Great Lakes Stressors

Hugh MacIsaac
Great Lakes Institute for Environmental Research
University of Windsor

CAISN CANADIAN AQUATIC INVASIVE SPECIES NETWORK

Stressors of the Great Lakes

1. Overharvesting
2. Chemical Pollution (N, P, Hg)
3. Climate Change
4. Habitat Change/destruction
5. Species Introduction

stressors may interact

- Interacting stressors are an under-studied yet commonplace phenomenon on the Great Lakes
- Most researchers and governments focus on single factors
- Management of interacting stressors can be challenging

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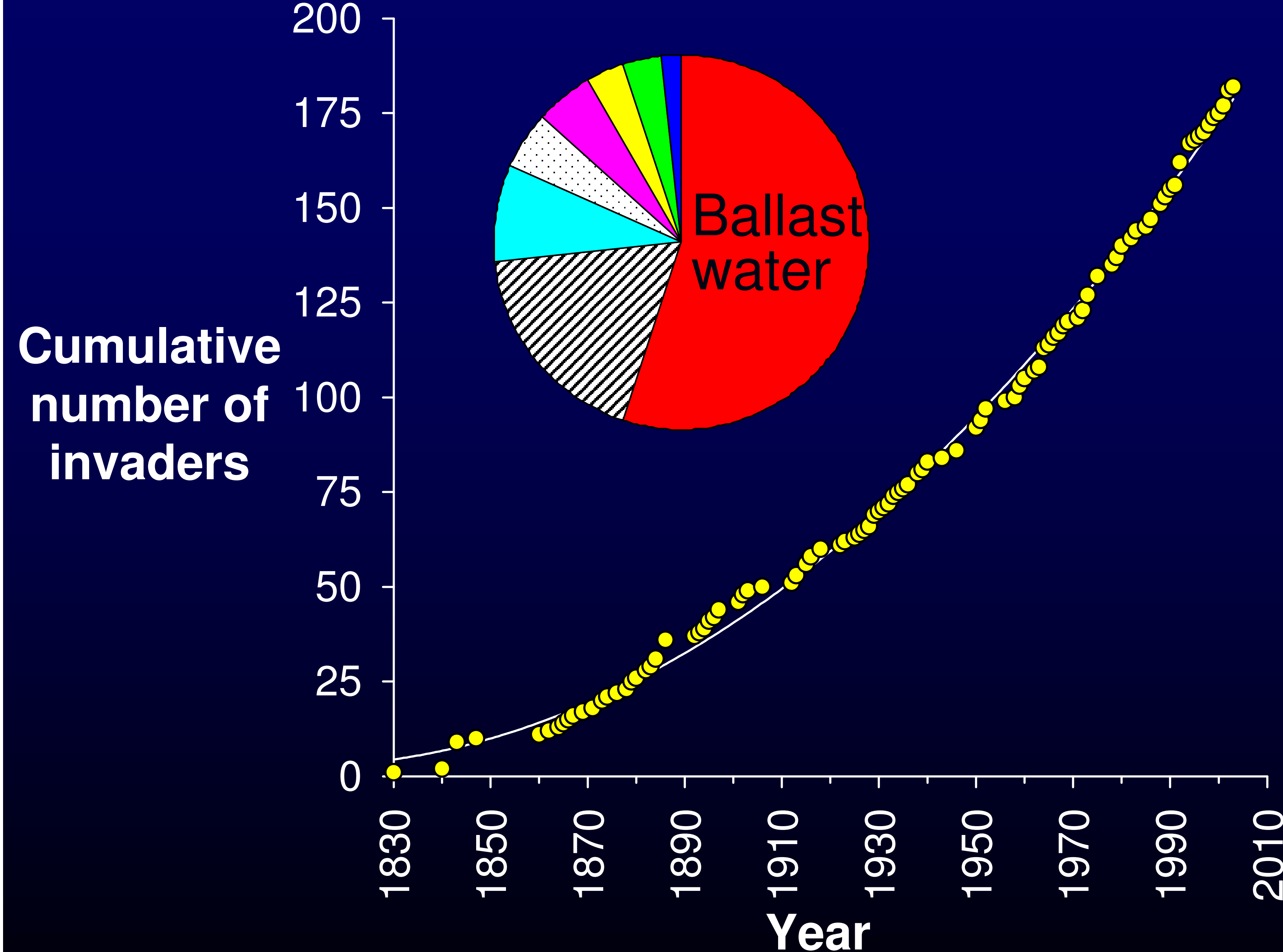
Case Study 1 (items 2 and 5)

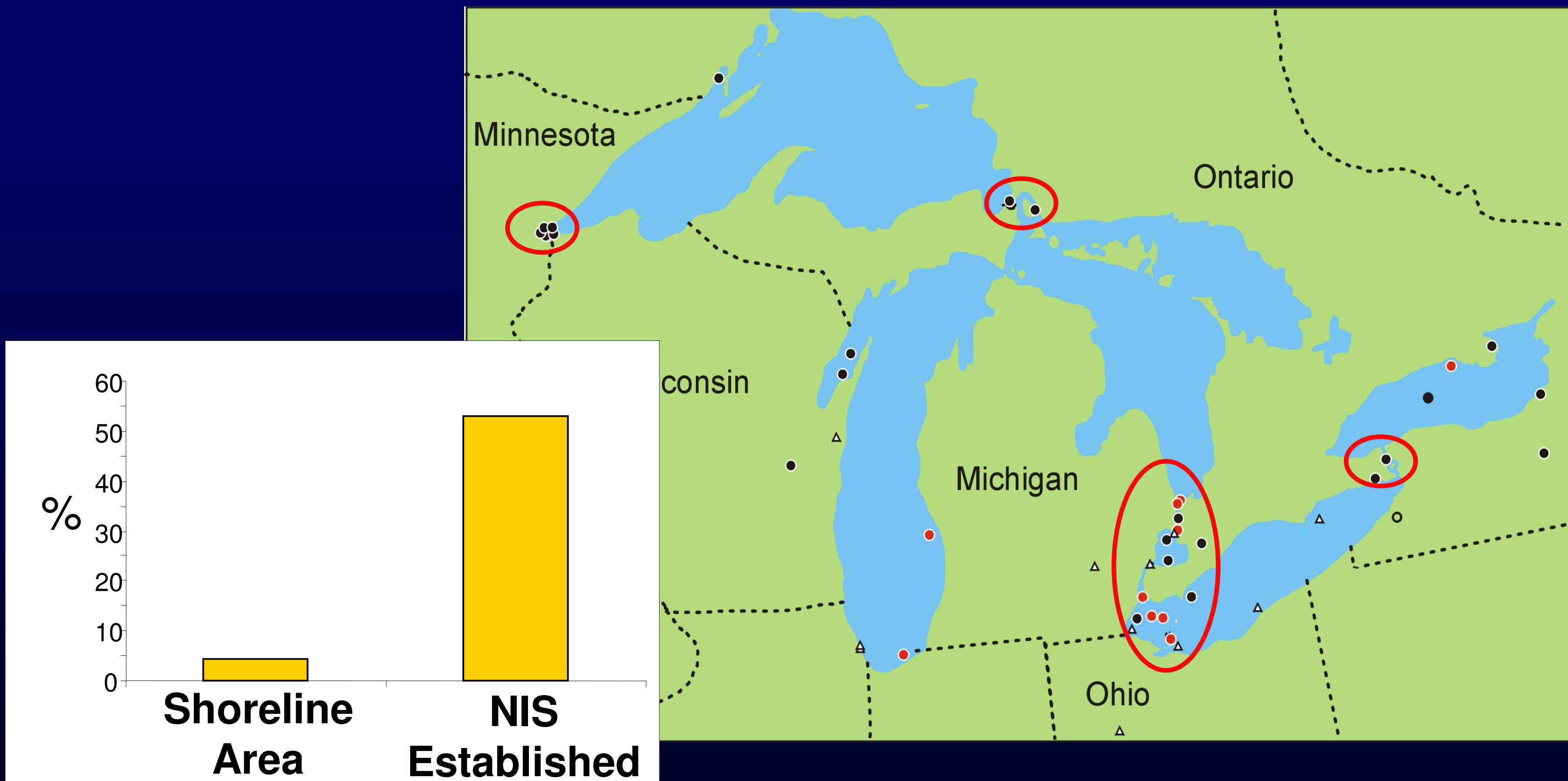
Introduction of invasive mussels combined with nutrient abatement is rapidly changing upper Great Lakes' ecosystems

Non-indigenous Species in the Great Lakes



Ricciardi (2006), Can. J. Fish. Aquat. Sci.; NRC (2011)

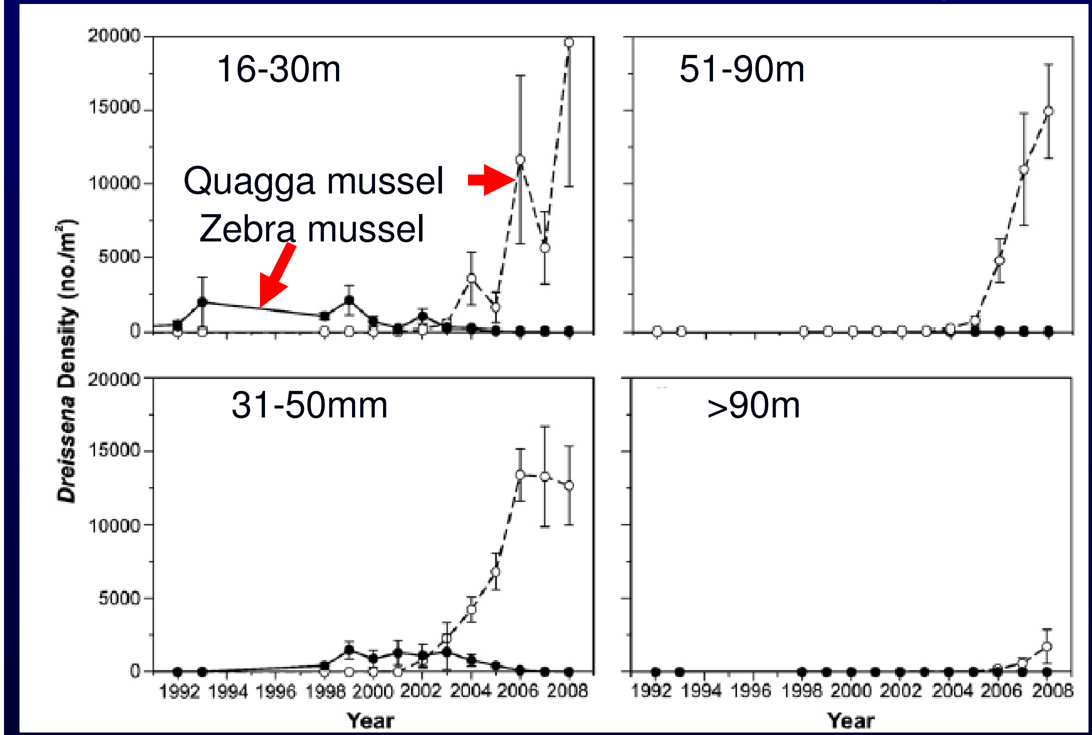
Nonindigenous animals and protists appear to establish principally in coastal areas



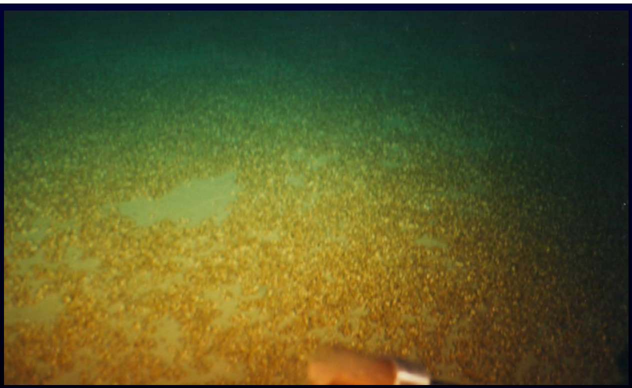
Connecting channels collectively account for <5% of shoreline area but >50% of NIS first sightings since 1959

Oligotrophication and Benthification of Upper Great Lakes' Foodwebs

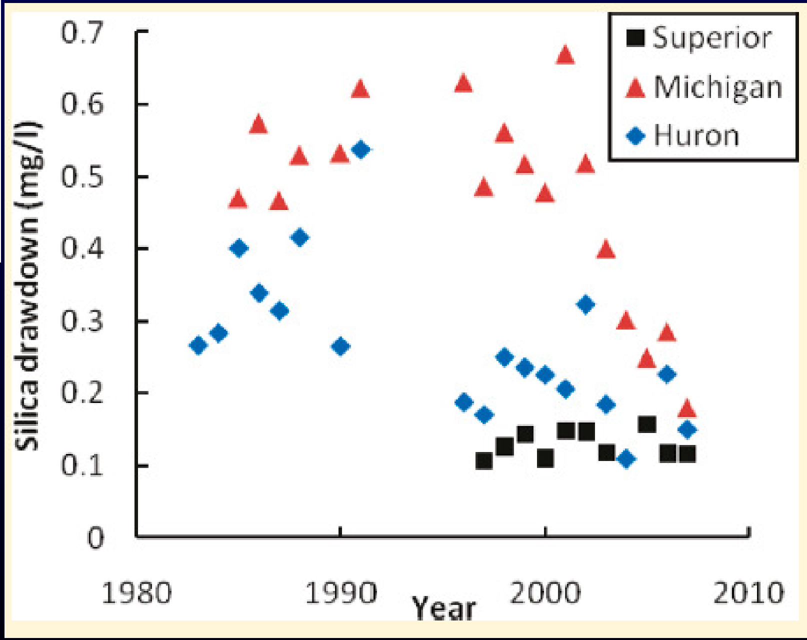
Dreissena mussel abundance (#/m²) in L. Michigan



Nalepa et al. (2010) J. Great Lakes Res.



Primary Production Proxy



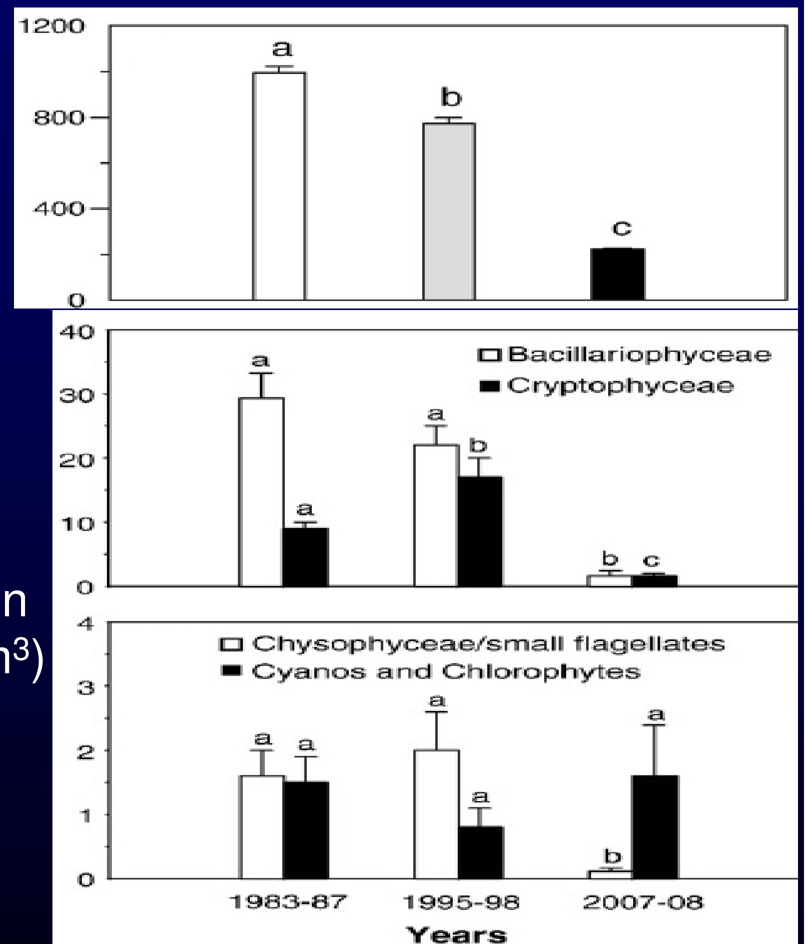
Evans et al. (2011) Environ. Science & Tech.

Oligotrophication & Benthification of Lake Michigan Foodweb

- Spring changes correspond with spread (2000) of quagga mussels
- Effect may be compounded by oligotrophication as P loading declined from ~3000 MT in 1980s to 1900 MT in 2005-2008
- Effects are cascading, with adverse effects on *Diporeia* and fish

Spring Phytoplankton Production (mg C/m²/d)

Spring Phytoplankton Carbon (mg/m³)



Fahnenstiel et al. (2010) J. Great Lakes Res.

Oligotrophication & Benthification of Lake Michigan and Huron Foodwebs

Alewife weight at age in L. Michigan

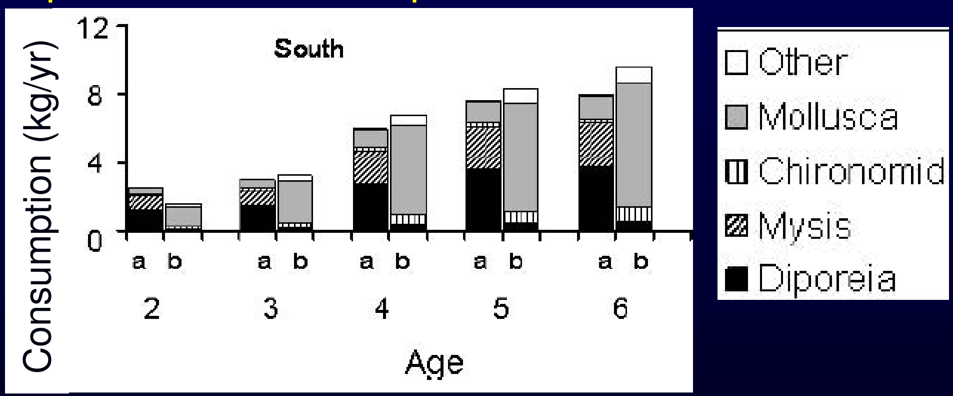
Age	Pre	Post
1	15.9	12.2
2	31.5	22.5
3	41.1	28.9
4	48.2	36.1
5	55.5	41.0
6	60.4	47.6

lake whitefish weight at age

	Lake Michigan		Lake Huron	
	Central		Central	
Age	Pre	Post	Pre	Post
1				
2			196	100
3	731	488	537	183
4	1076	702	870	366
5	1,431	1,034	1,241	669
6	1,757	1,174	1,440	992
7	2,047	1,352	1,860	1,145
8	2,269	1,602		

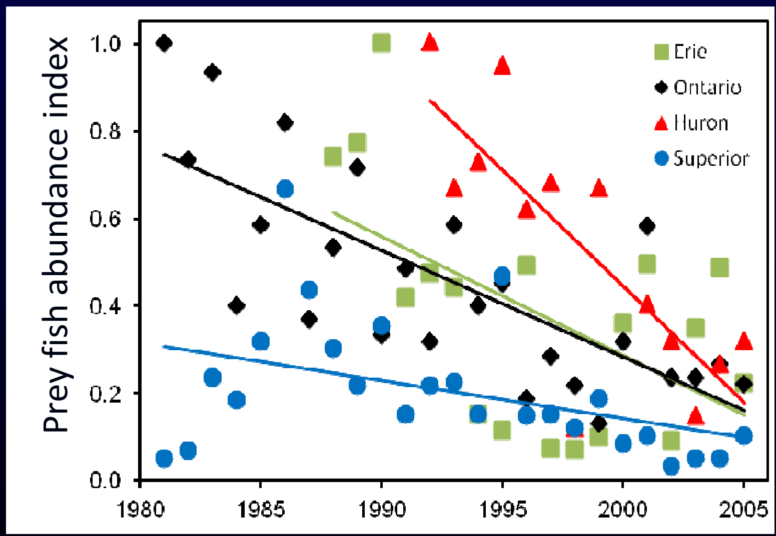
lake whitefish diet in Lake Michigan

a= pre-*Dreissena*; b = post-*Dreissena*



Pothoven & Madenjian (2008) North Amer. J. Fish. Manage.

Management options poor, limited to fish stocking rate and, more controversially, degree of nutrient abatement



Hebert et al. (2008) Ecology

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Case Study 2

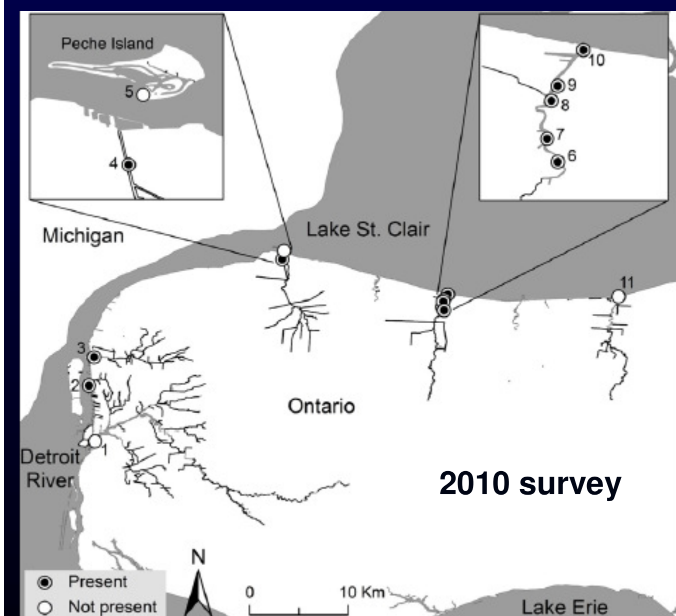
Colonization, survival and spread of invasive species may be facilitated by warmer winters

I will use macrophytes as an example

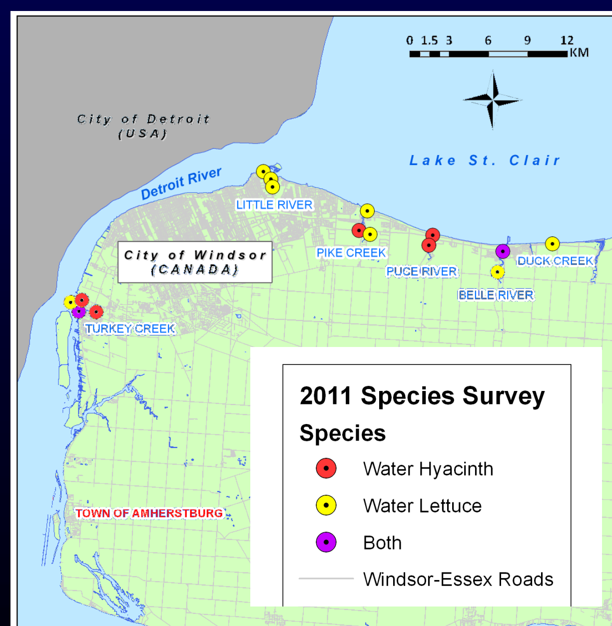
Lake Saint Clair


water lettuce


water hyacinth

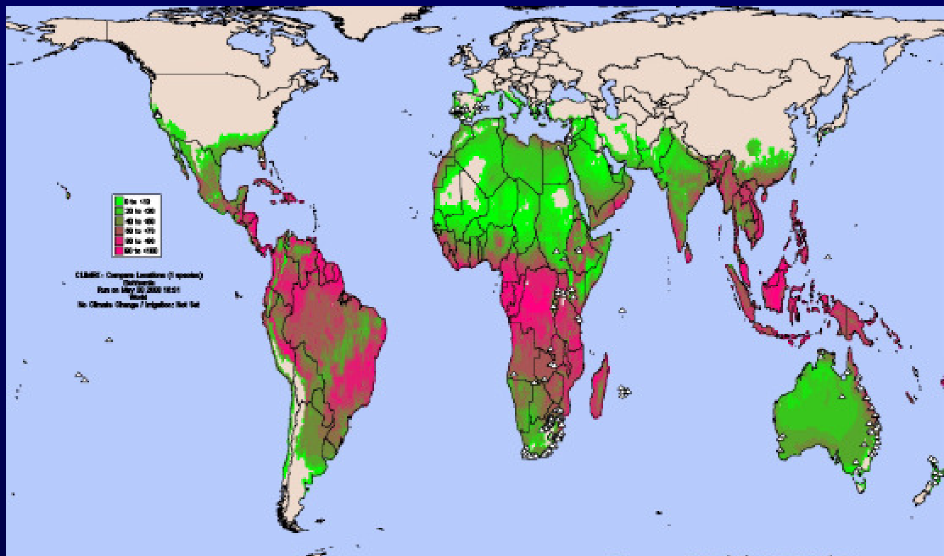


2010 survey



Abisola et al. (2011)
Aquatic Invasions

Can tropical and sub-tropical plants establish in temperate areas?



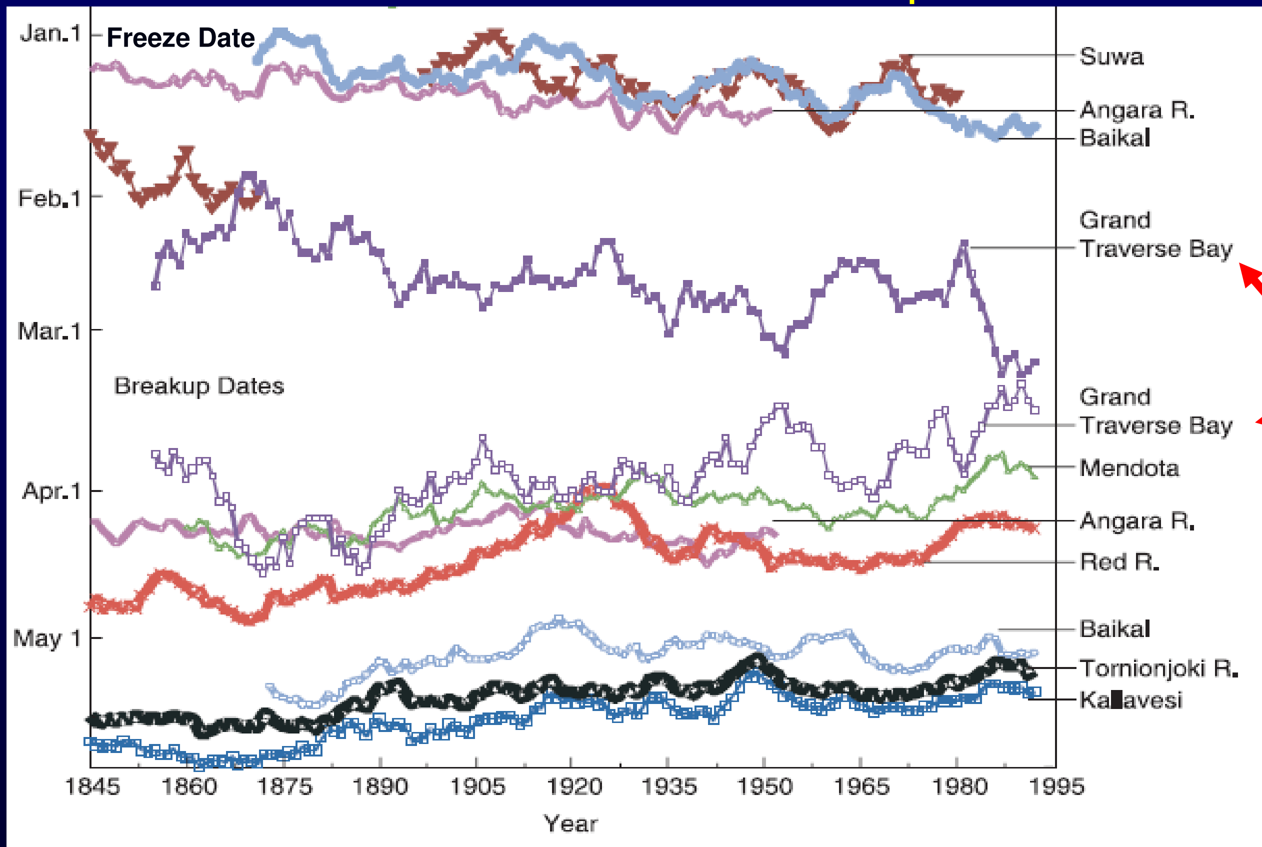
Predicted environmental suitability for water hyacinth based on CLIMEX niche model

European and Mediterranean Plant Protection Organization (2008)

- Possible that people simply throw plants into the waterways each year, causing local infestations

Warmer winters may facilitate nonindigenous species

Lakes freeze later and breakup earlier



Lake Michigan

Magnuson et al.
(2000), Science

- Will warmer winters allow colonization and survival of southern species? We simply do not know, but if they survive, coastal infestations of nonindigenous plants may occur.
- Management must consider restricting public sale of possibly invasive plants.

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Case Study 3 (items 4–5)

Growth of nuisance *Cladophora glomerata* macroalgae is facilitated by:

i) introduction of invasive mussels that enhance light in coastal waters,

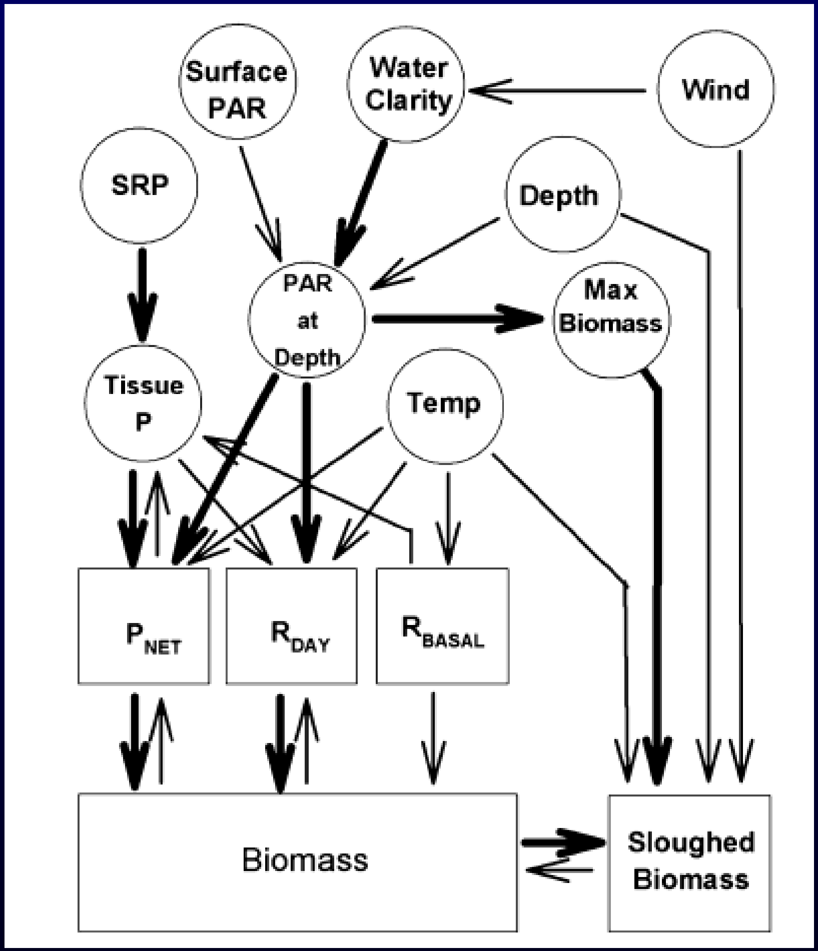
ii) enhanced nutrient runoff from cities.

Cladophora in the Great Lakes

Cladophora glomerata history in the Great Lakes

- *Cladophora glomerata* blooms were common in Lakes Erie, Michigan and Ontario between 1950s-1980s
- Implementation of the IJC's phosphorus abatement strategy resulted in reduction of the problem in most sites
- Blooms have recurred since mid-1990s, dramatically affecting nearshore habitats and human utilization of beaches

Physical, chemical and biological changes associated with *Dreissena*, and their effects on *Cladophora*

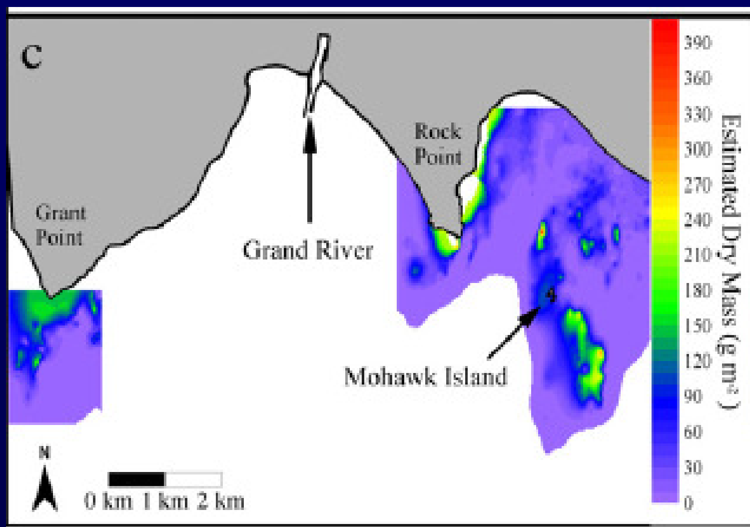


Higgins et al. (2008) J. Phycol.

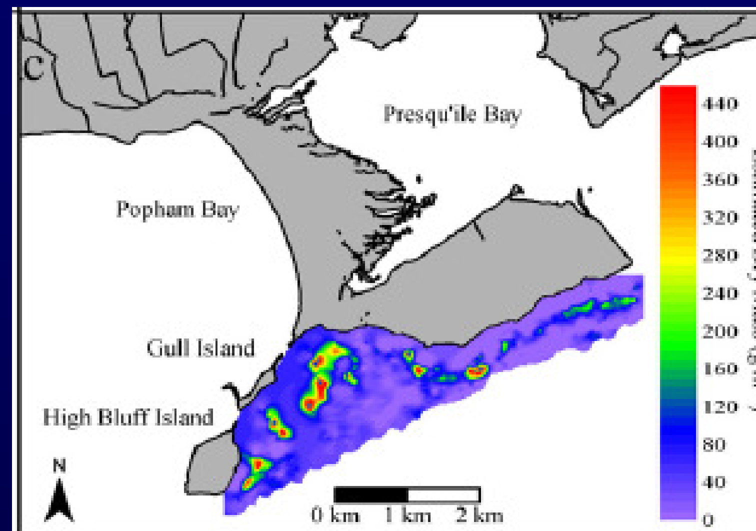
Dreissena mussels can affect (bold arrows) many of the processes that affect growth and sloughing of *Cladophora*

Cladophora biomass can reach >400 g/m² in nearshore areas

Eastern Lake Erie



Eastern Lake Ontario



Depew et al. (2011) J. Great Lakes. Res.

- *Dreissena* abundance is an especially important factor limiting abundance of *Cladophora*
- *Dreissena* abundance, land cover, nutrient concentrations and turbidity account for 95% of variation in *Cladophora* abundance
- Occurrence is not hindered by low ambient SRP, and mussels may be important in enhancing local nutrient supply
- Management options are very limited (P loading?).

Thank you