



Great Lakes Ballast Water Collaborative



Related Great Lakes Aquatic Invasive Species Research Initiatives

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(Presenter)

Related Great Lakes Aquatic Invasive Species Research Initiatives

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Sea Grant*

Funders: Great Lakes Protection Fund, GLRI, NOAA, USEPA, USFWS,

Invasion process

Uptake from native range



**Introduction from
pathway**



Establishment



Spread



**Ecological
impact**

Invasion

process

Introduction from
pathway



Establishment



Spread within GL



Ecological impact

Management Options

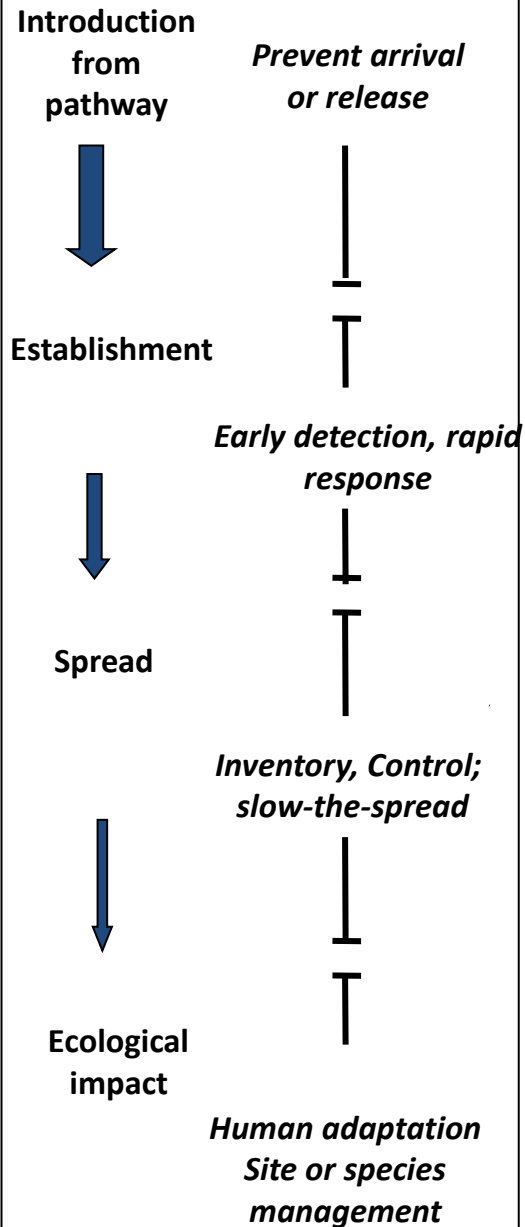
Prevention (focused on pathways of introduction)

Surveillance –early detection and rapid response

Containment , Control, Eradication
(Integrate pest management)

Adaptation

Invasion Management
process Options



Four major pathways of Invasion

- **Maritime shipping**
- **Trade in Live organisms**
 - aquarium
 - water gardens
 - live food
 - Aquaculture
- **Canals**
- **Trailer Boats & associated recreational activities**

Four research programs based at UND

Invasion process Management Options

Introduction from pathway

Prevent arrival or release



Establishment

Early detection, rapid response



Spread

Inventory, Control; slow-the-spread



Ecological impact

*Human adaptation
Site or species management*

Great Lakes Risk assessment (GLRI)

- Organisms in live trade

Great Lakes Environmental DNA surveillance (GLRI)

- all pathways

Great Lakes Protection Fund

- Maritime shipping
- Trailer boats
- Prevention and EDRR

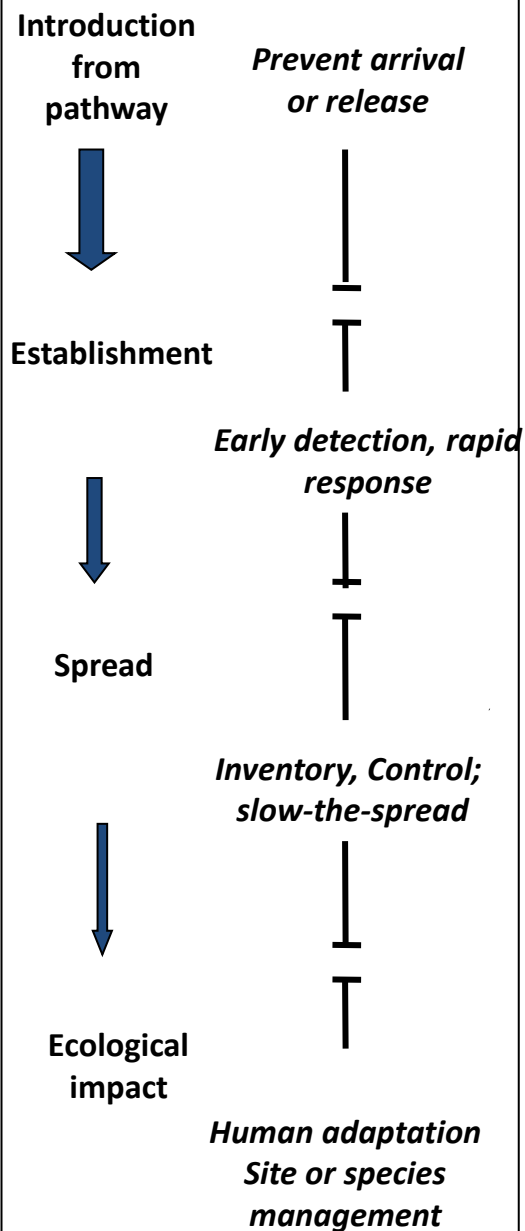
Forecasting Spread and Bio-economic Impacts (NOAA CSCOR & GLRI)

- all pathways

Management advisory board and partnerships to ensure relevance

Invasion Management

process Options



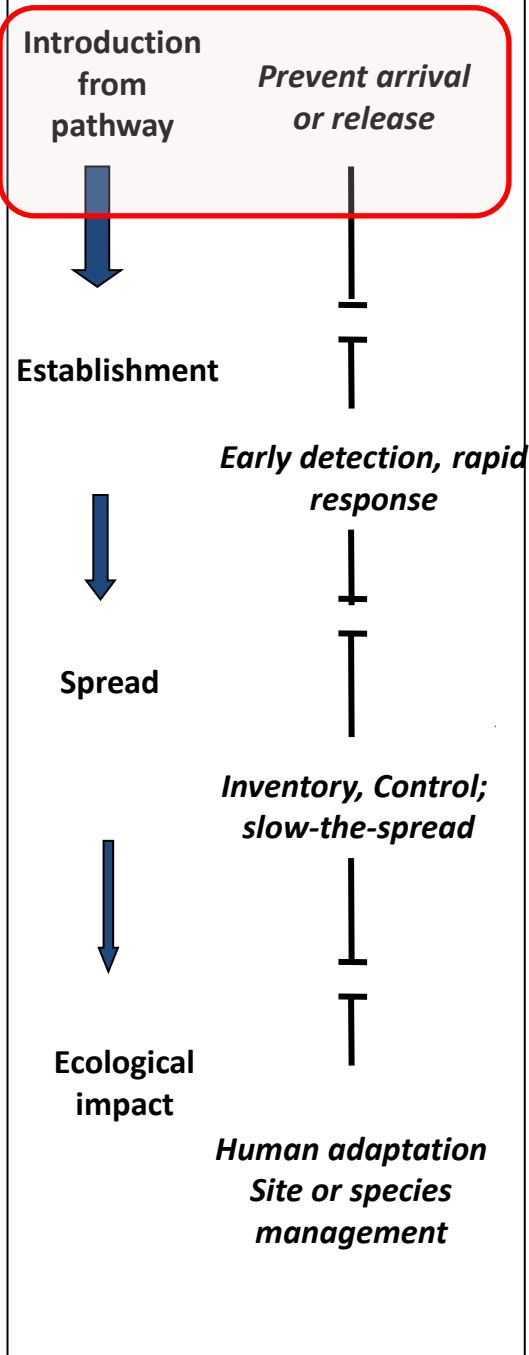
Science-management collaboration to decide which things to focus on . . .

- **Pathways**—can manage many species at once
- **Stages of invasion**—prevention is cost effective
- **Species**—not all exotic species are harmful
- **Policy and/or management scenarios**—which options provide the biggest bang for the buck?

. . . Aim is to provide general guidance on most cost effective allocation of management resources to prevent, slow-the-spread, or control impacts of as many and the most harmful invasive species as possible.

Invasion Management

process Options



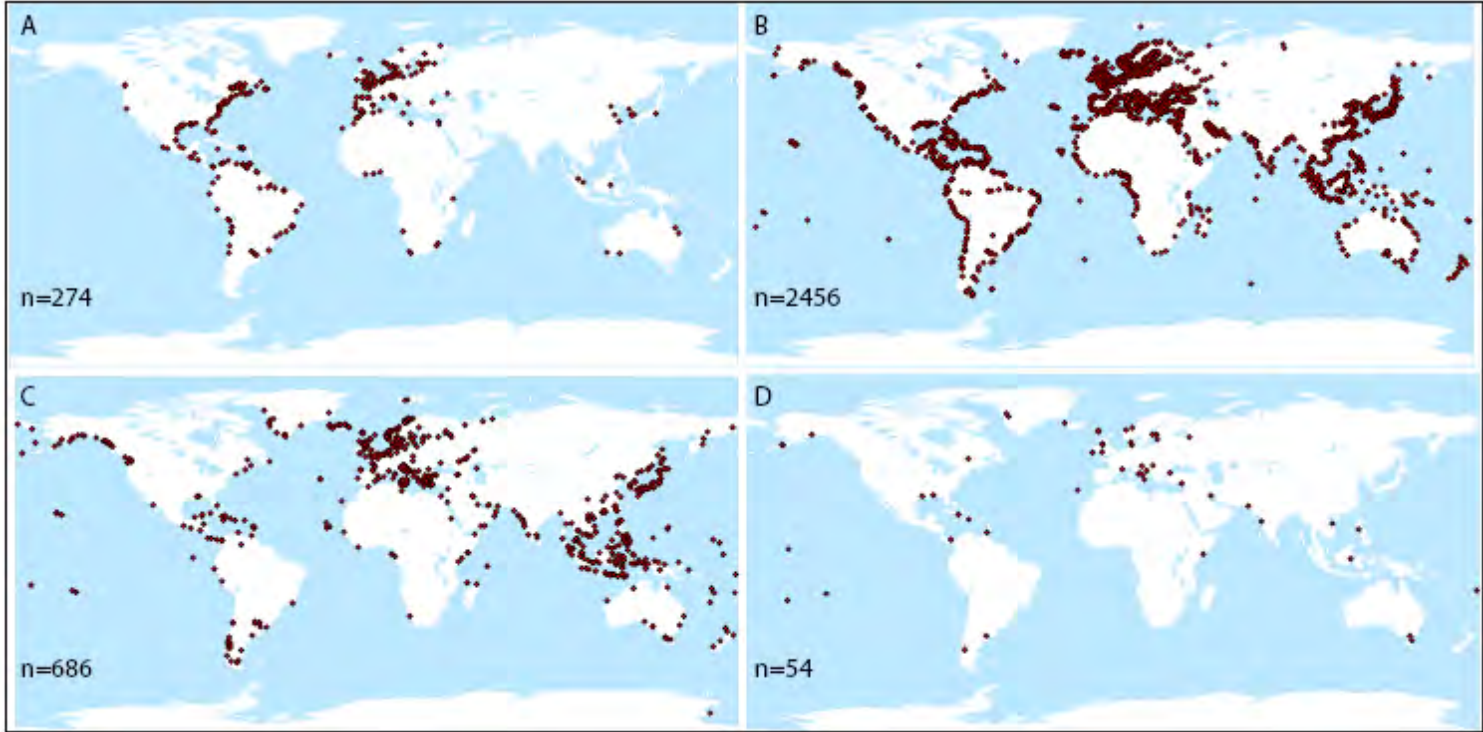
1. Establishment -what places have access to Great Lakes - *identify species, propagule pressure*

GLPF: Risk assessment of shipping

(Keller, Drake, Drew, Lodge 2010 Div & Dist)

Direct connections to Great Lakes

2-step connections



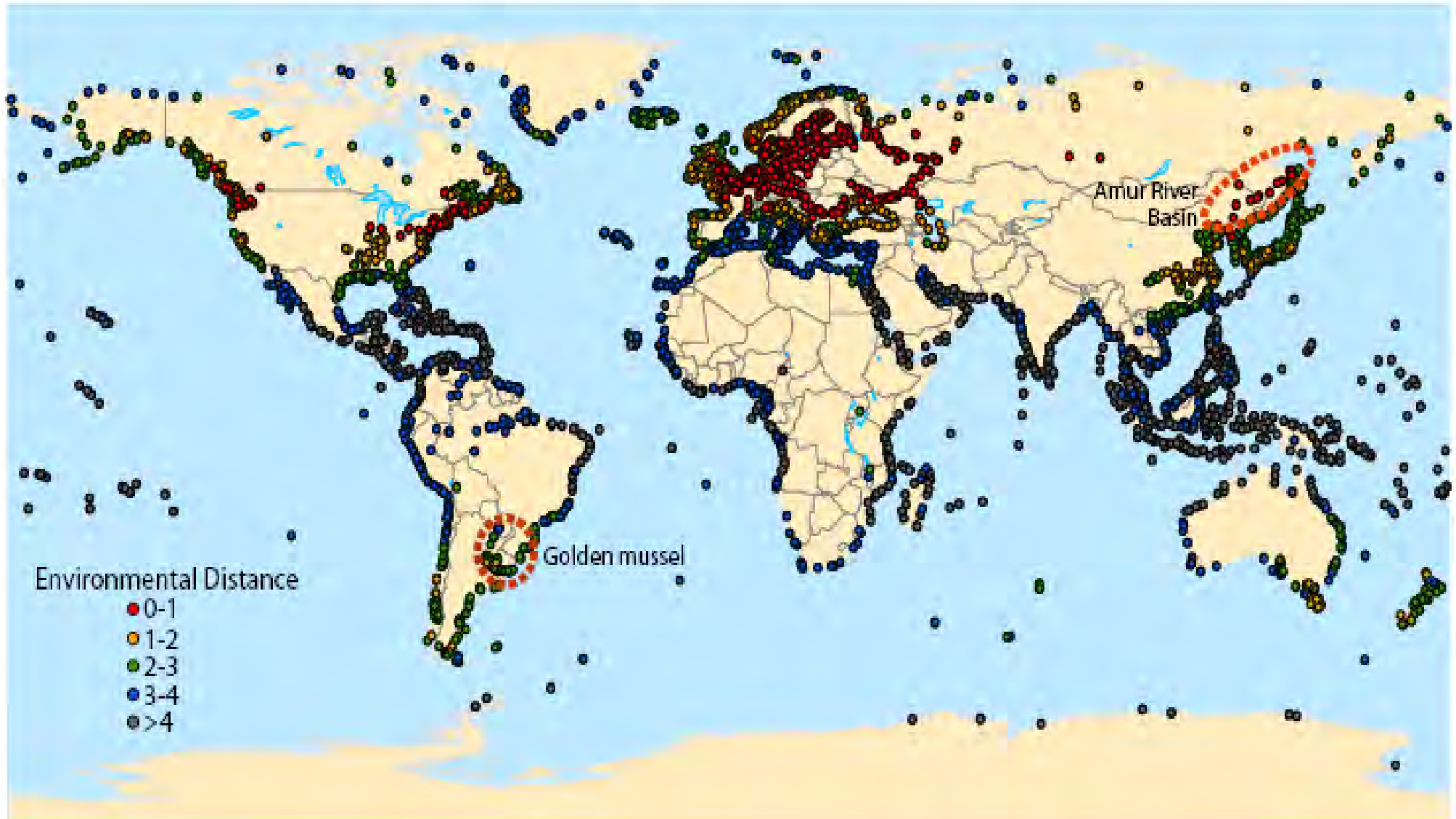
3-step connections

4-step connections

What ports are most similar to Great Lakes

Temperature & salinity matching for aquatic species

GLPF: Risk assessment of shipping



(GLPF: Keller, Drake, Drew, Lodge 2010 Div. & Dist.)

GLPF: Risk assessment of shipping

Known aquatic invasive species in ports with environments that match Great Lakes

(Keller, Drake, Drew, Lodge 2010 Div. & Dist.)



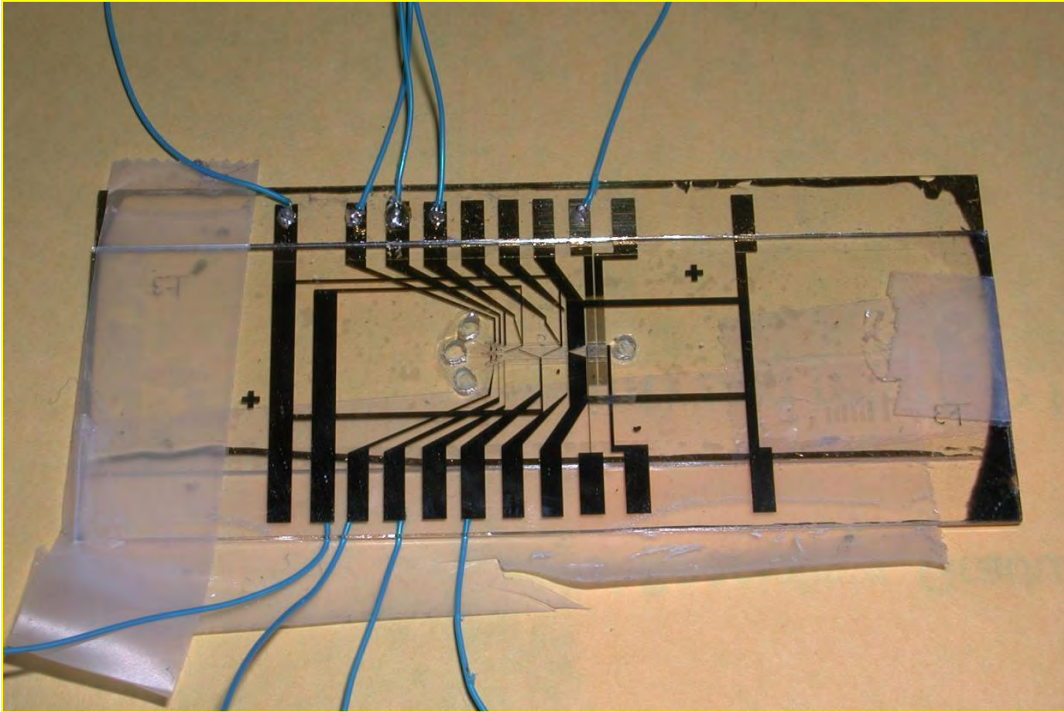
***Killer Shrimp -
Dikerogammarus
villosus***

***Golden mussel:
Limnoperna
fortunei***

How might you or your constituencies use the shipping risk assessment information or in what form would it be most useful to you?

Great Lakes Protection Fund Project #2:
**Developing and Applying a Portable Real-time Genetic Probe for Detecting
Aquatic Invasive Species in Ships' Ballast**

*David Lodge (Notre Dame), Jeff Feder (Notre Dame), Andy Mahon (Notre Dame), Chia Chang (Notre
Dame), Matt Barnes (Notre Dame)*



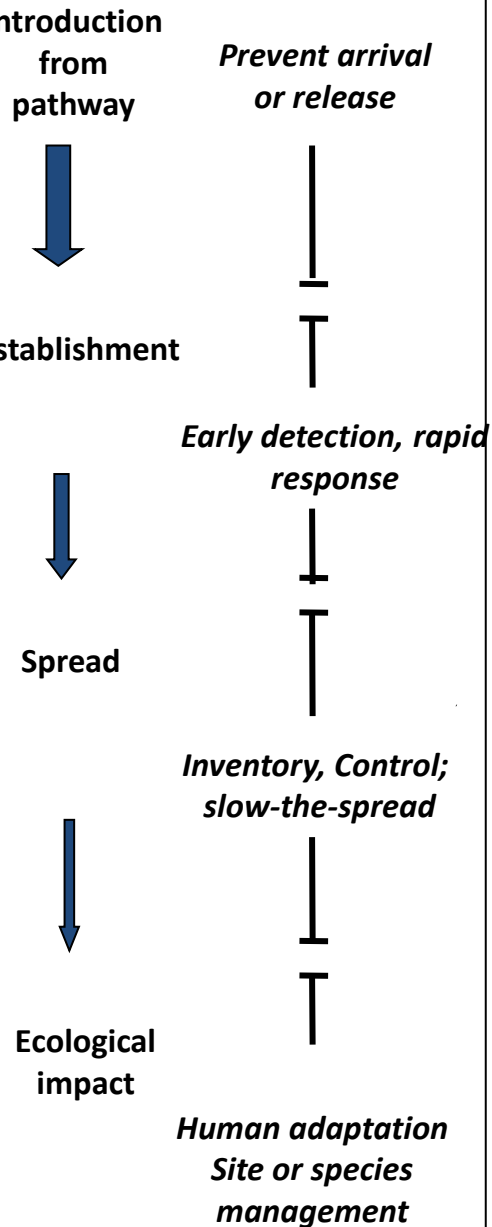
Successful detection of

- green crab
- golden mussel
- quagga mussel
- Chinese mitten crab

*Could you use such a tool, and how would the availability of this tool
affect management and/or policy development?*

Four research programs

<u>Invasion process</u>	<u>Management Options</u>
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Great Lakes Protection Fund

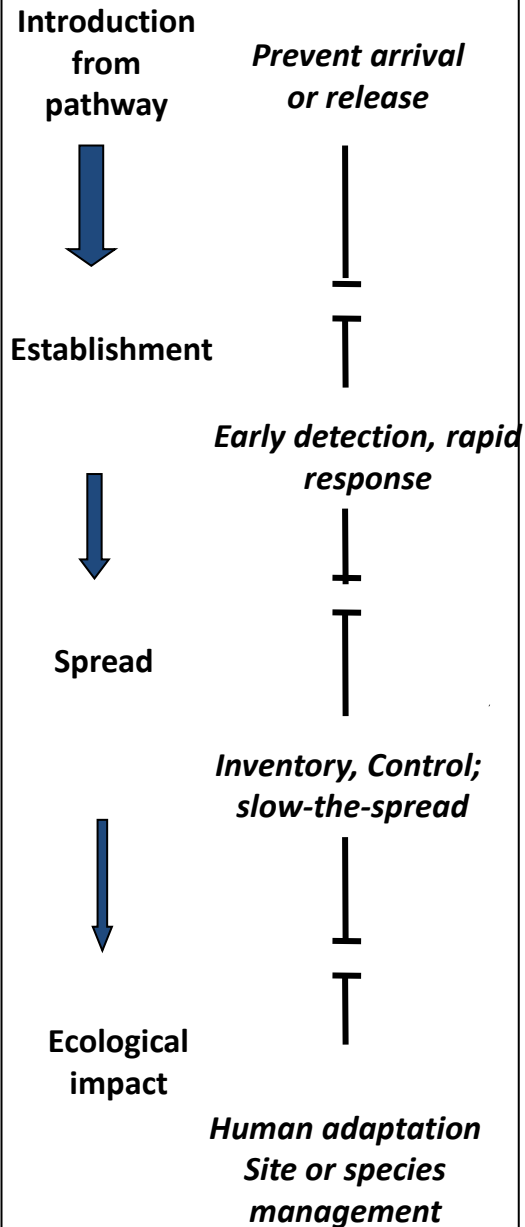
- Maritime shipping
- Trailer boats
- Prevention and EDRR

Forecasting Spread and Bio-economic Impacts
(NOAA CSCOR & GLRI)

- all pathways

Invasion Management

process Options

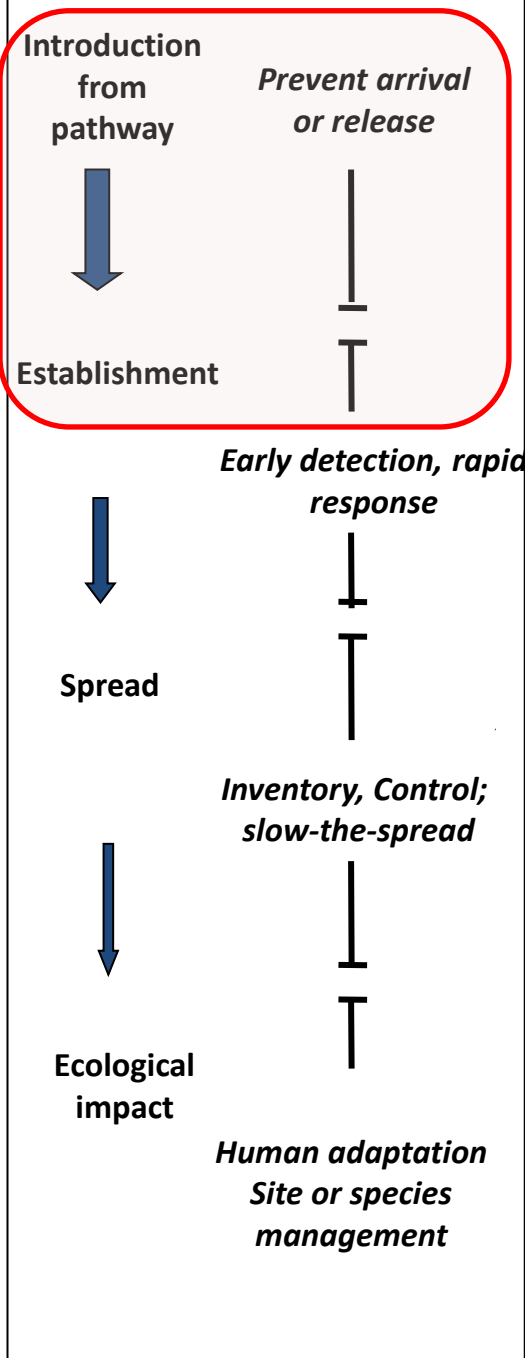


NOAA CSCOR Project:

Forecasting Spread and Bioeconomic Impacts of Aquatic Invasive Species from Multiple Pathways to Improve Management and Policy in the Great Lakes

- **What species are most likely to be successfully introduced and establish – (have access to GL, numbers, and tolerance)**
- **Where will they live in the Great Lakes**
- **How will they spread within the Great Lakes**
- **What are likely ecological impacts,**
- **What are likely regional economic impact,**
- **What are most cost effective management strategies to avoid, remedy or mitigate impacts**

Invasion Management
process Options



NOAA CSCOR Project:
Forecasting Spread and Bioeconomic Impacts of Aquatic Invasive Species from Multiple Pathways to Improve Management and Policy in the Great Lakes

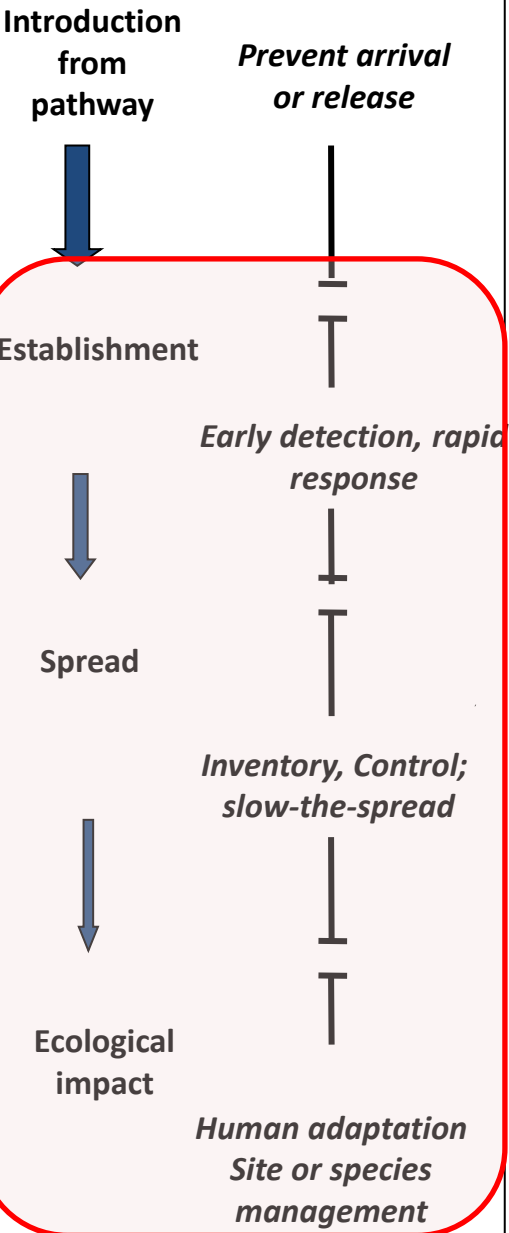
1. Establishment

Identify species, propagule pressure from all pathways

- *What species are in what pathways,*
- *what and how many are arriving*
- *where are they arriving*
- *What options exist to prevent entry into pathway or their release*

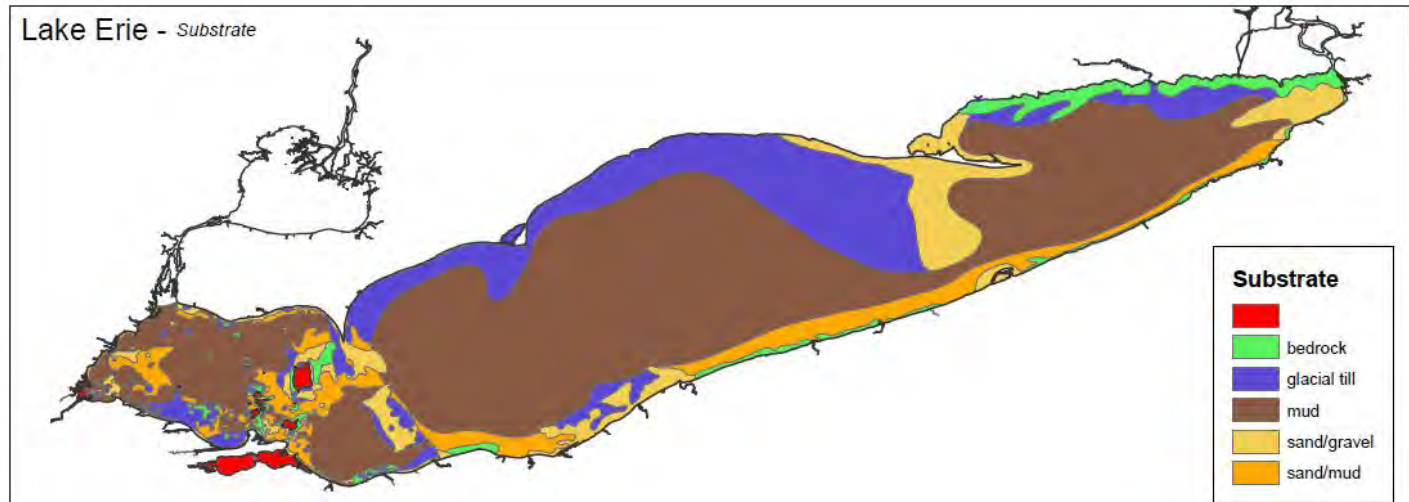
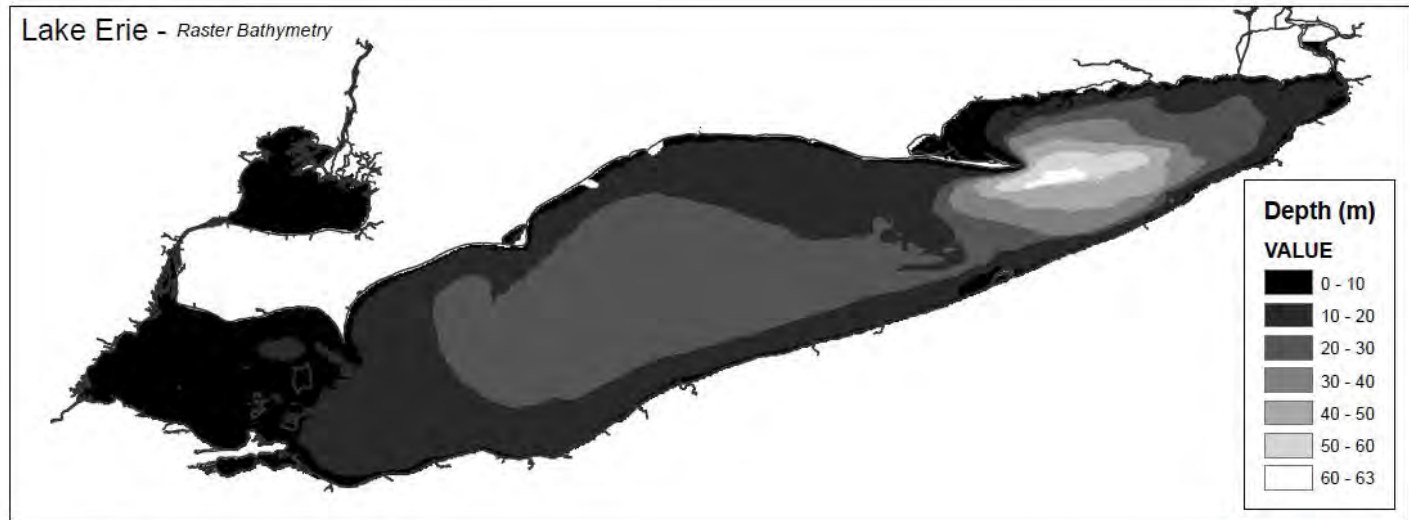
Invasion Management

process Options



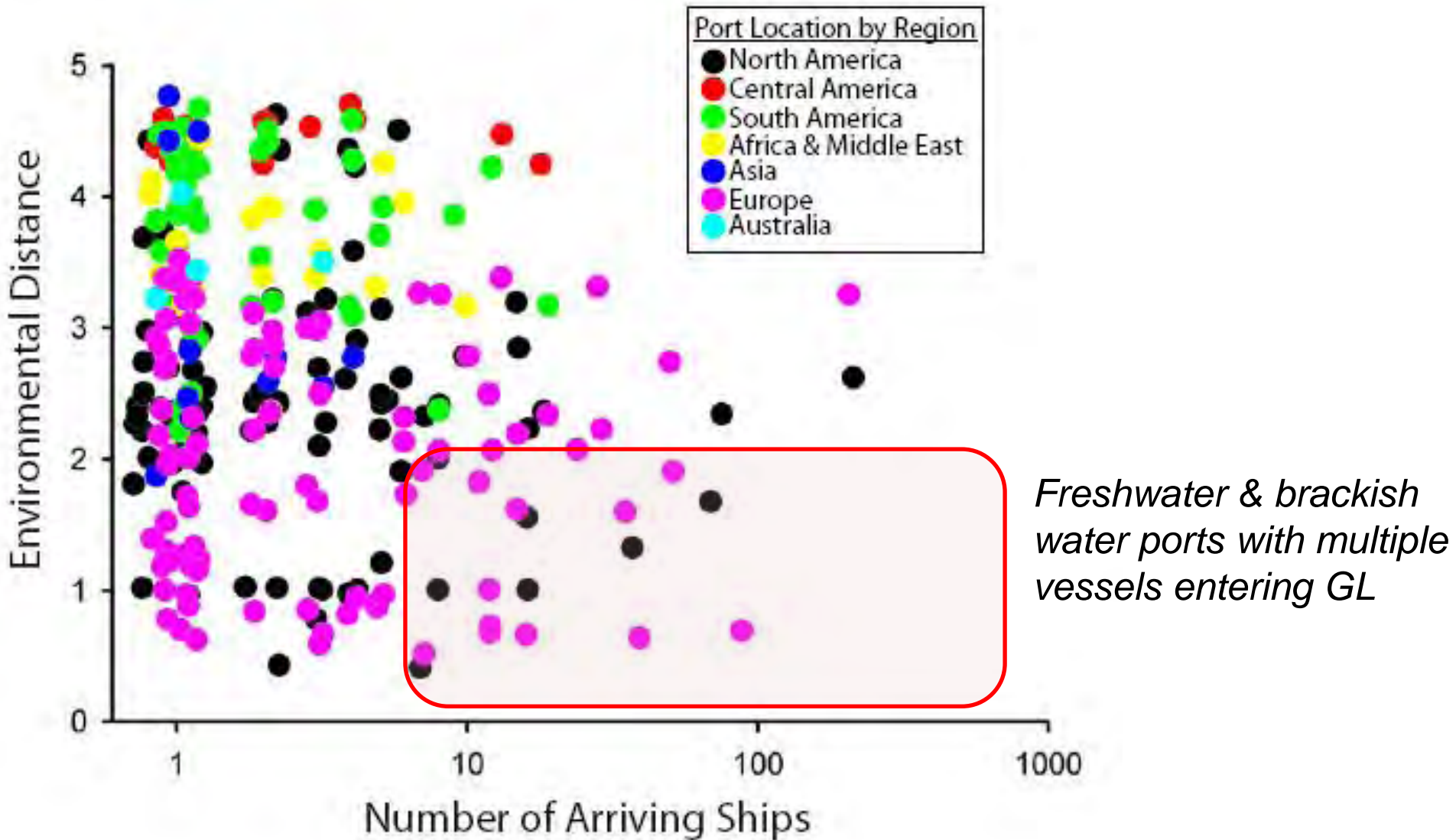
2. Potential habitat - environmental niche models
(a) develop GIS layers —environment
(b) model where species most likely to do well

Hydrilla verticillata - potential habitats



GLPF: Risk assessment of shipping

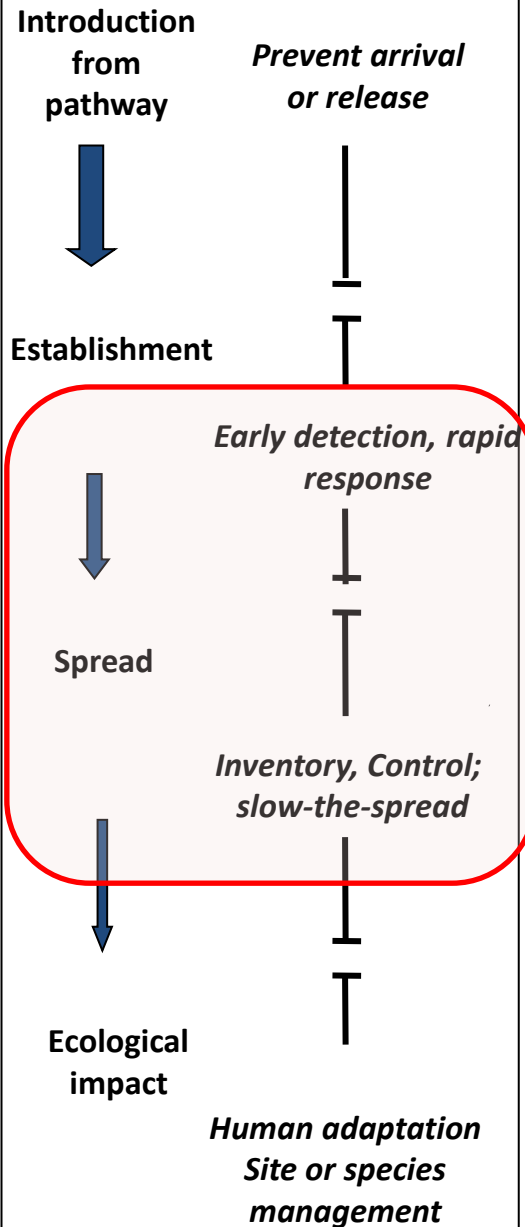
Risk Assessment Combining Origin, Propagules, and Environment



(Keller, Drake, Drew, Lodge 2010 Div & Dist)

Forecasting Spread and Bio-economic Impacts

Invasion process Management Options



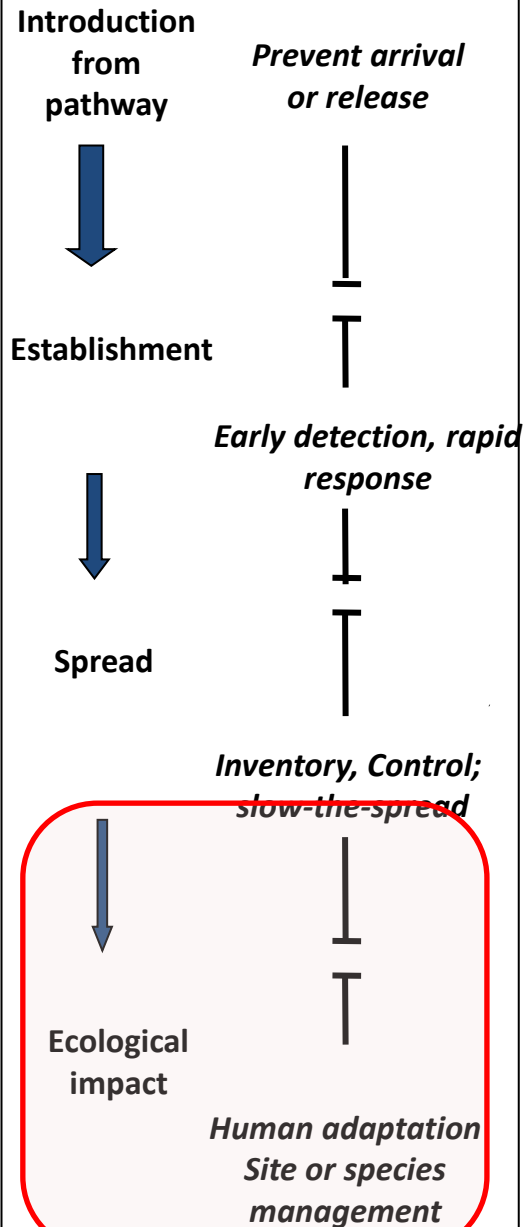
1. Establishment
Identify species, propagule pressure from all pathways

2. Potential habitat - environmental niche models
(a) develop GIS layers —environment
(b) model where species most likely to do well

3. Spread
(a) background dispersal
(b) via shipping & trailered boats

Invasion process Management Options

Forecasting Spread and Bio-economic Impacts



1. Establishment

Identify species, propagule pressure from all pathways

2. Potential habitat - environmental niche models

(a) develop GIS layers —environment

(b) model where species most likely to do well

3. Spread

(a) Background dispersal

(b) via shipping & trailered boats

4. Ecological Impact s

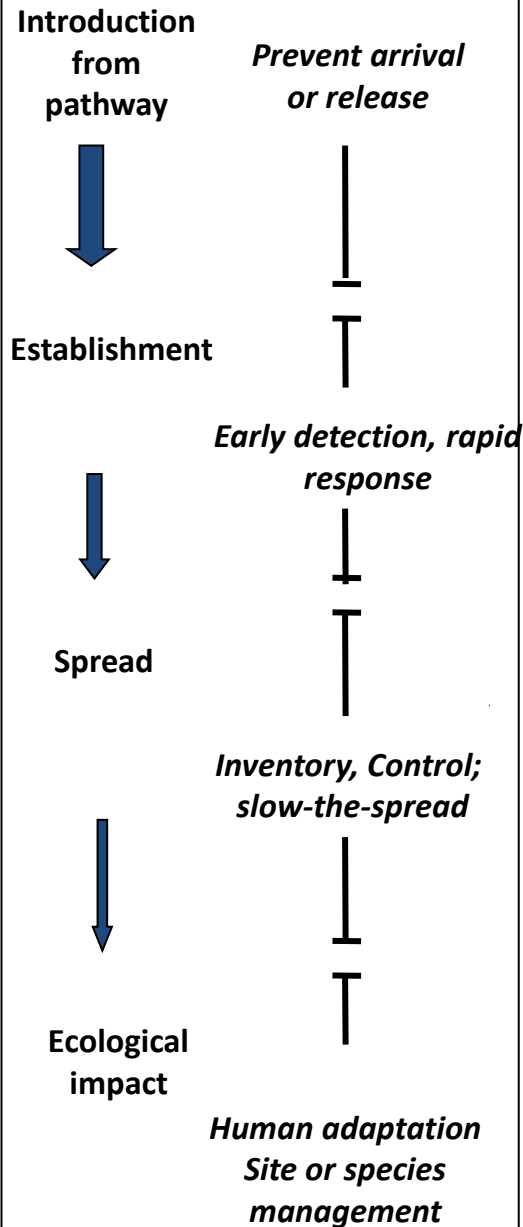
(a) direct and indirect impacts - food web modeling

5. Economic Impact s

(a) Links food web models to regional economic models

Invasion process Management Options

Forecasting Spread and Bio-economic Impacts



1. Establishment
Identify species, propagule pressure from all pathways

2. Potential habitat - environmental niche models
(a) develop GIS layers —environment
(b) model where species most likely to do well

3. Spread
(a) Background dispersal
(b) via shipping & trailered boats

4. Ecological Impact s
(a) Trait based modeling
(b) Food web modeling

5. Economic Impact s
(a) Links food web models to regional economic models

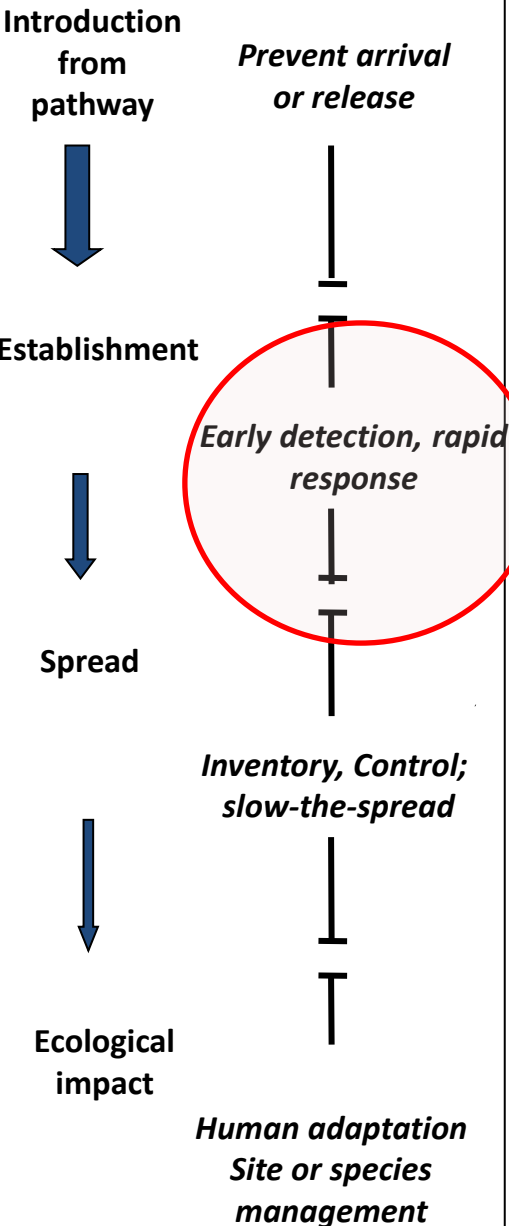
6. Management advice

Cost benefit analysis of alternative management scenarios

- Early Detection and rapid response
- Species screening & regulations to remove from trade
- Restoration of ecological separation – Chicago Canal
- Ballast water treatment
- control – integrated pest management

Four research programs

Invasion process Management Options



Great Lakes Environmental DNA surveillance (GLRI)
➤ all pathways

Great Lakes Protection Fund
➤ Maritime shipping
➤ Trailer boats
➤ Prevention and EDRR

Forecasting Spread and Bio-economic Impacts (NOAA CSCOR & GLRI)
➤ all pathways

USFWS-EPA GLRI project #2:
Environmental DNA Surveillance: Applied Early Detection

David Lodge (Notre Dame), Chris Jerde (Notre Dame), Andy Mahon (Notre Dame), Lindsay Chadderton (TNC), Cameron Turner (Notre Dame), Matt Barnes (Notre Dame)

Primary objectives:

1. Establish an environmental DNA surveillance program in the Great Lakes – focus on priority invasive species and pathways
2. Build environmental DNA surveillance capability (training and methods)

➤ *Initial focus on Asian Carp*

➤ *potential spawning rivers*

➤ *bait trade and Chicago
Lakes*

➤ *Ports and other pathways
and species in yr 2 - 3*

Key questions for shipping pathway

- What species are prone to taken up and spread?
- What habitats would support them – where can they survive and flourish, what communities are at risk, what ports or areas are likely sources of secondary spread?
- Where are they likely to enter the pathway?
- Where are they likely to be discharged?
- How does background spread compare to assisted dispersal from shipping activities?
- What are the management options and what do they cost
 - E.g. where should surveillance be undertaken – for what species
 - Where, when and for what species would treatment be warranted

Overlap with objectives of Ballast Water Collaborative (BWC)

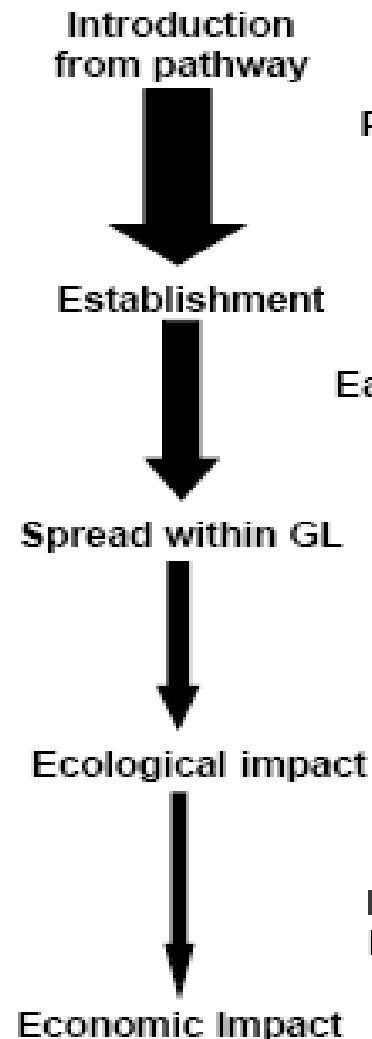
1. Better understand what trade patterns and species present the greatest risk, and the consequences of such risks; for example, is it more important to slow the spread of micro-organisms or certain species of fish?
2. Prioritize the risk/consequences that we are trying to address.
3. Determine improvements to ballasting protocols and best practices that can address these risks.
4. Determine what cost effective and feasible technological investments can best reduce these risks.

NOAA CSCOR Project:

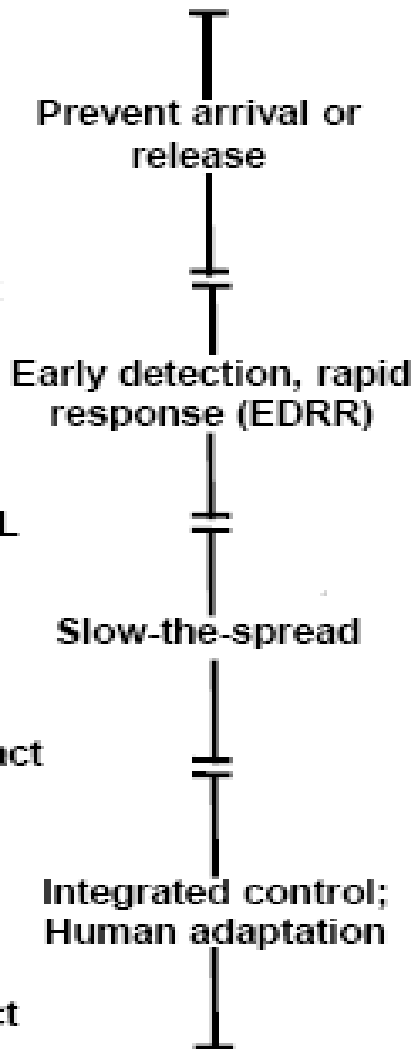
Forecasting Spread and Bioeconomic Impacts of Aquatic Invasive Species from Multiple Pathways to Improve Management and Policy in the Great Lakes

Conceptual Model

Invasion Process



Management Options



Proposal

Project Forecasting Goals

Goal 1. Establishment:
identify species, propagule pressure from ships, organisms in trade, and canals

Goal 2. Potential habitat:
(a) GIS layers
(b) multiple environmental niche modeling methods

Goal 3. Spread:
(a) background dispersal
(b) via ships, boaters

Goal 4. Ecological impact:
(a) trait-based modeling
(b) food web modeling with expert elicitation

Goal 5. Economic impact:
link food web model to model of regional economy

Goal 6. Management advice:
Cost-benefit analyses of alternative scenarios for every invasion step above

Management Outcomes

Prevention:

Improved ballast water treatment; Species screening protocols, species suggested for black list; Increased hydrologic separation. *EPA, USCG, APHIS, FWS, DNR, ACE*

EDRR:

Prioritize species & high value habitats for surveillance and rapid response; Guide canal barrier specifications re target species. *DNRs, TNC, ports, USCG, APHIS, ACE*

Slow-the-spread:

Prioritize (by risk from dispersal) harbors, boat landings for management; Prioritize bait sources for management; Identify dispersal bottlenecks for management. *USCG, DNRs, GLFC, FWS, ACE*

Control:

Identify invader removal, fish harvest, stocking and other strategies to minimize impact of established invasives. *GLFC, FWS, TNC, DNRs*

Acknowledgements

NOAA
USFWS
GLRI
EPA
GLPF



CENTER FOR AQUATIC CONSERVATION

The Nature
Conservancy



Protecting nature. Preserving life.™

KEEP OUT
ELECTRIC FENCE
BARRIER