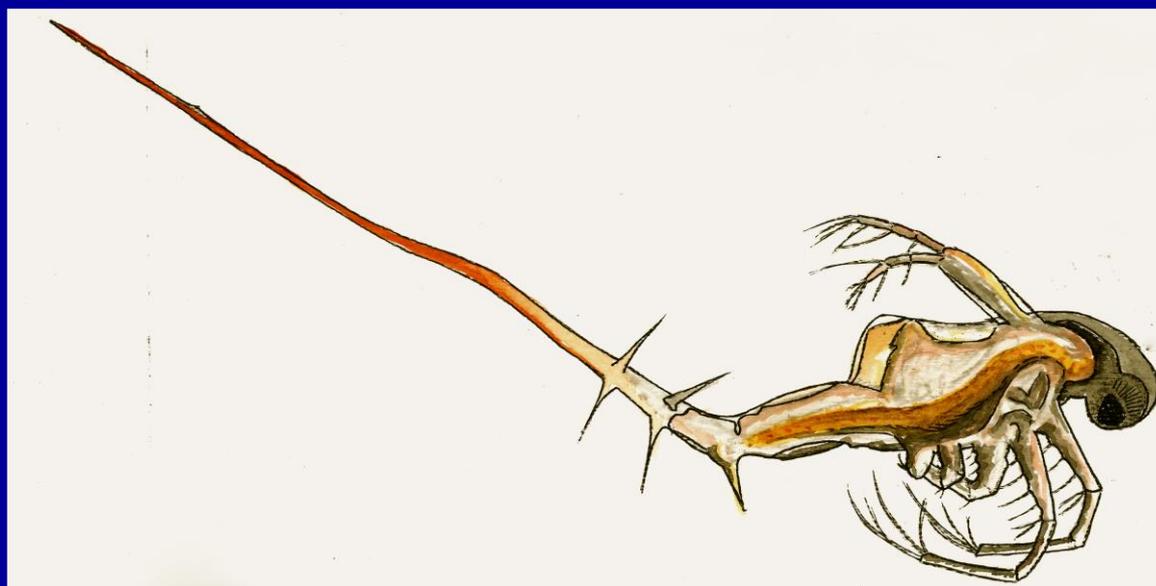


Population Establishment by *Bythotrephes longimanus* in a Minnesota Lake from Sediment Records

Donn Branstrator, Ashley Beranek, Meghan Brown, and Leif Hembre



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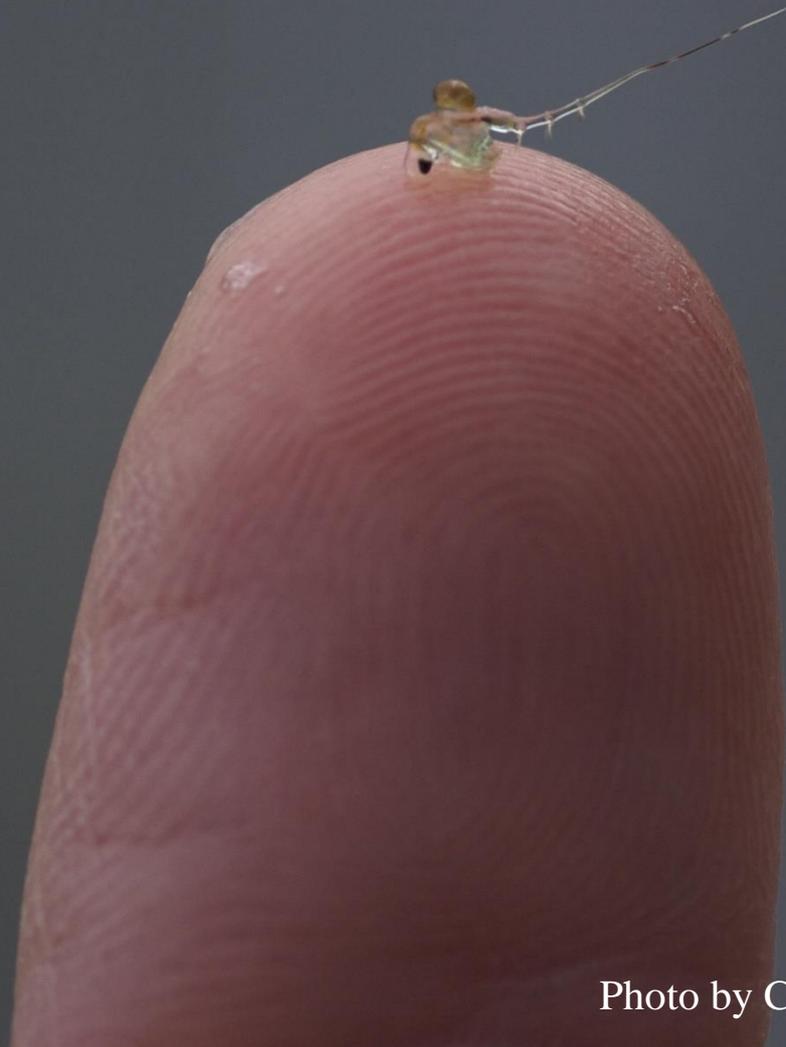


Photo by Chris Hagen (UMD undergraduate)



Piscivorous
Fish



Planktivorous
Fish



Invertebrate
predators



Bythotrephes

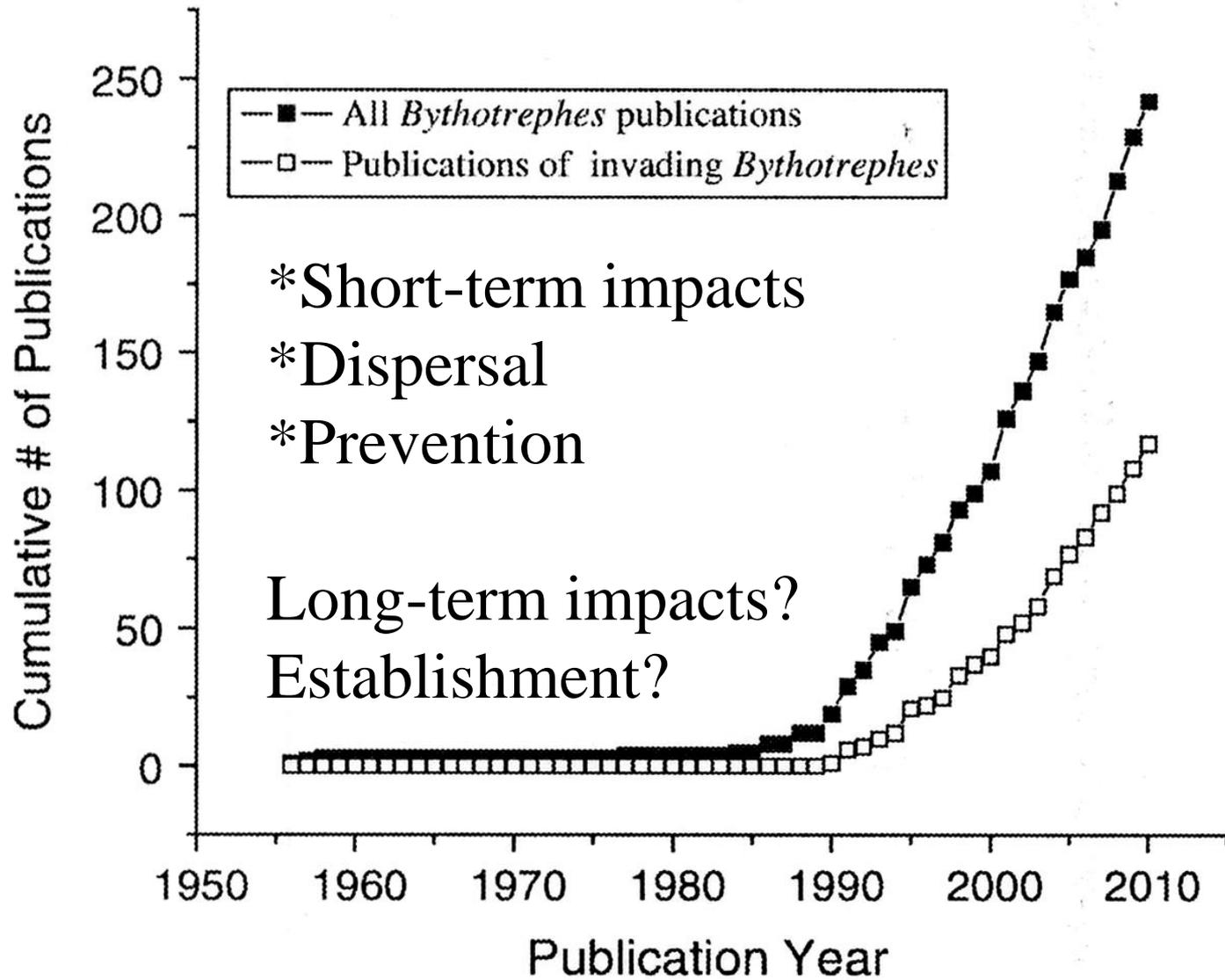


Herbivorous
Zooplankton



Phytoplankton

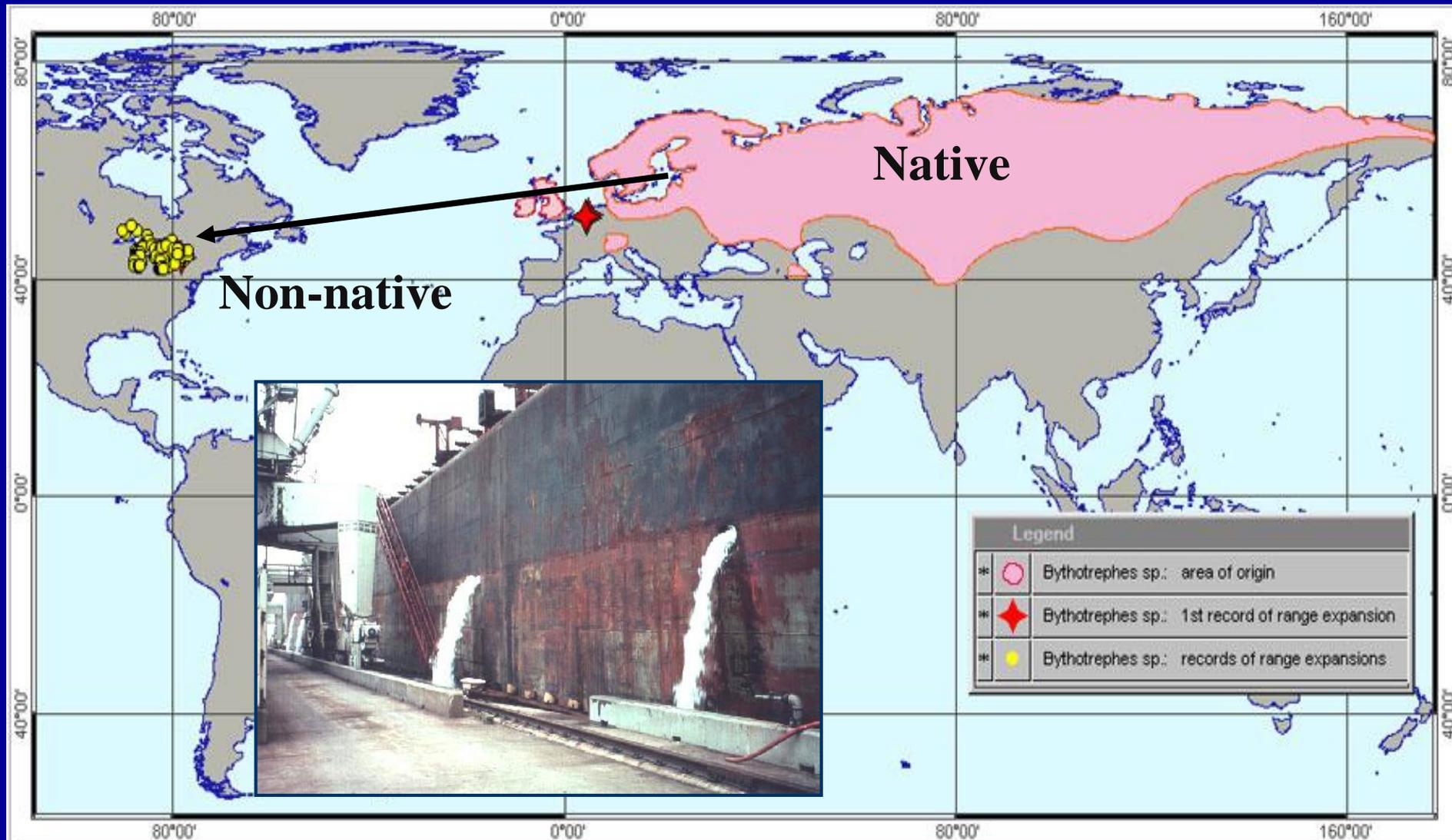




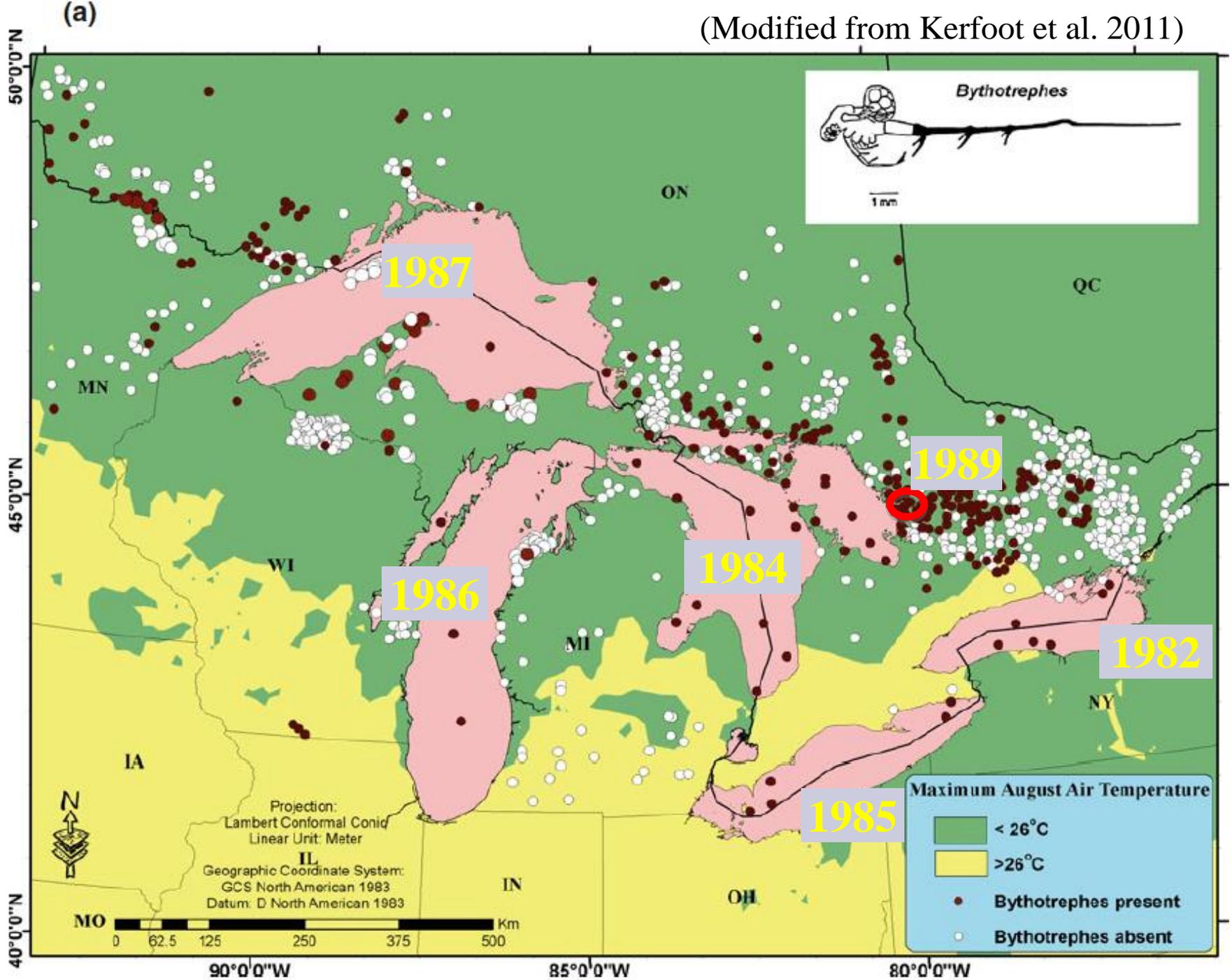
(Yan et al. 2011)

North American Introduction: 1980s, by ballast water exchange.

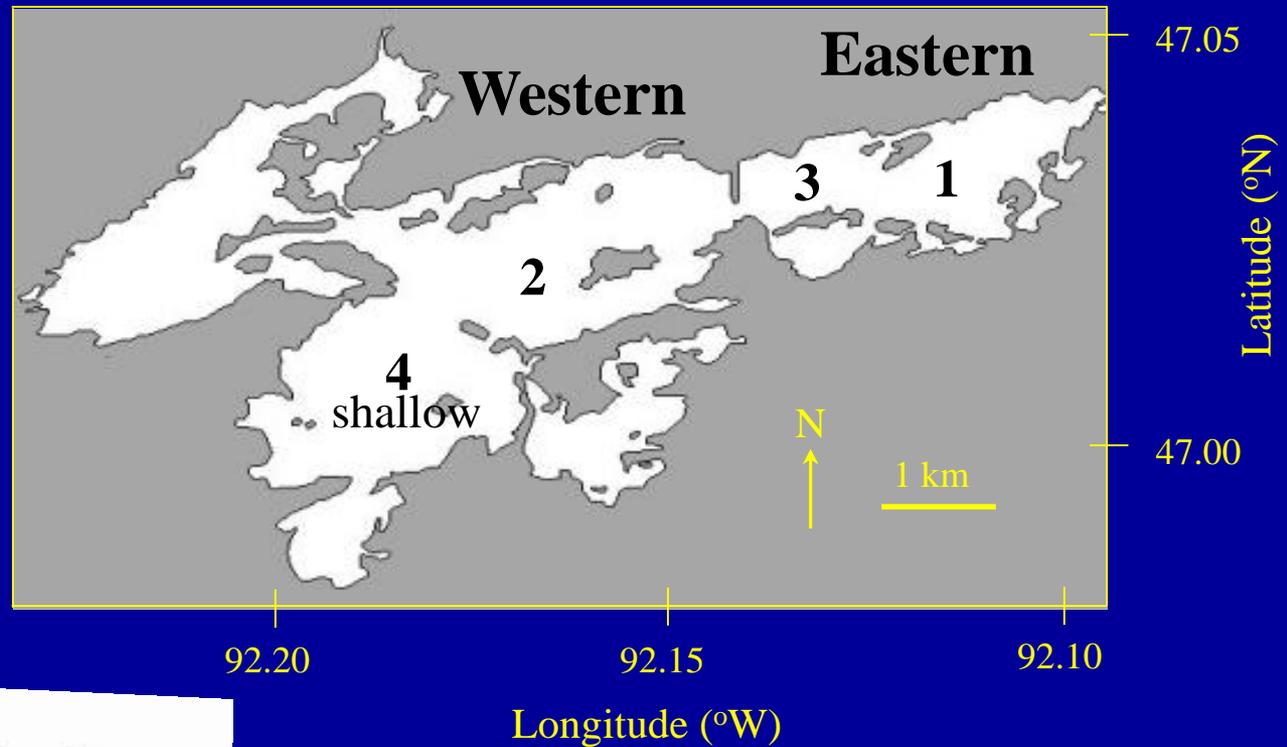
By 2010: ~ 200 inland lakes invaded.



(Modified from Kerfoot et al. 2011)

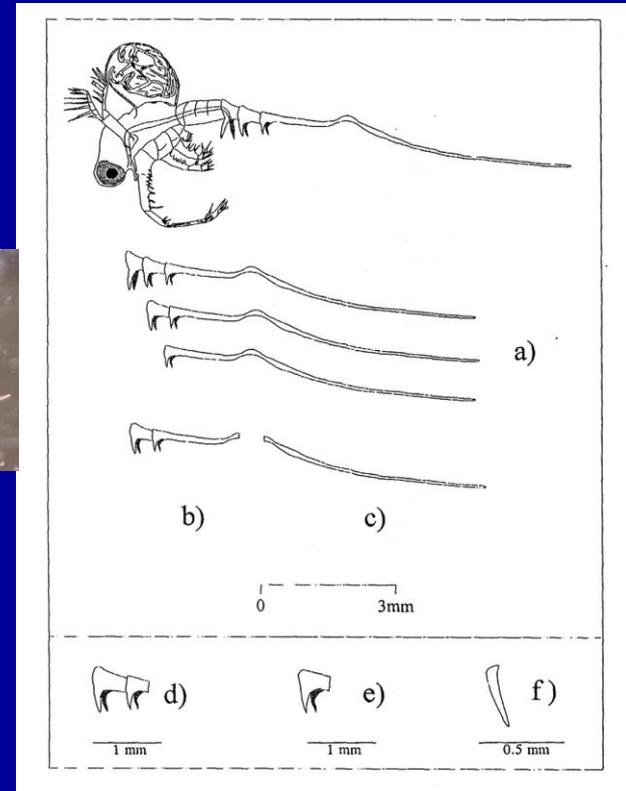


Island Lake Reservoir





- Core extruded in ½ cm increments.
- ^{210}Pb and ^{137}Cs (St. Croix Lab).
- 1 to 3 year resolution.
- *Bythotrephes* spines counted.
- *Daphnia ephippia* – identified, counted & measured.



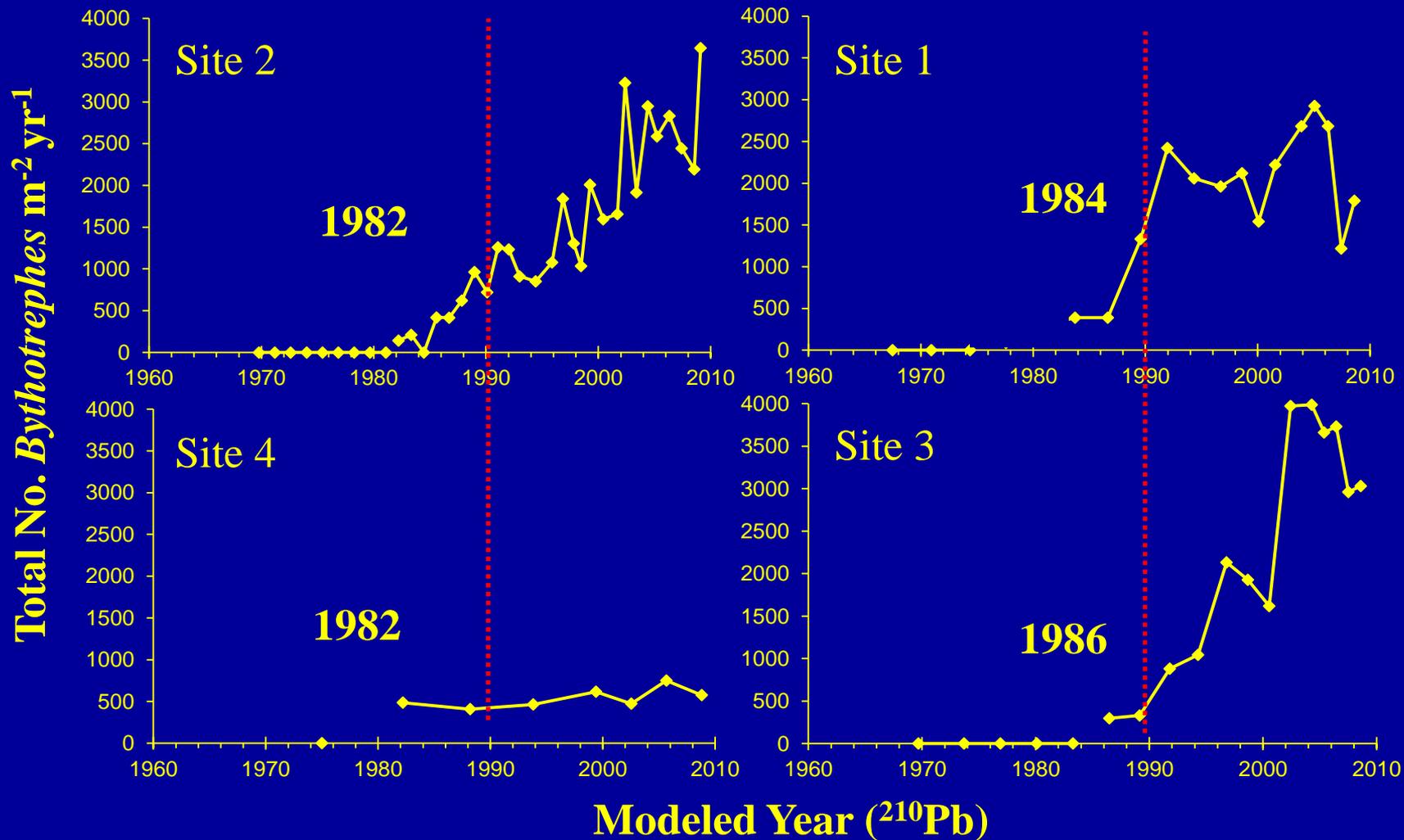
Sediment coring (March 2009)

(Bolivia-Livingstone corer)

Date of First Appearance

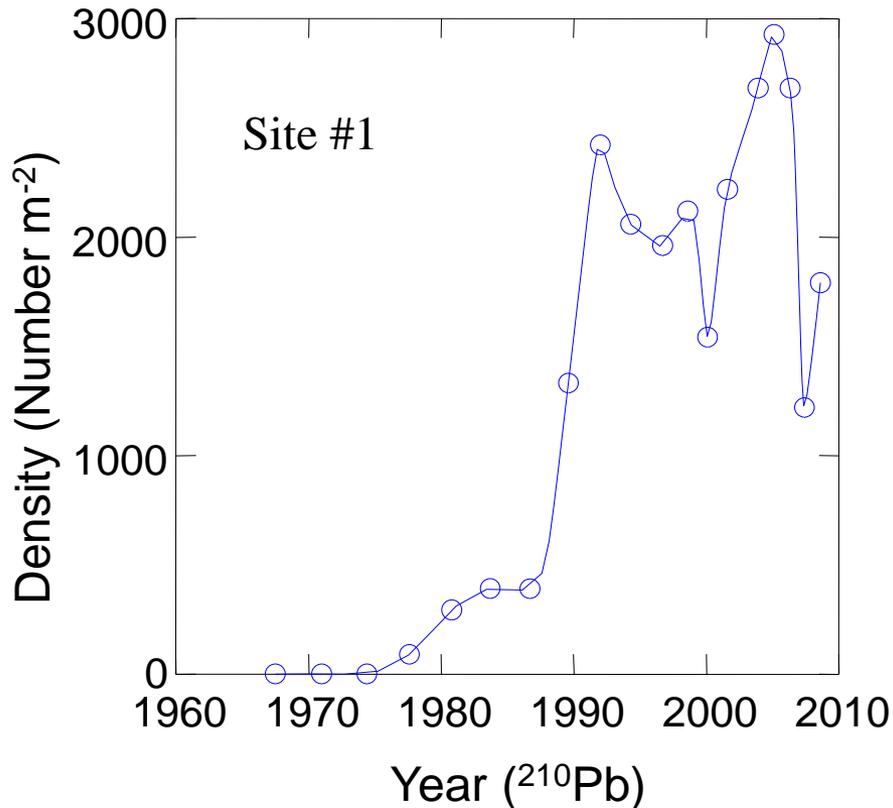
Western Basin

Eastern Basin

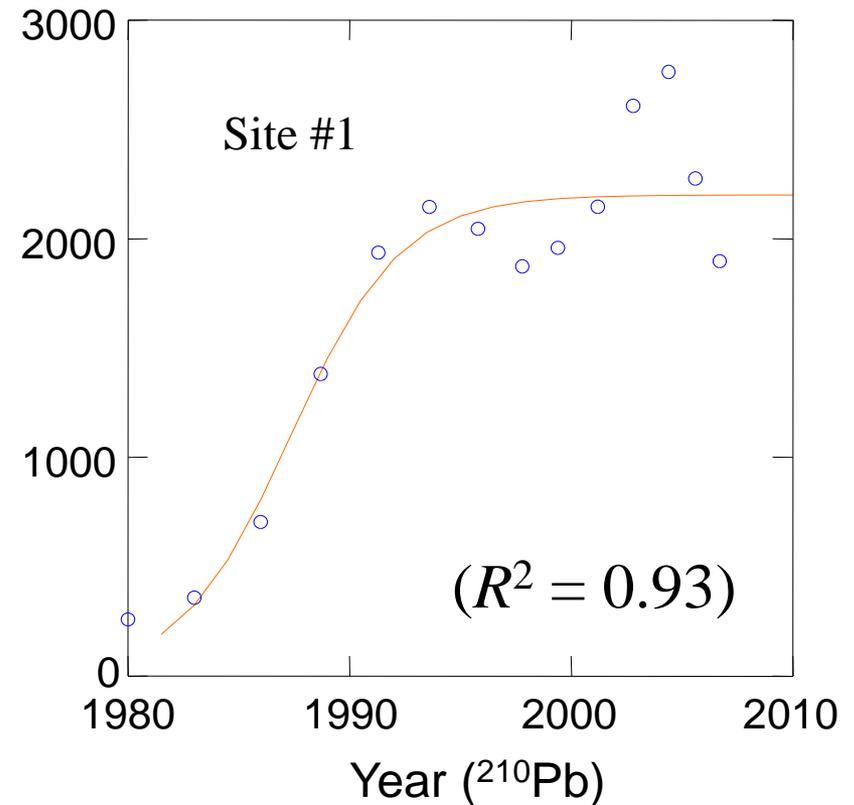


Growth during colonization was logistic.

Raw Numbers

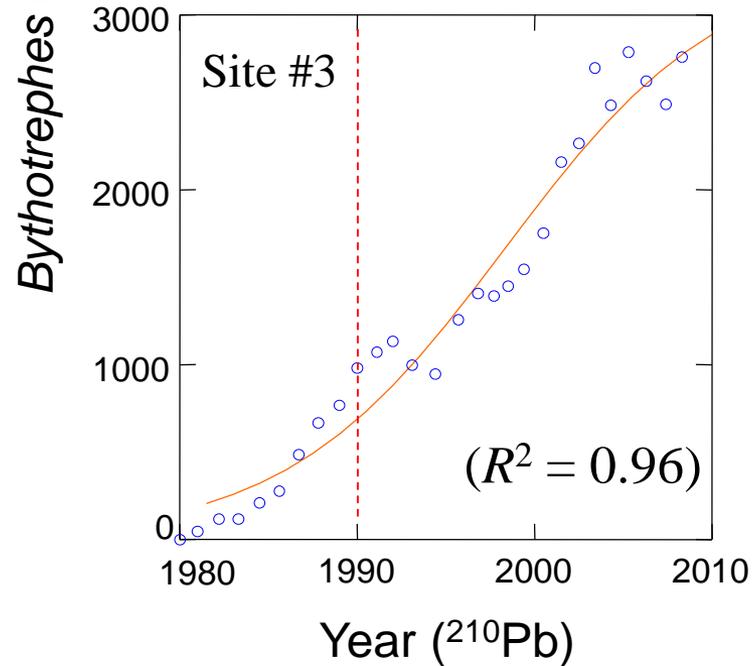
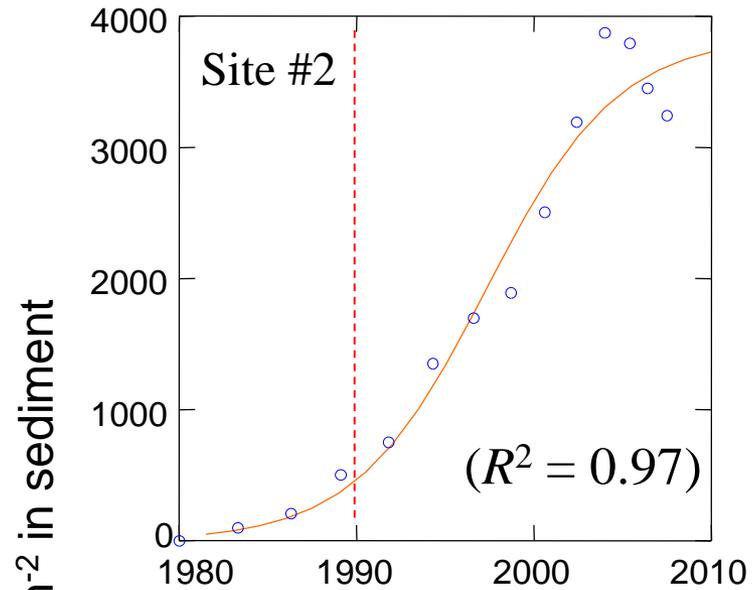
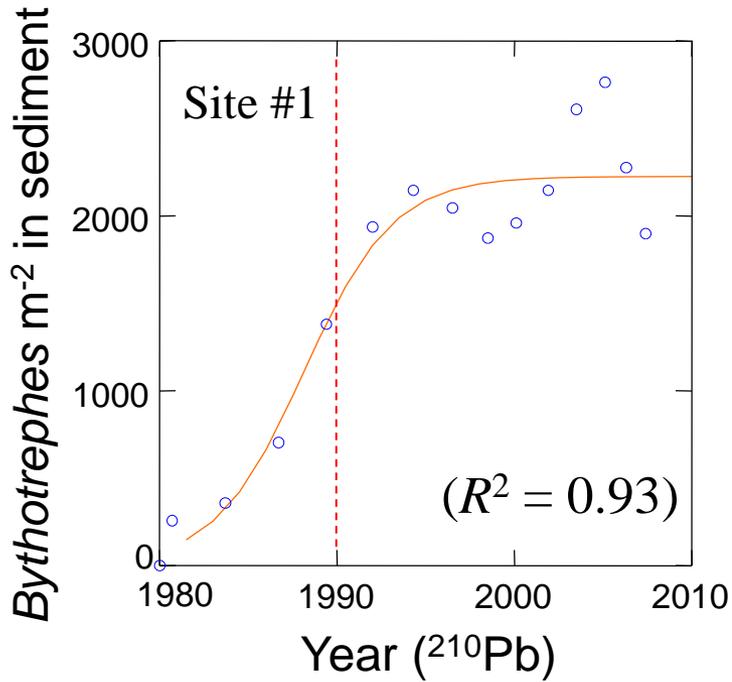


3-Year Running Average



$$dN/dt = rN (K - N/K)$$

$$Nt = K / (1 + be^{-rt})$$



Logistic growth was observed at all three deep sites.

10-20 years required to reach seasonal carrying capacity.

Why does a clonally reproducing species take so long (10-20 years) to reach a seasonal carrying capacity (seasonal inventory)?

- Did the establishment require repeated invasions?

Maybe

- Did *Bythotrephes* become better at living in the lake over time?

Maybe

- Is it linked to Allee effects associated with fall resting egg production?

Maybe

- Is it linked to high mortality (85%) of overwintering eggs? (Brown and Branstrator 2011)

Maybe



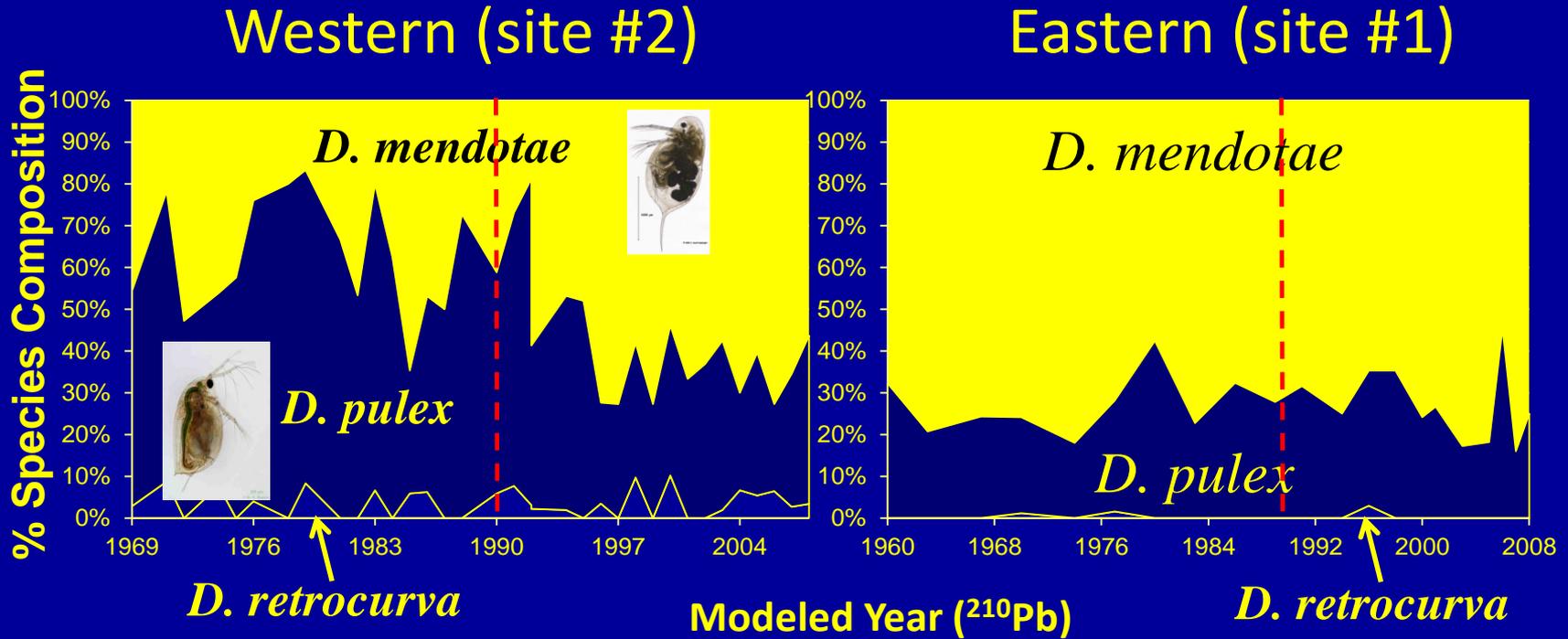
- Is Island Lake Reservoir a poor habitat for *Bythotrephes*?

No

Name	D_{\max} (No. m^{-3})	D_{mean}	D_{cycle} (yr^{-1})	Yrs	DVP	Deeply mixed	Chl <i>a</i>	Ref*
Reservoirs								
De Gijster†	475-1,800		2-5	4			18	1
Honderd en Dertig†	100, 325, 475		1-4	3			14	1
Petrusplaat†	100-325		3-4	4	near bottom	yes	6	1, 2
Gile	155	69		1	near bottom	yes	10.5	3
Island Lake	110, 110, 150	20, 47, 57	4-6	3	near bottom	yes	8.5	4, 5
Rybinsk	95	16	1	1				6
Natural Lakes								
Maggiore (1989-2003)	60-160	17-40		15	metalimnion	no	3.5	7, 8
(1981-1988)	up to 30	up to 7		8	metalimnion	no	5	7, 8
Constance	68, 125		1-4	2	metalimnion	no	4	9, 10
McFarland	74	54		1	near bottom	yes	1.9	3
Long	30	14		1		no	1.1	11
Michigan	8, 23	4, 11	2		metalimnion	no	1.5	12, 13
Huron	up to 22			13			1.5	14, 15
Harp	1-25	up to 6	1-2	5	metalimnion	no	2.2	16, 17
Pine	23	11		1	metalimnion	no	2.7	3
Michigamme	8, 13, 20	3, 6, 7	1-2	3	metalimnion	no	8.0	3, 18
Greenwood	14	7		1	metalimnion	no	2.9	3
Simcoe	6, 11	3, 4	1-2	2			4.3	19, 20

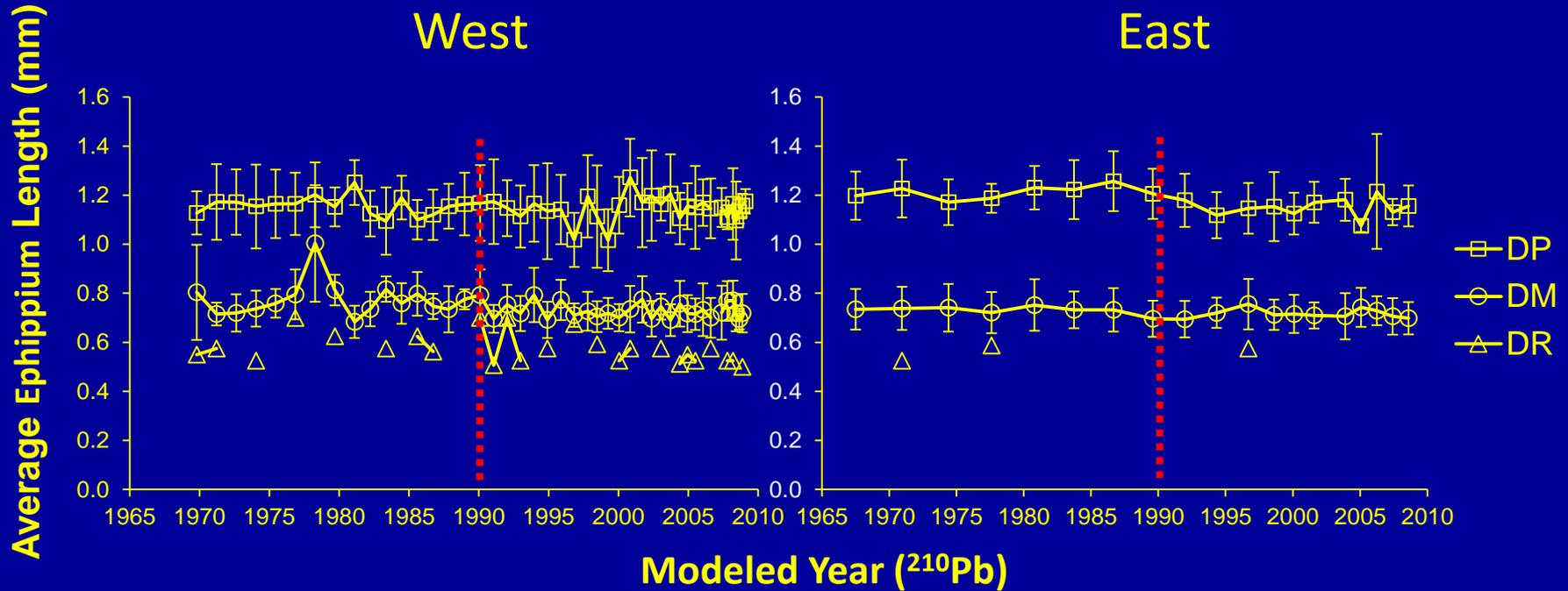
(Brown et al. 2012)

The *Daphnia* species assemblage changed in proportional composition in the West basin.



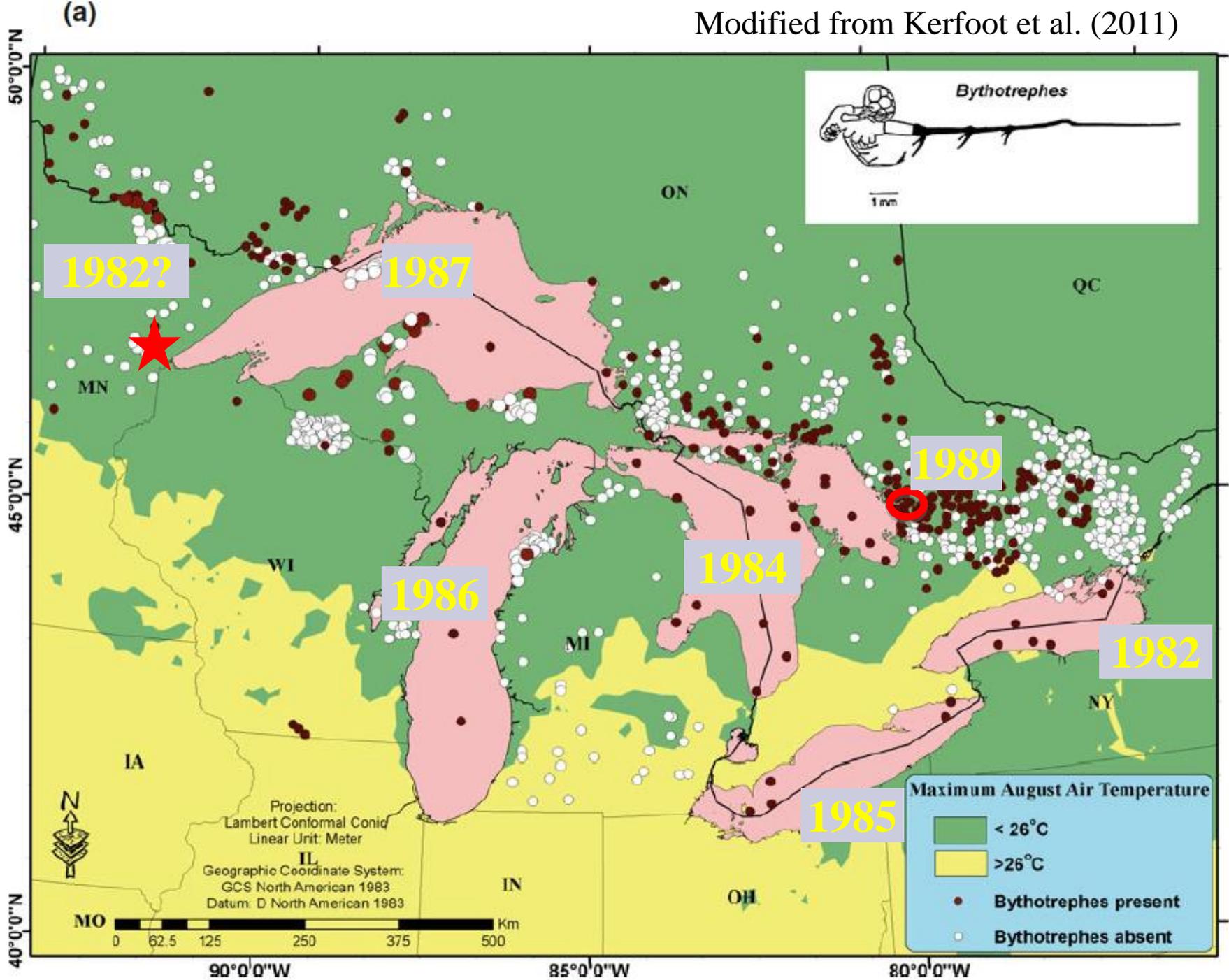
- West basin : significant increase in proportion of *D. mendotae* semi-coincident with invasion.
- East basin : no notable changes in proportional composition.
- *D. retrocurva* not numerically important.

The *Daphnia* mean ephippium lengths declined in both basins.



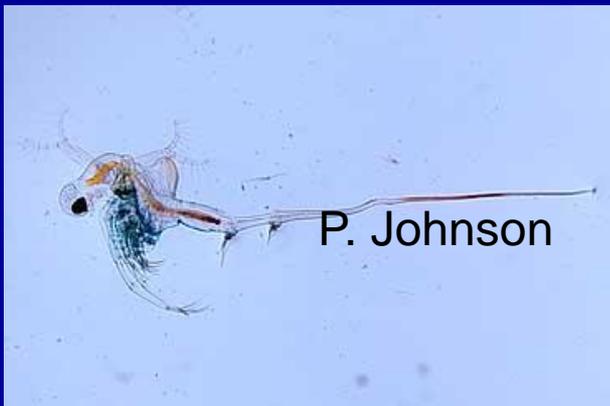
Significant decreases in average ephippium length.

- *D. mendotae*: West ($P < 0.01$) and East ($P = 0.05$).
- *D. pulex*: West ($P = 0.60$) and East ($P < 0.01$).
- Smaller maturation size, size-selective mortality, or both.



Management Implications:

- 1) Invasion date may not equate with date of first detection.
- 2) Evidence supports managing all water bodies as infested, whether there is evidence or not.
- 3) Historical timelines of invasion and source (hub) lakes may need to be reconsidered for the Great Lakes.



Exotic Species Advisory

THESE WATERS ARE INFESTED WITH THE FOLLOWING HARMFUL EXOTIC SPECIES:

 <p>Eurasian watermilfoil (10-20 pairs of leaflets) Minimum plants: 1 leaflet</p>	 <p>Zebra Mussels Adult life span: 10 to 1 year</p>
 <p>Ruffe Adult life span: 2 to 3 years</p>	 <p>Spiny Water Flea Adult life span: 24 days</p>

Prevent the spread of harmful plants and animals:

- ✓ **Remove** aquatic plants and animals from all parts of your boat, trailer and accessory equipment before leaving the water access area.
- ✓ **Drain** your bilges, live wells and other water containers before leaving the water access area.
- ✓ **Never** dump water from infested waters into another body of water or release live minnows into any waters.
- ✓ **Wash** your boat, tackle, downriggers, lines and trailer when you get home. Flush water through your motor's cooling system, livewells and other areas that hold water.

Under Minnesota Laws it is unlawful to:

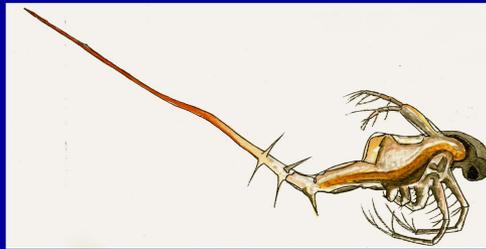
- Transport Eurasian watermilfoil (or its look-a-like northern watermilfoil), ruffe, spiny waterflea or zebra mussels on a road or highway.
- Transport water from lakes or rivers infested with zebra mussel or spiny waterflea.
- Launch a watercraft with Eurasian watermilfoil, zebra mussel or other harmful exotic species.

Remember Clean boats - clean waters.

Minnesota Department of Natural Resources

Acknowledgements:

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