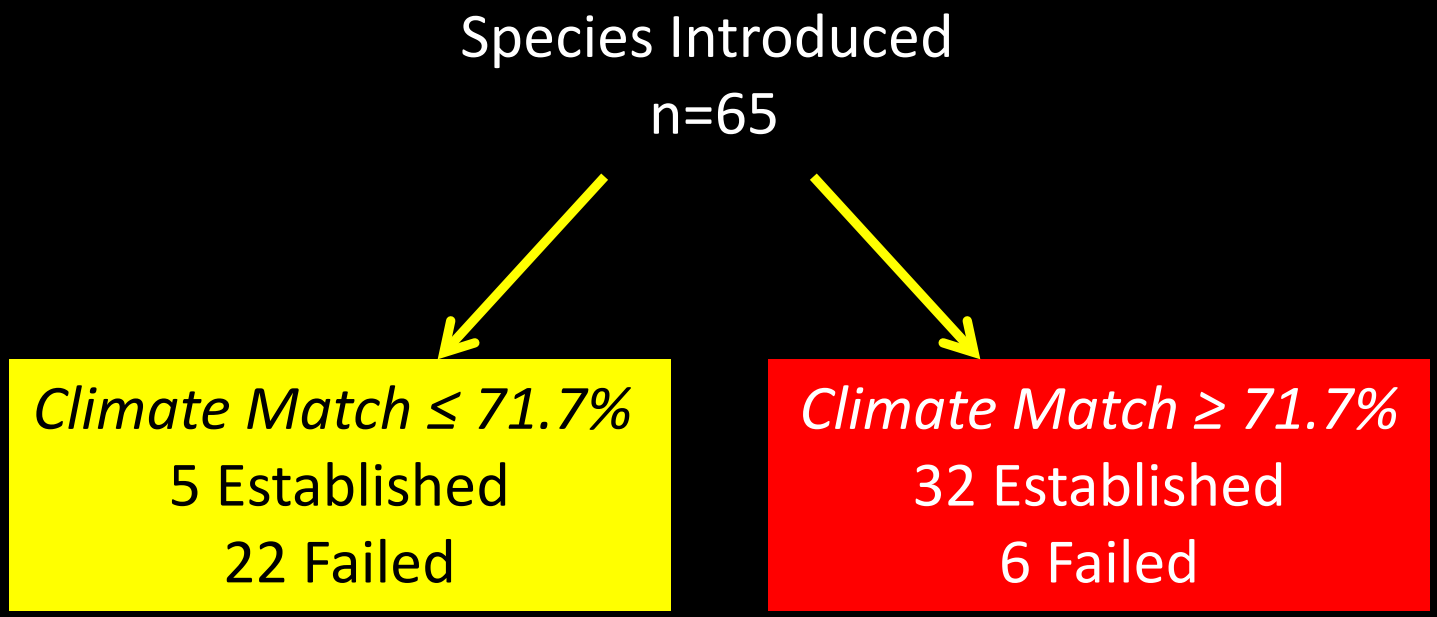
Species Introduced

n=65

3. Risk Assessment Tool

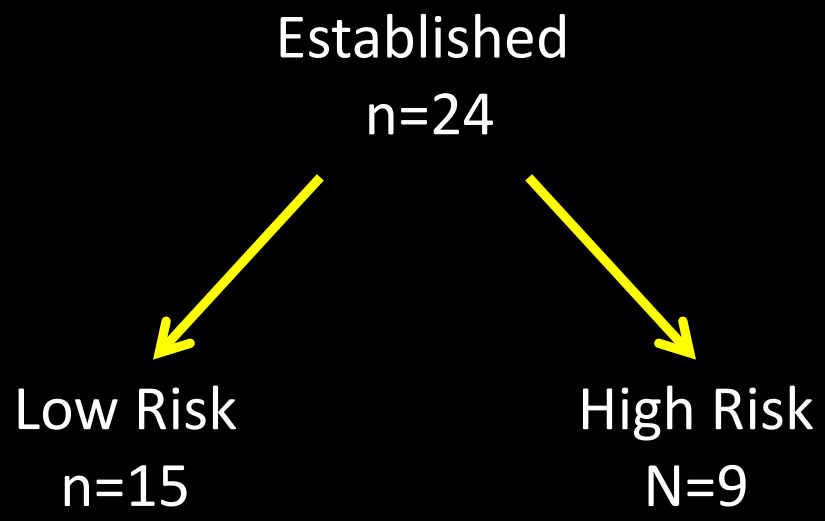


Risk Assessment Tool



- AUROC = 0.775
- 10% Cross-validated test sample: 78.04%
  Established: 81.08%
  Failed: 75.00%

High vs. Low Risk



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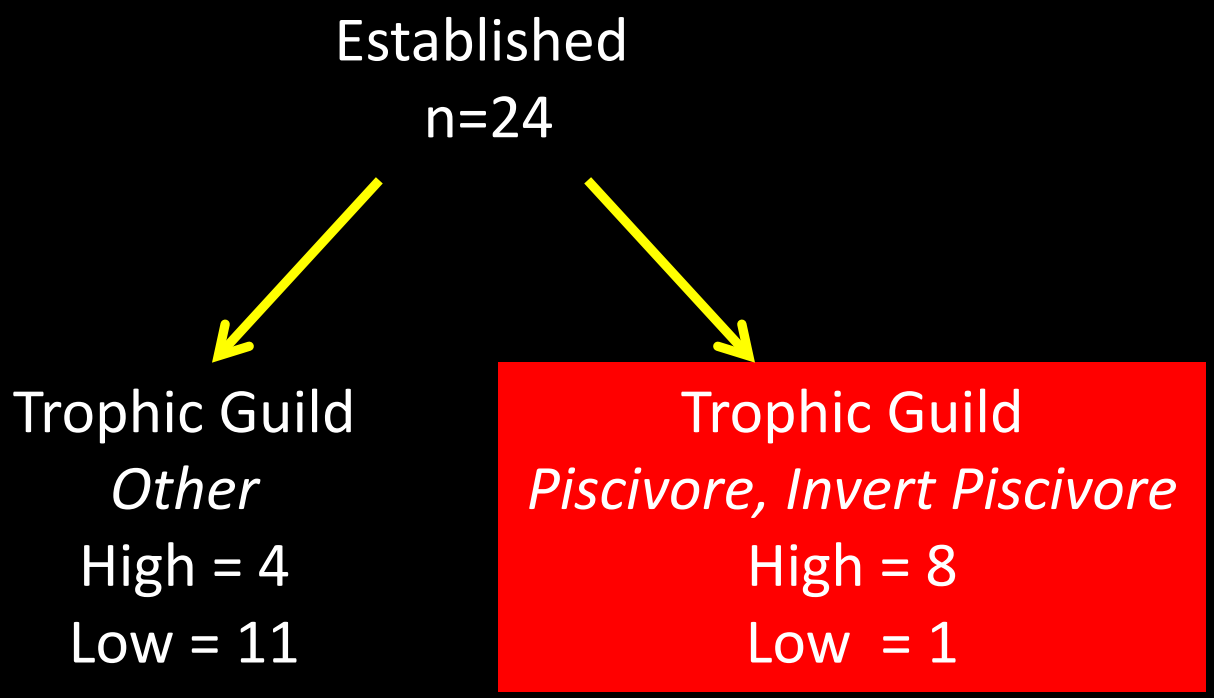
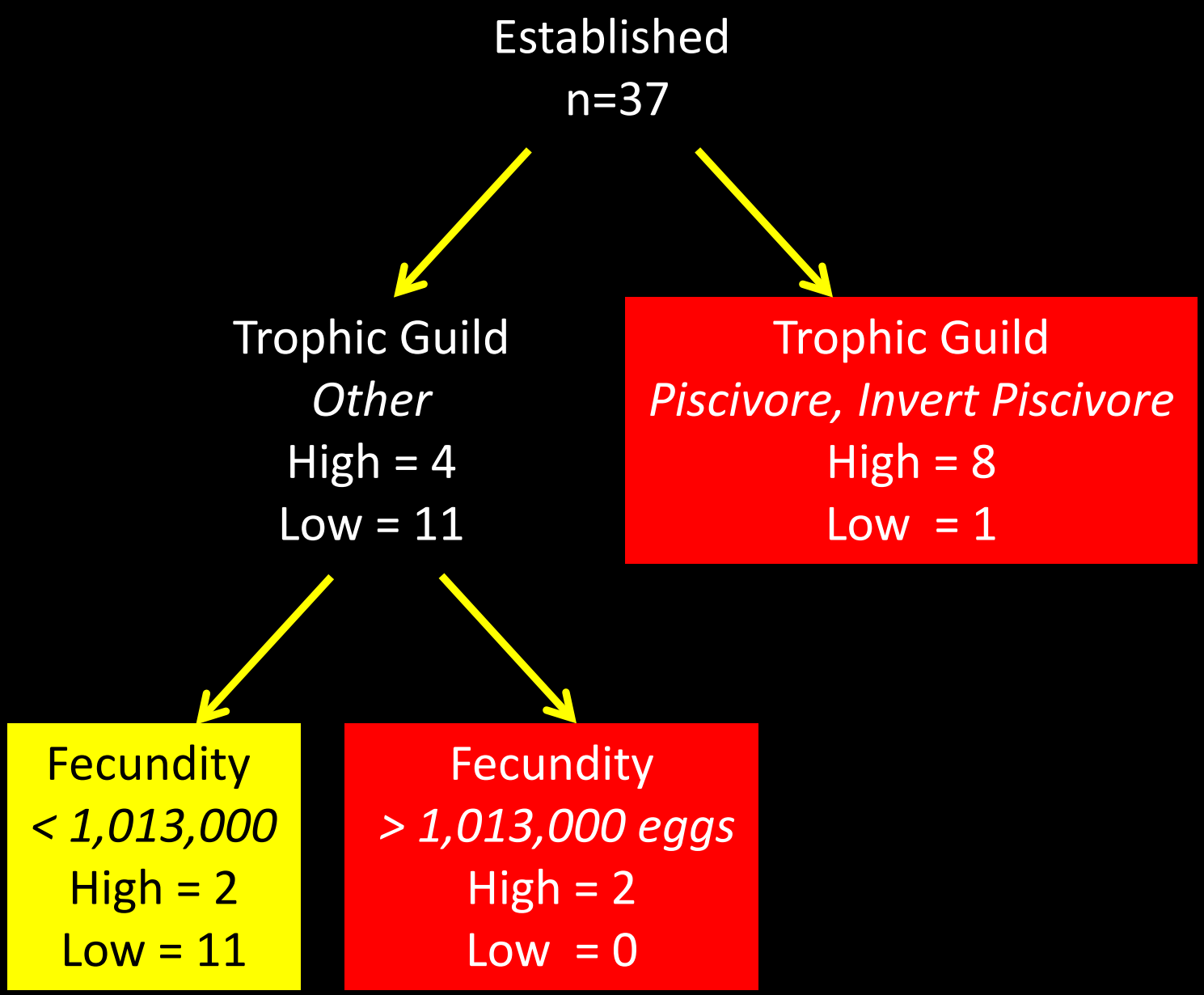


3. Analyze Data: High vs. Low Risk



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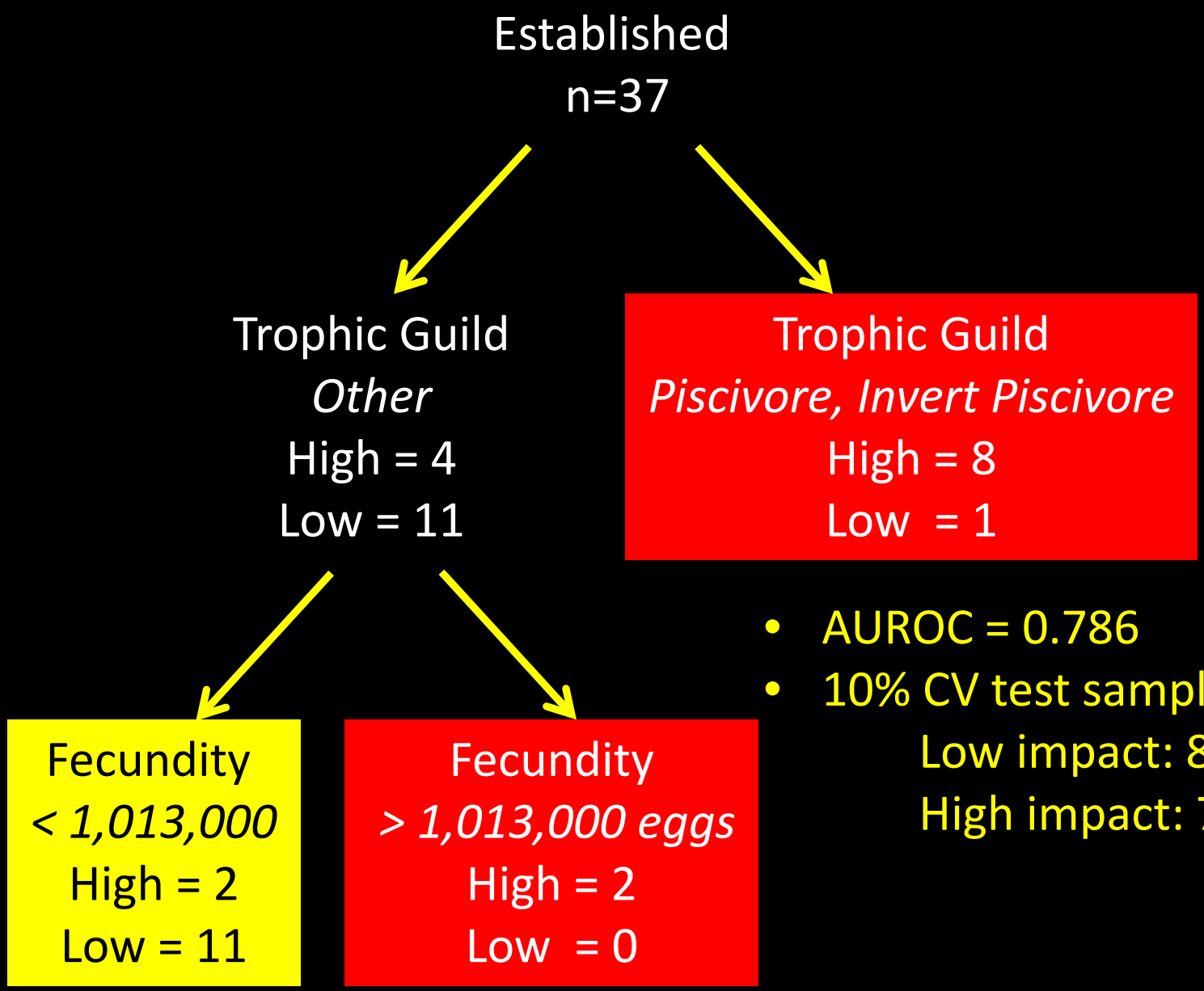


- AUROC = 0.786
- 10% CV test sample: 79.17%
  - Low impact: 83.33%
  - High impact: 75.00%

Economics of Risk Assessment: US Herptile Trade

Current U.S. Policy: Essentially 'open-door'

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

Question: Under a policy of Risk Assessment, 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

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

Michael Springborn, Christina Romagosa & Reuben Keller (2011) The value of nonindigenous species risk assessment in international trade. *Ecological Economics* 70:2145-2153

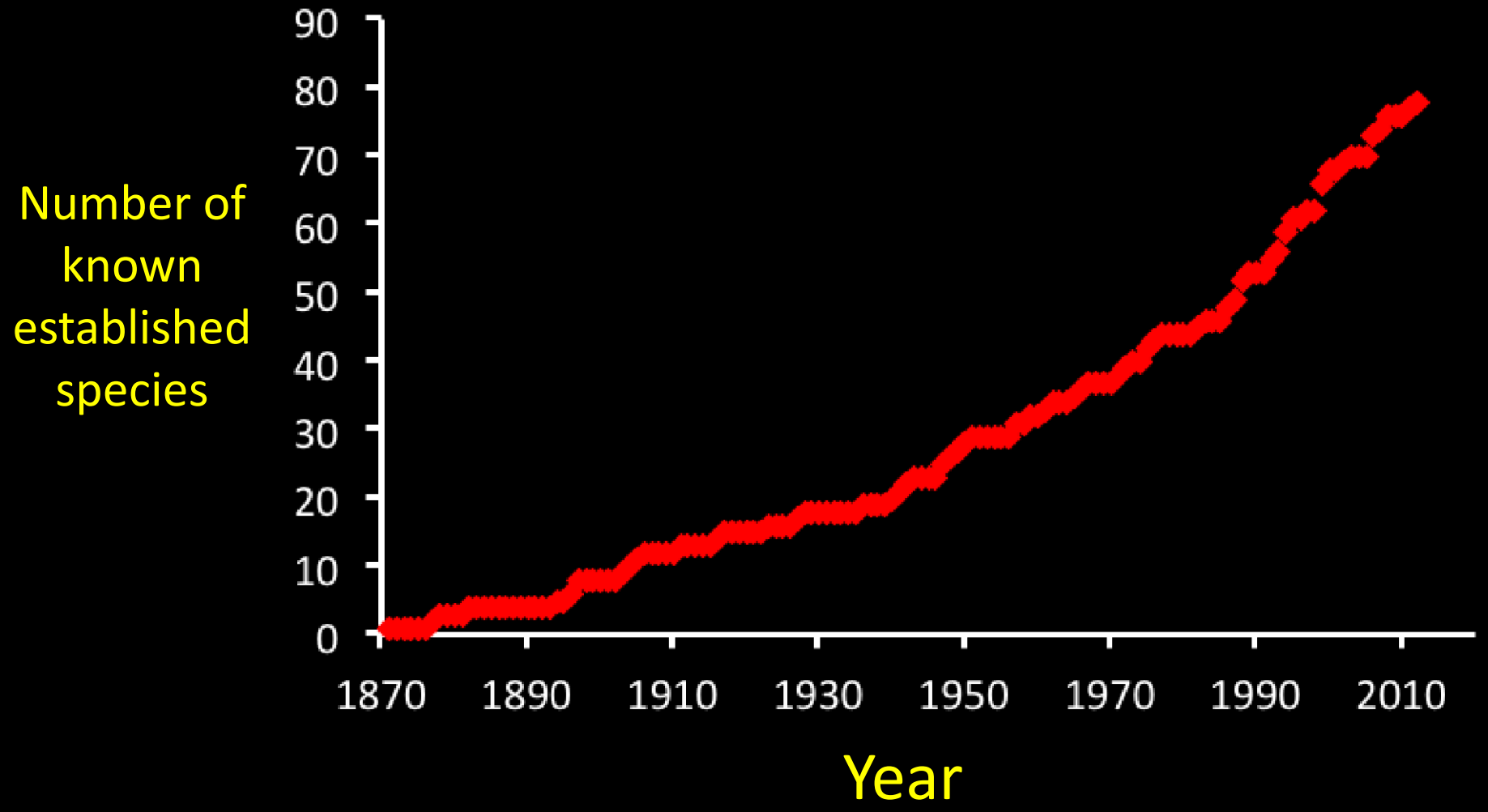
Looking Forward

- Prevention is the most effective way to reduce future impacts from invasive species

- Many species are in trade, and new species are added regularly
  - e.g., We found 826 freshwater and euryhaline species, from 106 families, in trade in GL Basin

- Rapid risk assessment tools are needed
  - Accurate risk assessment is possible (and not too complicated)
  - Risk Assessment can generate environmental *and* economic benefits

Proactive Policy Can Slow Rates of Invasion



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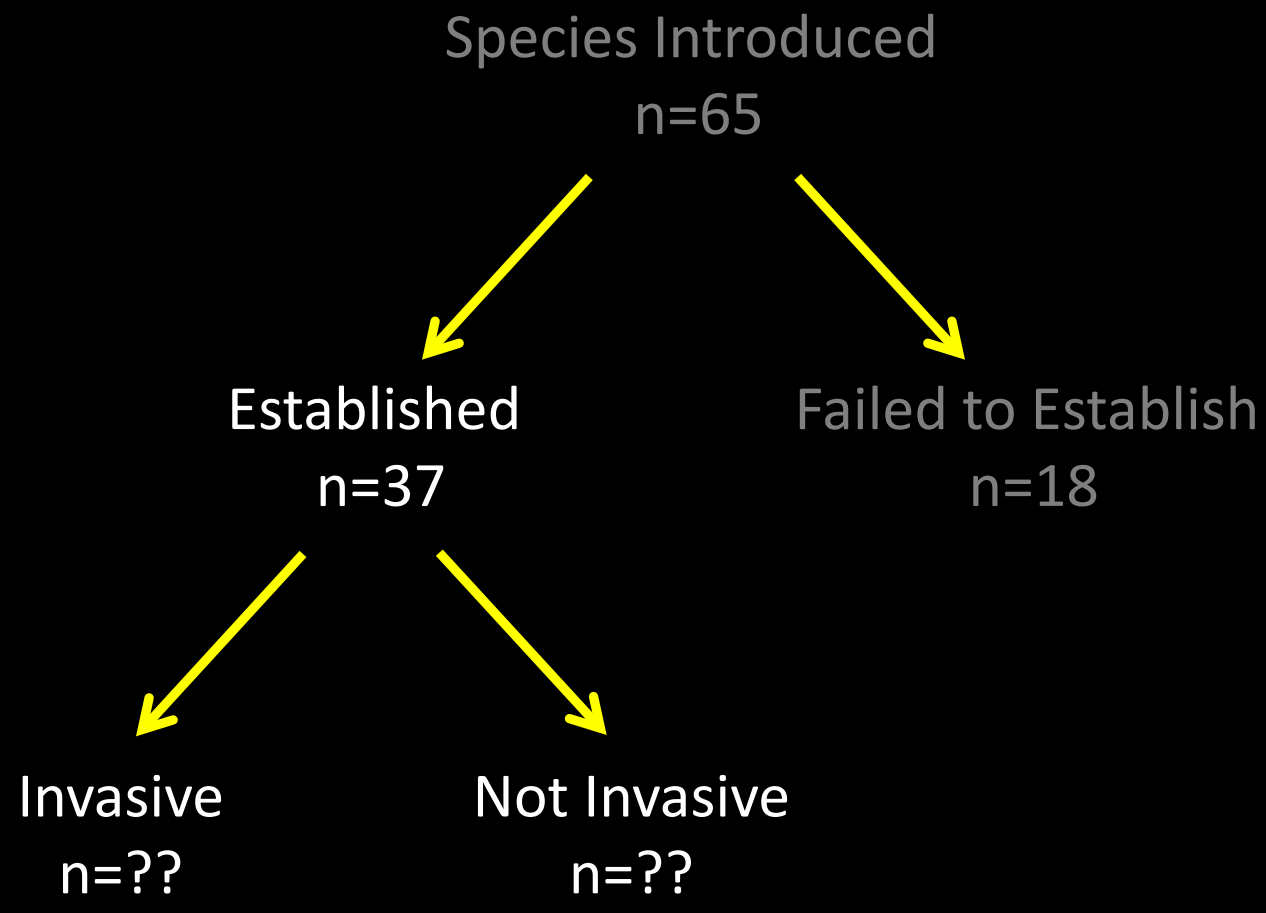
Gather Species Lists: Established to Invasive



Ecological Impact Questionnaire

Impact level	Description
1 *(none to low)*	Species has little to no discernible impact on existing biota
2 *(moderate)*	Species causes discernible decline in the abundance of existing biota in most locations
3 *(high)*	Species causes discernible decline in the abundance of existing biota and becomes a dominant component of the food web
4 *(very high)*	Species causes discernible decline in the abundance of existing biota with extirpation of species likely. Food webs are highly altered and ecosystem-level consequences apparent

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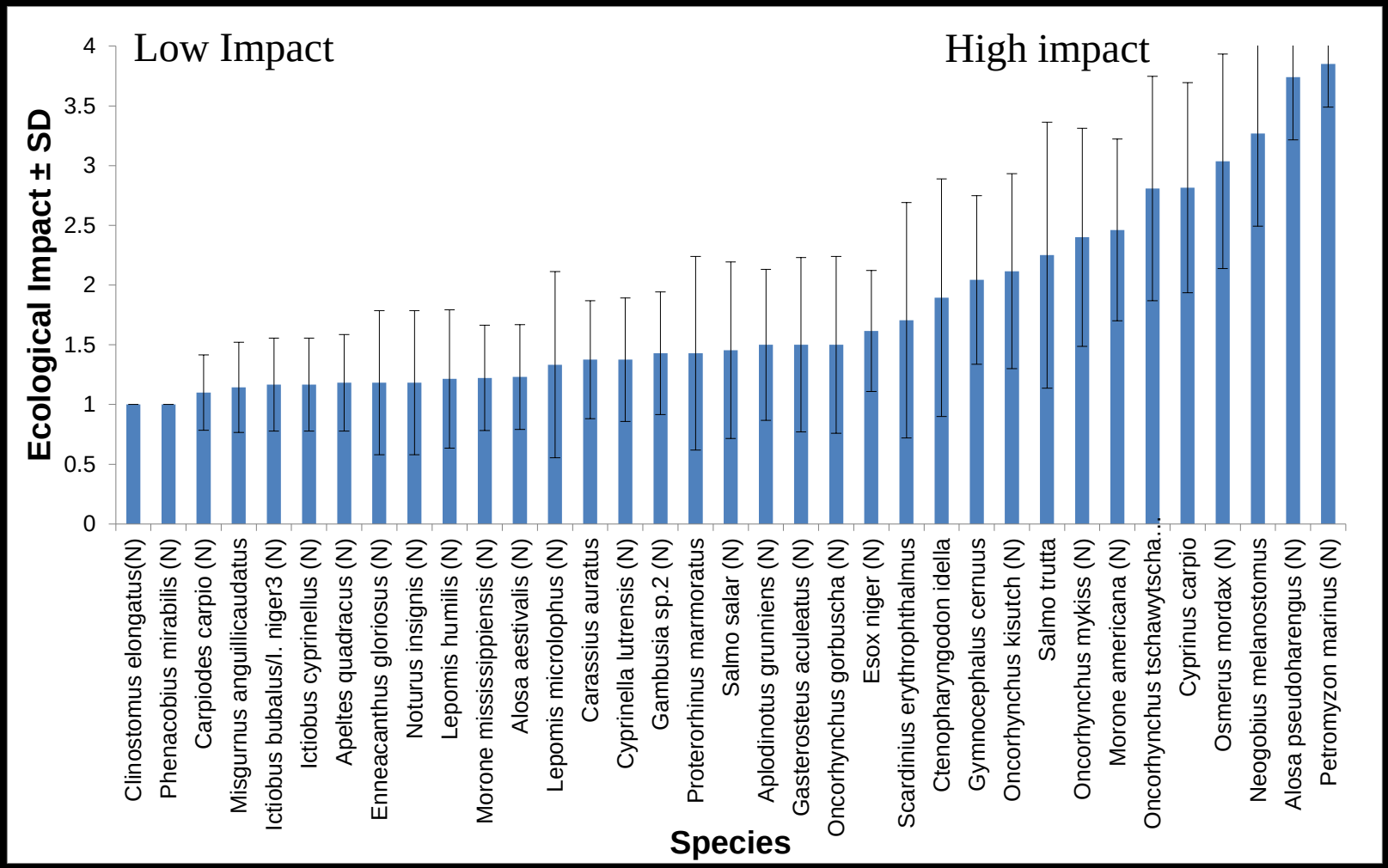
- Twenty-seven Great Lakes Fishery experts ranked the established species into these categories

Ecological Impacts of Established Fishes in Great Lakes



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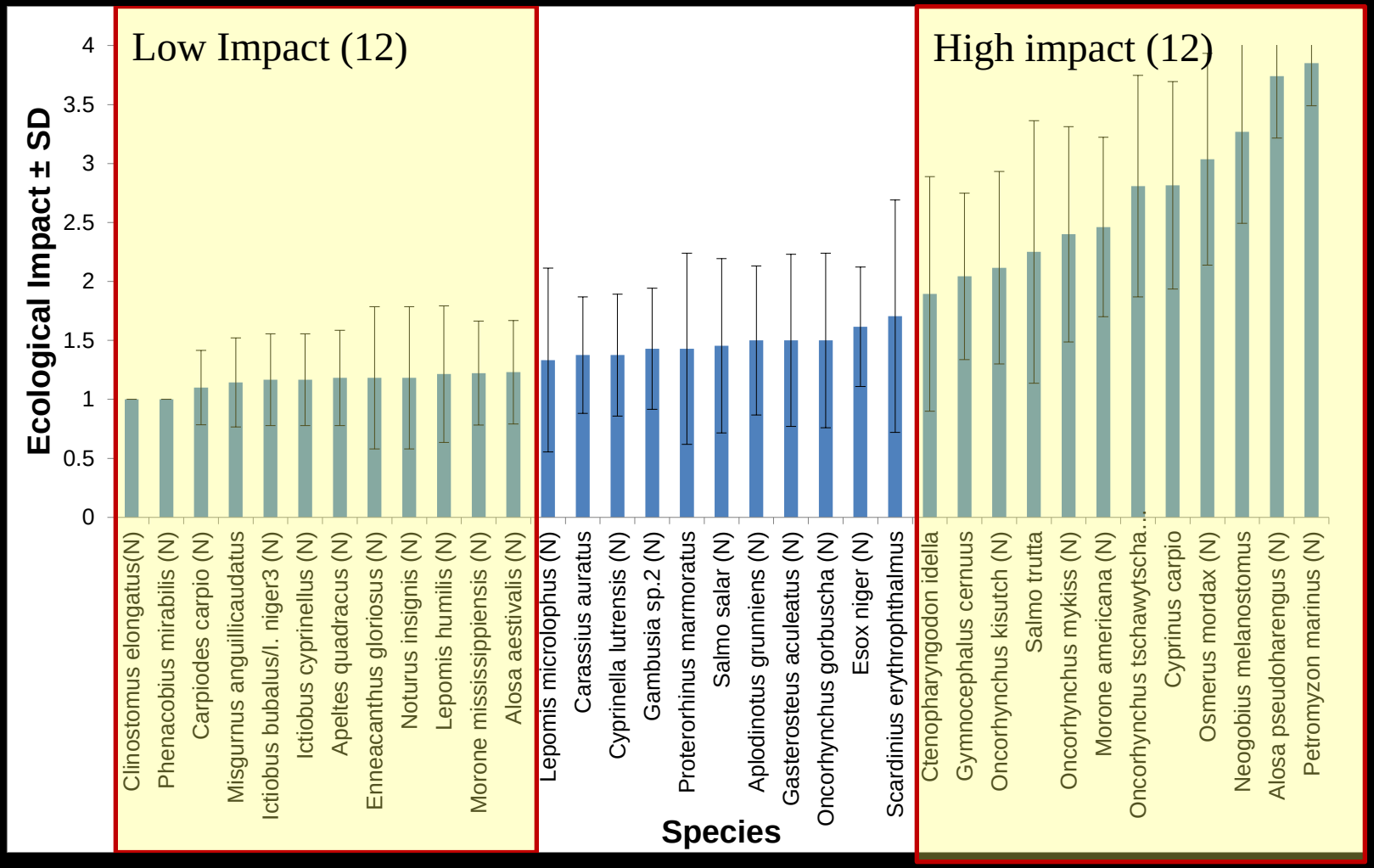

Risk Assessment for Reptiles & Amphibians

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

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