Spiny waterflea

Building Sustainable Solutions to the Issue of Ballast Water Treatment: Testing Relationships Between Propagule Pressure and Colonization Success of Invasive Species.

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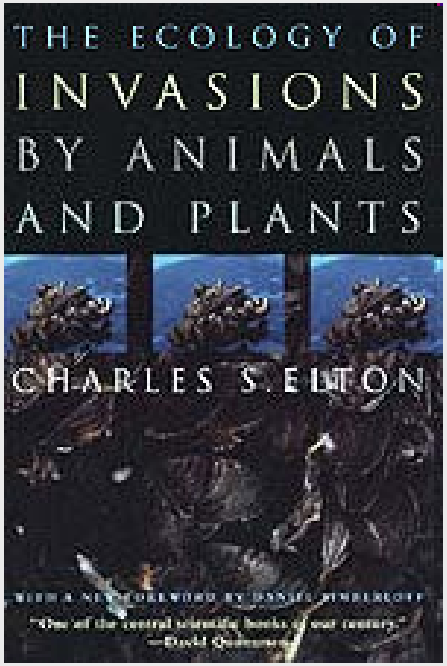
Recent Estimates concerning Alien Species in the United States:

- 50,000 taxa present (plants, animals, microbes…)

- Costing $120 billion per year in damage

- Responsible for 42% of listings of other taxa on the Endangered species list

(Pimentel et al. 2004)



Elton, C. S. 1958. The Ecology of Invasions by Animals and Plants. Univ. of Chicago Press. 181 pp.

Carson, R. 1962. Silent Spring.

"The real thing is that we are living in a period of the world's history when the mingling of thousands of kinds of organisms from different parts of the world is setting up terrific dislocations in nature."

Charles Elton (1958)

The components of the problem:

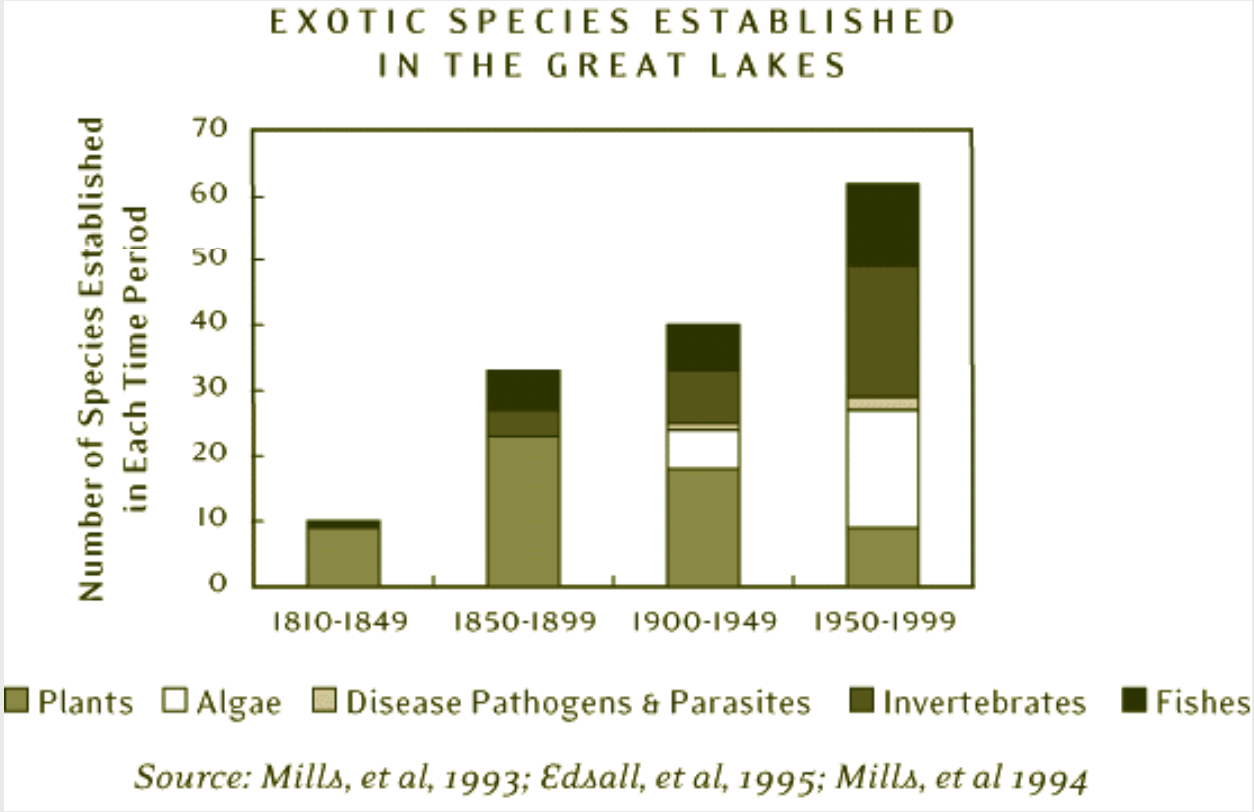
1) “Over hundreds of millions of years, plant and animal communities of the different continents evolved to be very distinct from one another.”

2) “Human trade and travel are rapidly obliterating these distinctions.”

3) “The process has grave implications for the conservation of diversity.”

(Simberloff 2000)

Of British Empire Vessels, on 7 March 1936,
1,462 were at sea, 852 were in port. (Elton 1958)



Since 1970, 75% of alien introductions in the Great Lakes has been by Eurasian ship ballast water discharge. (Ricciardi and MacIsaac 2000)

Managing Ballast Water:

- Ballast Water Exchange (BWE) : Saltwater flushing
- Ballast Water Treatment (BWT) : Filtration, Disinfection
- IMO Standards : <10 organisms m^{-3} for biota ≥ 50 µm in size

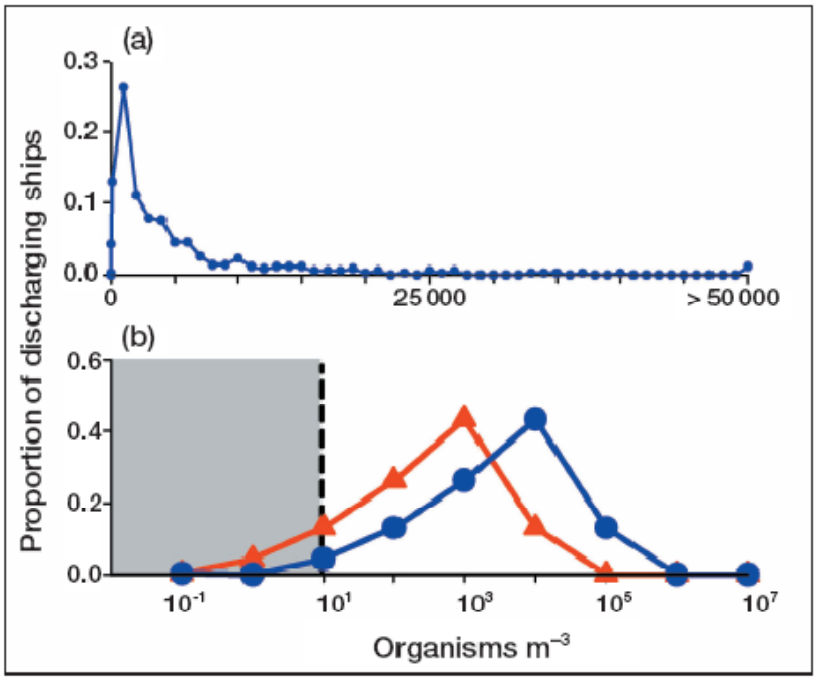


Figure 2. Zooplankton concentrations in ballast water. (a) Smoothed histogram of zooplankton concentration (organisms m^{-3}) in ballast tanks (n = 354) upon arrival at four US ports. (b) Smoothed histograms of zooplankton densities on the log-scale in unexchanged ballast water (blue circles) and ballast water after theoretical BWE (red triangles). Those ships meeting the IMO discharge standard are in the shaded area to the left of the hatched line.

(Minton et al., 2005, Frontiers Ecol Environ 3:304-398)

Our Objectives:

1) Experimentally evaluate the efficacy of IMO standards for crustacean zooplankton >50 µm in size through dose-response relationships of innocula in mesocosms.

2) As context to Objective 1, characterize species composition, density, and spatial variation of zooplankton in the Duluth-Superior Harbor and St.Louis Estuary.

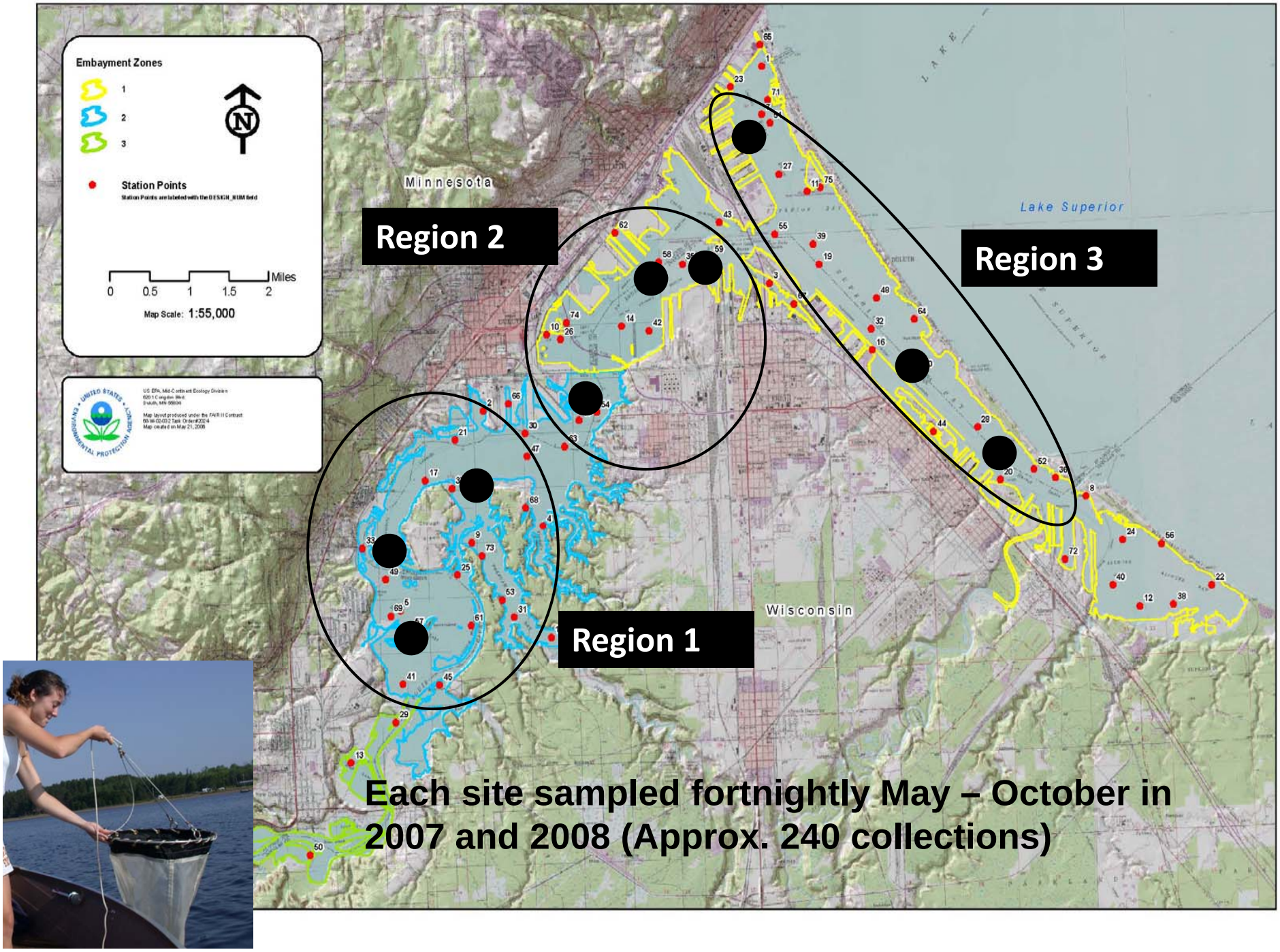
   Duluth-Superior Harbor and St. Louis Estuary

   Estuary – Dynamic physically, chemically, biologically

   A) Establish comprehensive species list in order to identify an appropriate surrogate invader

   B) Understand seasonal density patterns in order to guide the timing of experiments to capture a range of densities

   C) Understand seasonal pattern of species succession to guide the timing of experiments to capture a range of species


Embayment Zones
1
2
3
Station Points
Miles
0 0.5 1 1.5 2
Map Scale: 1:55,000
Minnesota
Wisconsin
Lake Superior
Region 1
Region 2
Region 3
Each site sampled fortnightly May – October in 2007 and 2008 (Approx. 240 collections)

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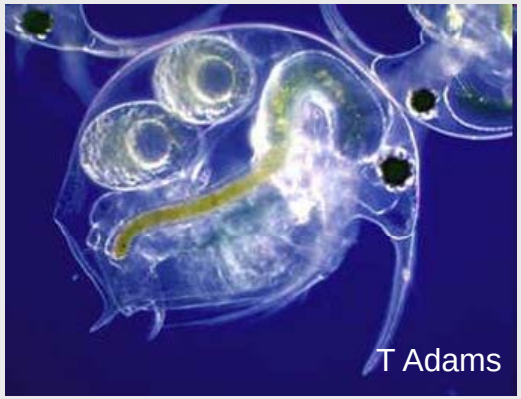
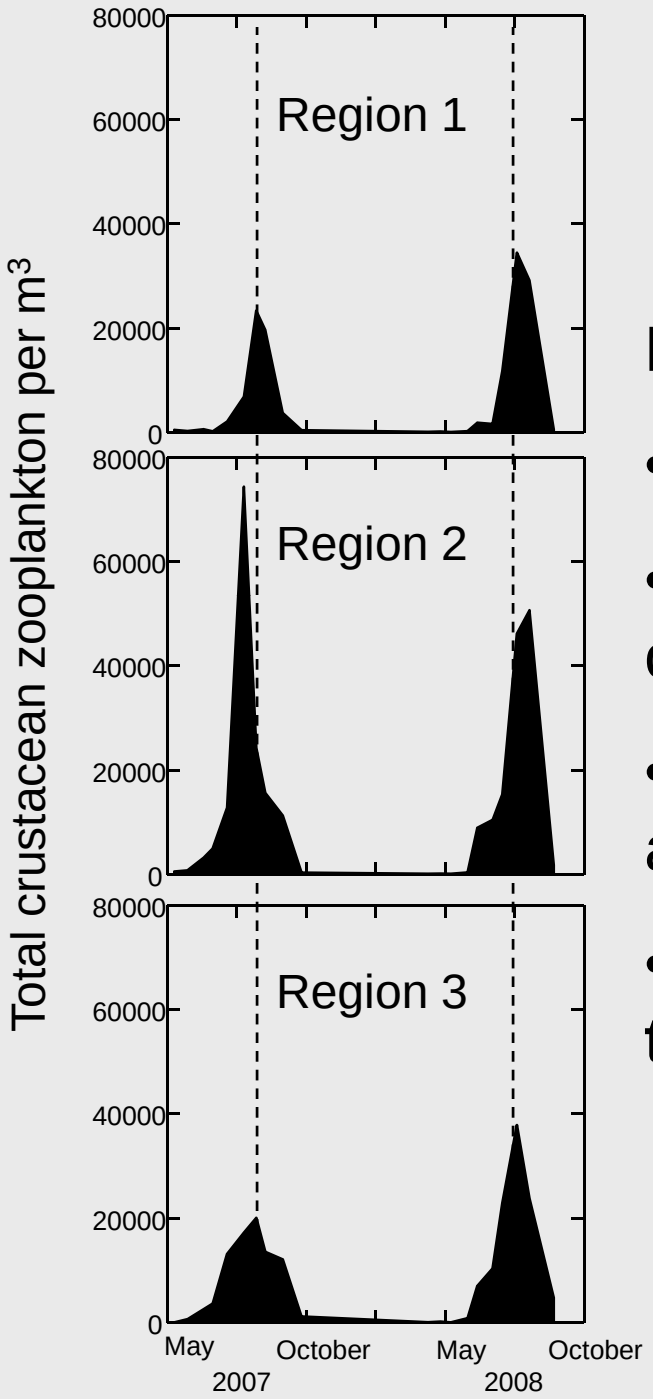


<u>Surrogate Invader</u> : *Daphnia magna*

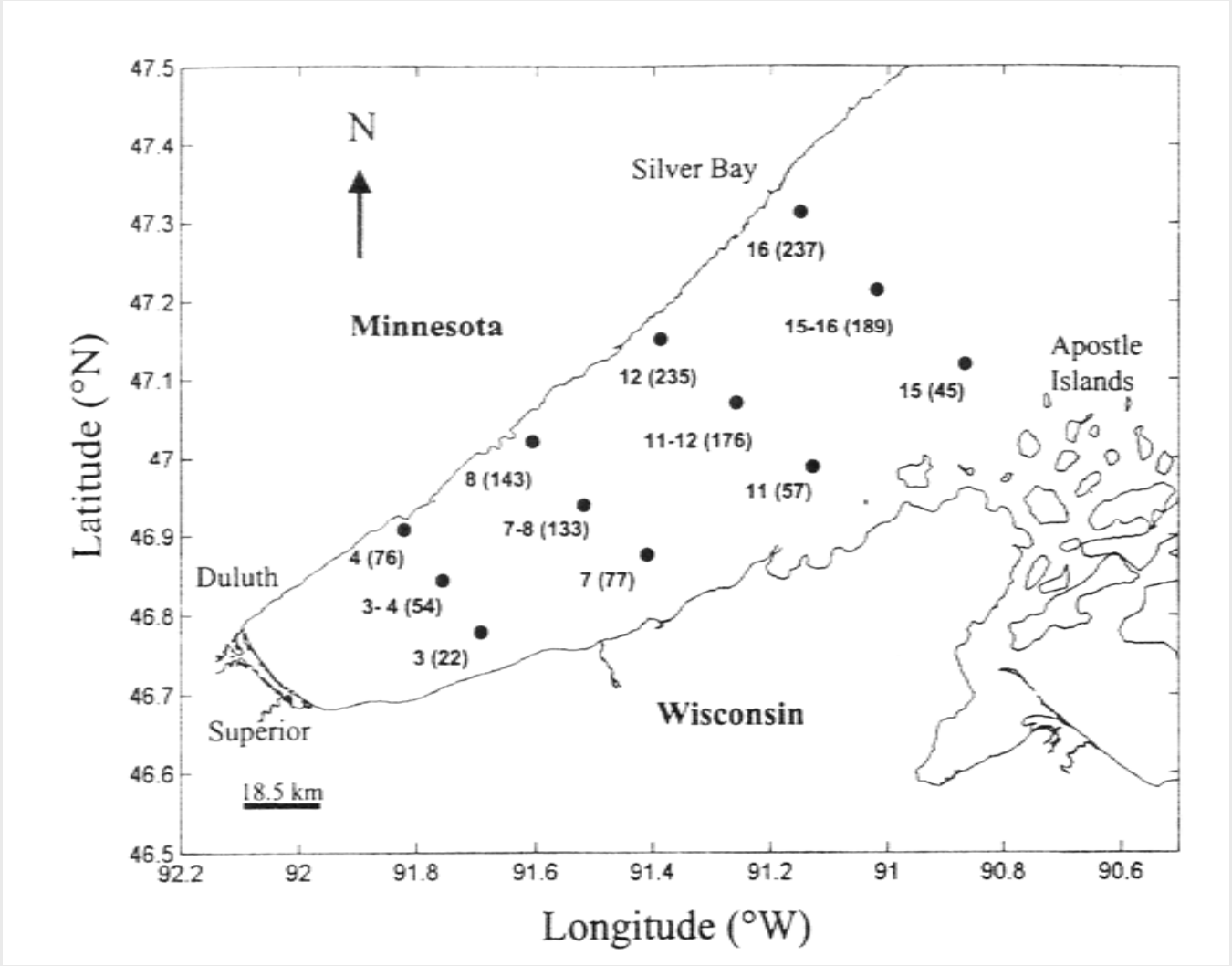
- **Propagates clonally (quick response)**
- **Effective grazer (competitor)**
- **Toxicology and ecology widely studied**
- **Produce males and dormant eggs when over-crowded (index of establishment)**

B) Understand seasonal density patterns in order to guide the timing of experiments to capture a range of densities



B) Seasonal <u>density</u> patterns

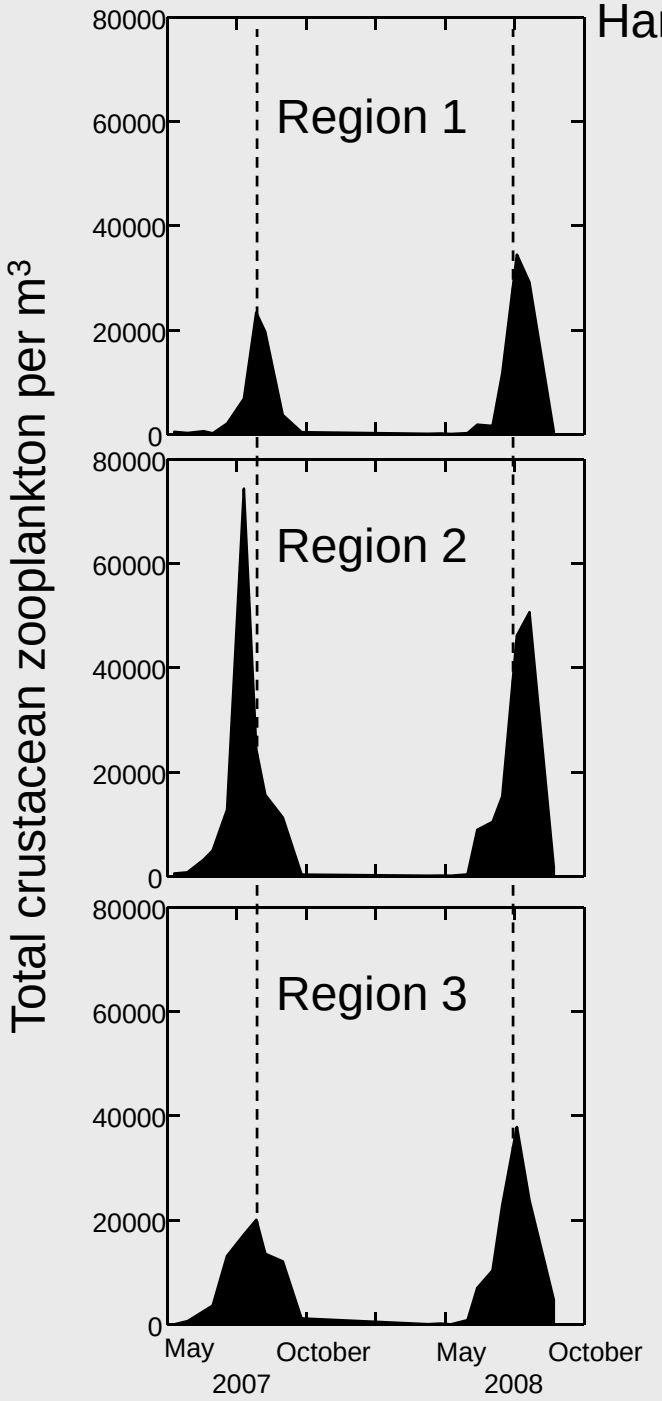
- Single seasonal peak (July-Aug)
- Monthly variation spans several orders of magnitude
- Patterns conserved among regions and years
- Densities strongly predicted by water **temperatures** and food concentrations.

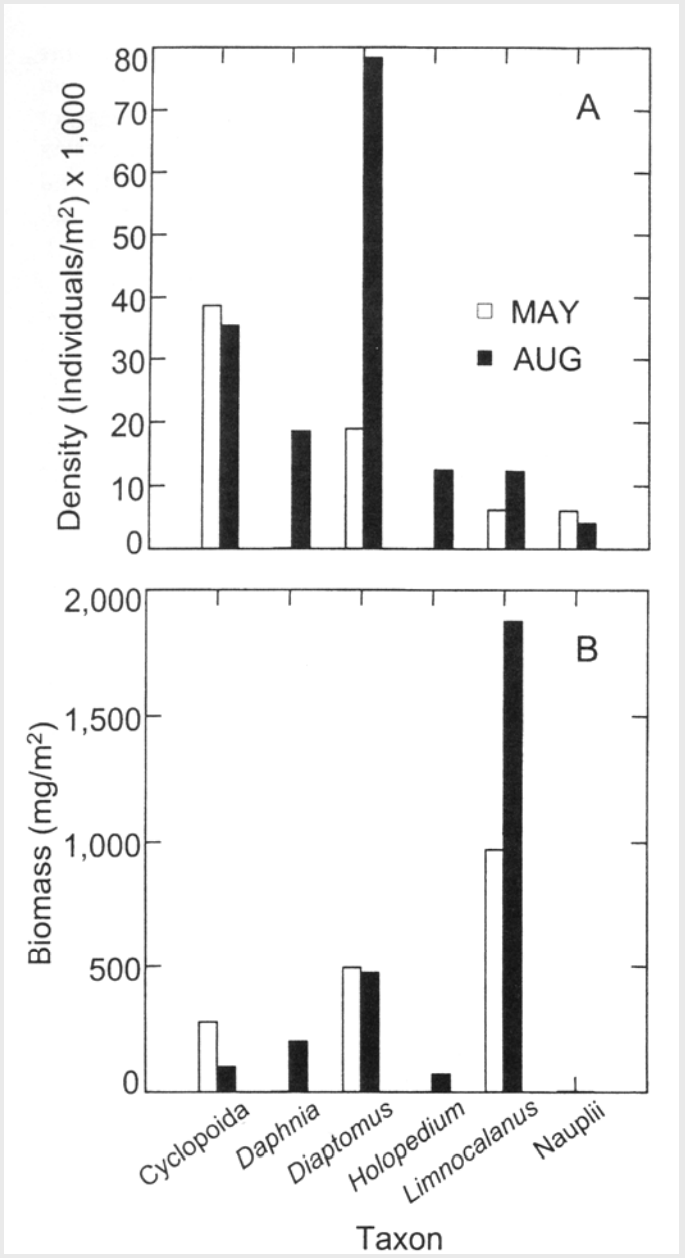


(Brown and Branstrator 2004)

Harbor

Lake Superior

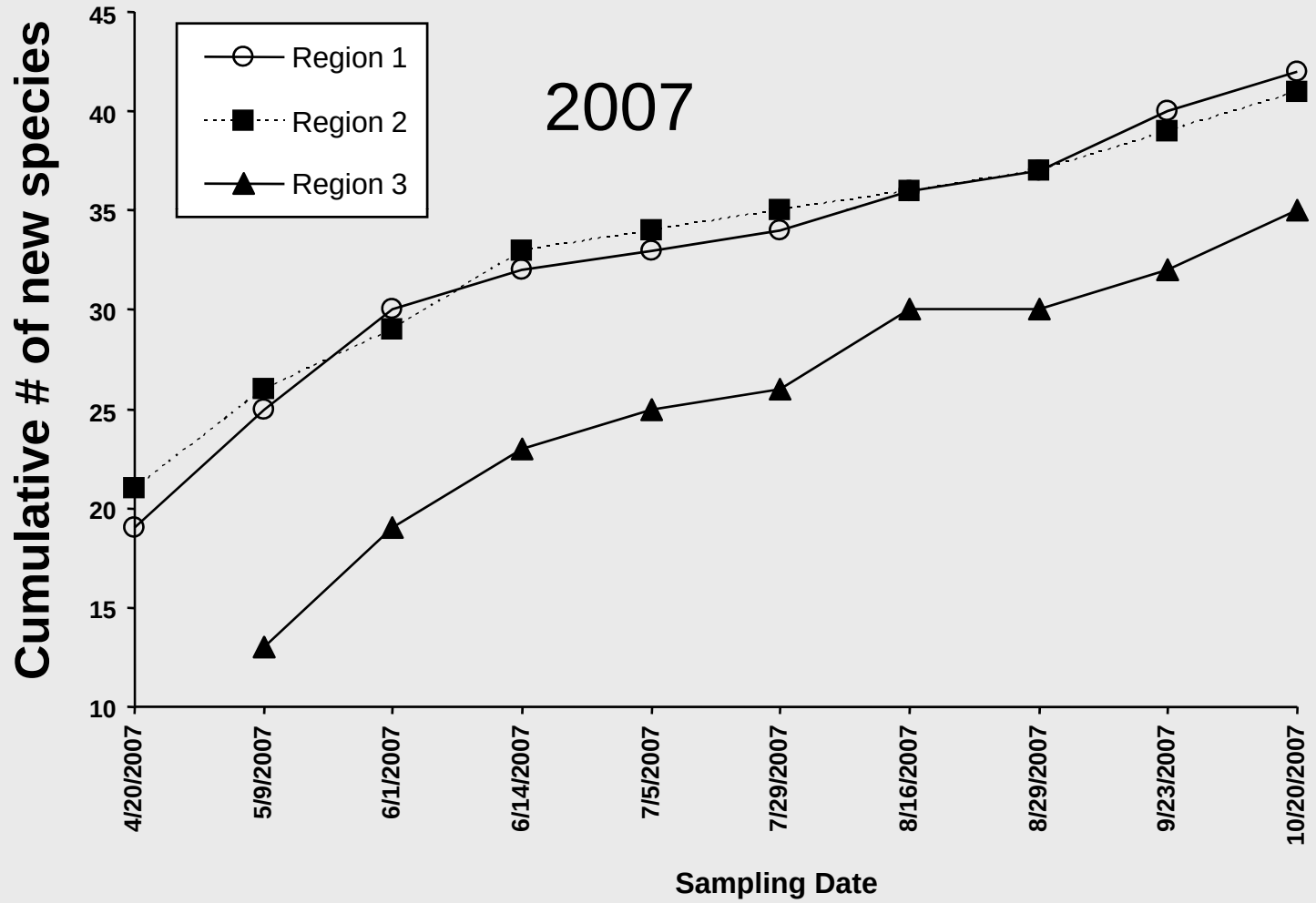




C) Understand seasonal pattern of species succession to guide the timing of experiments to capture a range of species

C) Seasonal species succession patterns

- Continual additions of new taxa
- Diversity lowest at Region 3.



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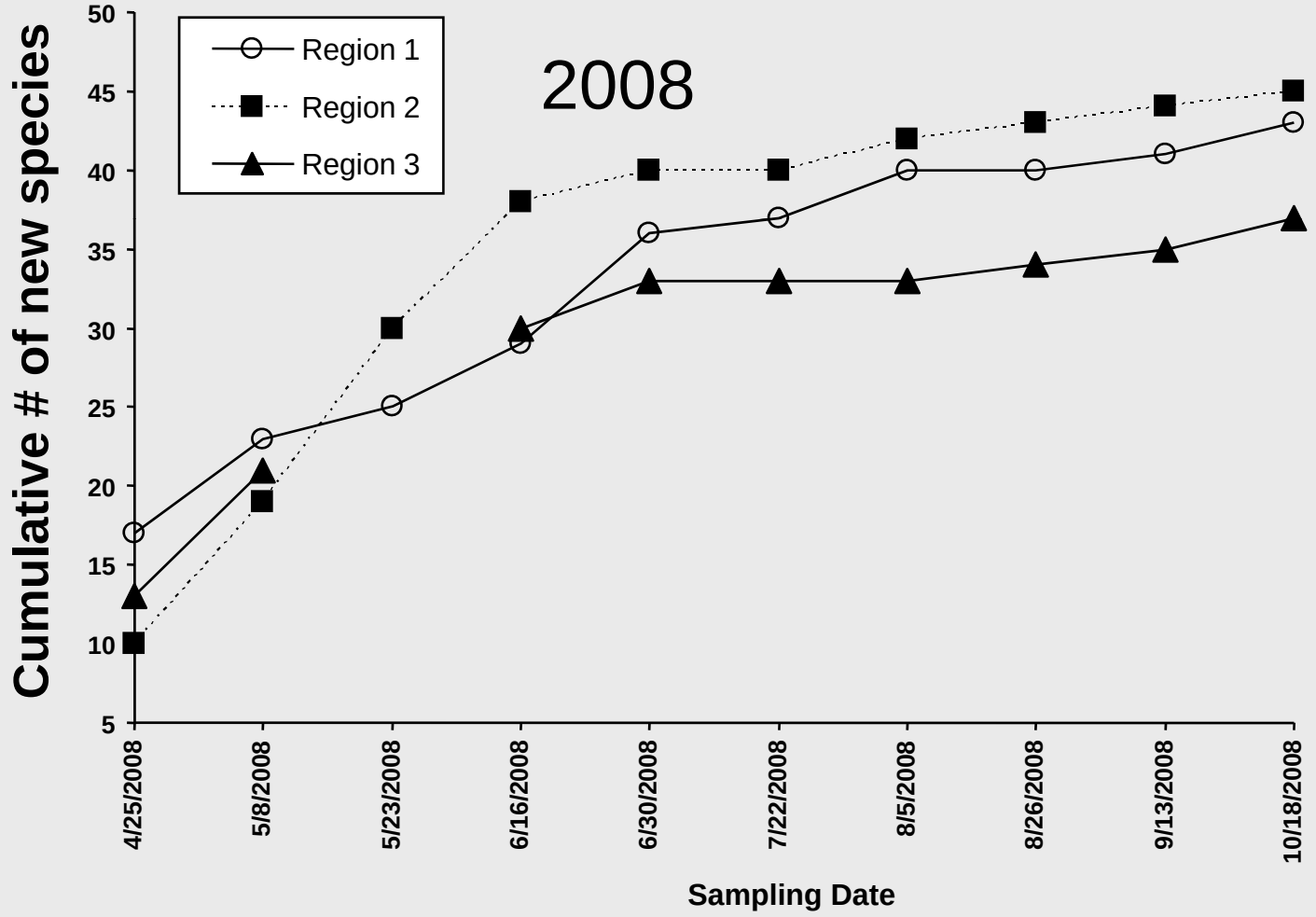

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    UWS indoor facility (climate controlled)

    Permit year-round experimentation

    Suitable to contain alien taxa

    Plan to begin initial testing in November 2009