

Effectiveness of Salinity in Protecting the Great Lakes

A Synopsis of Recent Research

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and the Mississippi River Basin Panel**

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Closing the Ballast Management Gap in the Great Lakes

- **1993, U.S. mandatory ballast water exchange for ballasted vessels entering Great Lakes**
- **Ships with unpumpable ballast residuals (“NOBOBs”) not regulated**
- **NOBOB Assessment (2001-2005) documented low salinity residuals and thousands of live organisms in NOBOB ballast tanks**

Closing the Ballast Management Gap in the Great Lakes

- **2005, USCG voluntary guidelines, routine use of saltwater flush in NOBOBs**
- **2006, Canadian regulations require salinity and sediment management, all water in ballast tanks entering Canada EEZ >30 ppt**
- **2008, Seaway management corporations harmonize regulations with Canada – all water in ballast tanks entering the Great Lakes from outside EEZ must be >30 ppt.**

Science Supporting the New Regulations

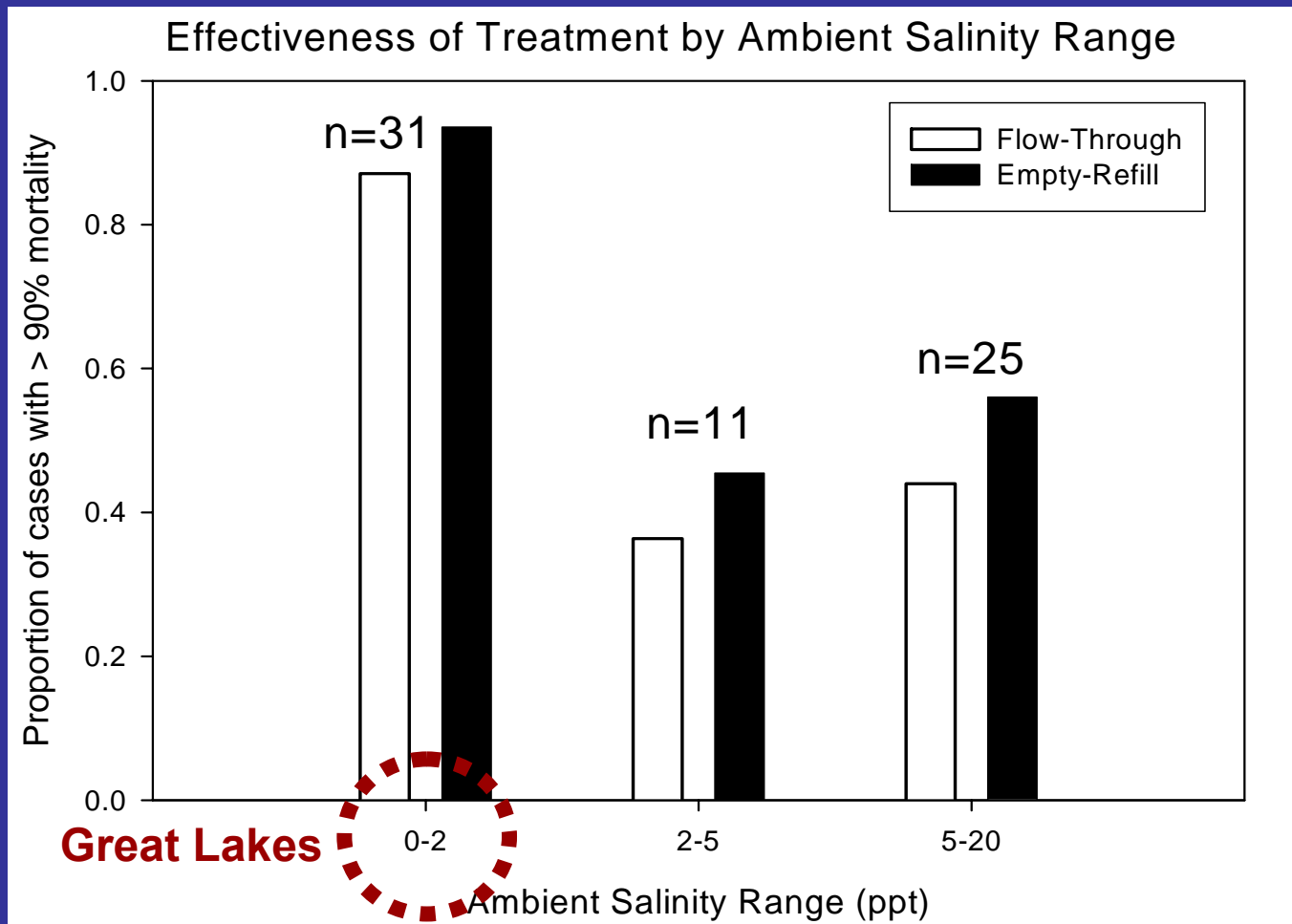
Salinity Shock Hypotheses

- **Organisms adapted to low-salinity and freshwater ecosystems less likely to survive saltwater exposure**
- **Organisms adapted to higher salinity environments less likely to survive in freshwater ecosystem**

Field-Lab Salinity Tolerance Experiments by SERC & GLERL

(Santagata et al. 2008. Aquatic Invasions, Vol 3(1): 61-76)

Salinity Tolerance Experiments



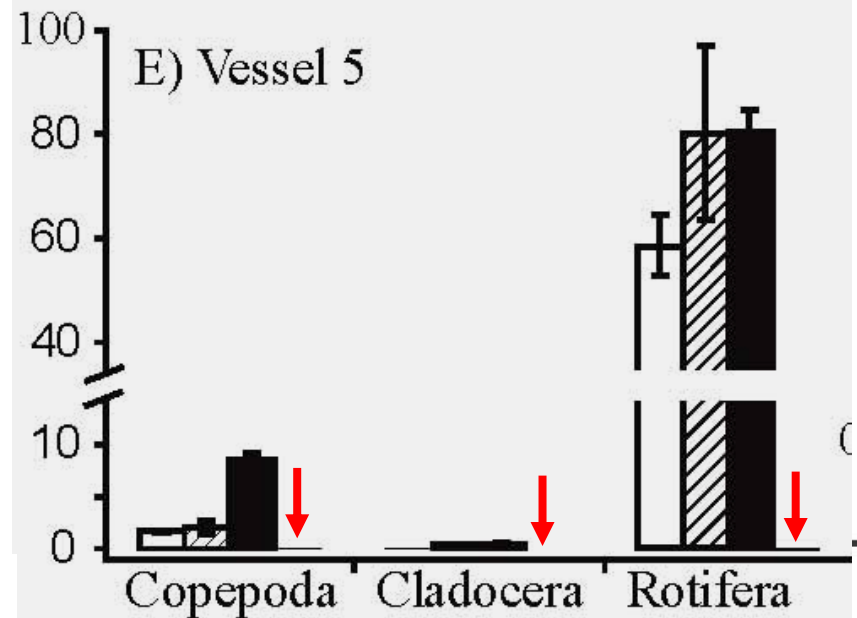
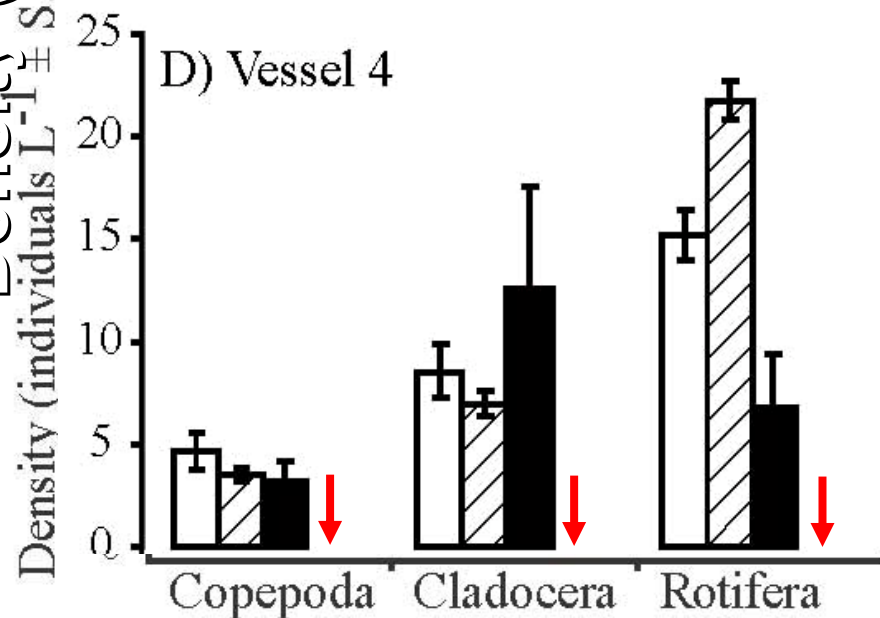
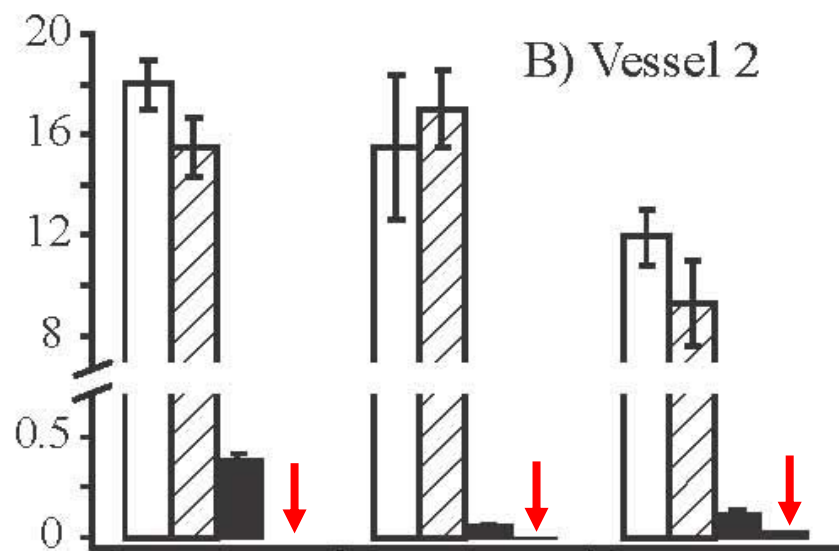
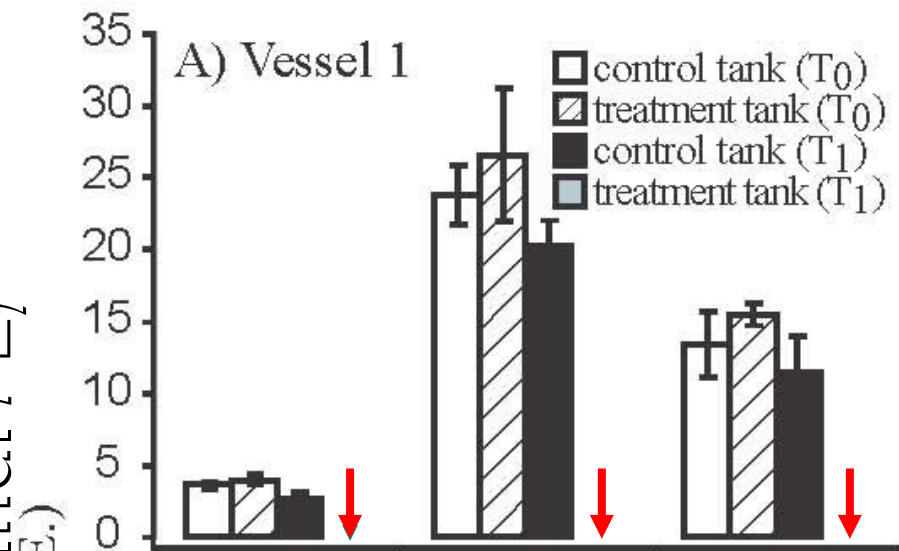
Salinity is highly effective against organisms from oligohaline habitats

In-Tank BWE Experiments by University of Windsor

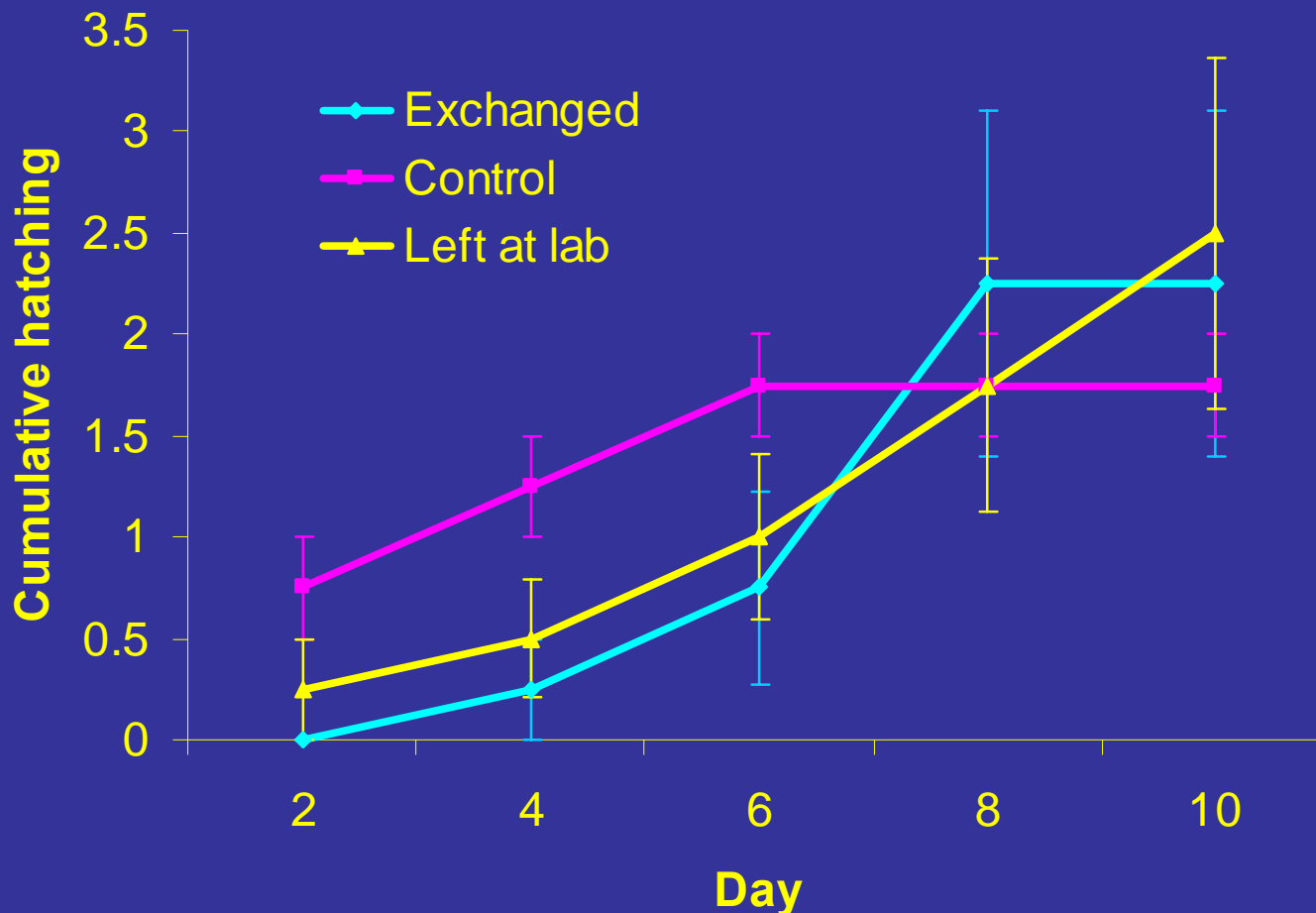
Gray et al, Limnol. Oceanogr., 52(6), 2007

Changes in abundances of zooplankton

Density (Ind. / L)



Salinity does not kill diapausing eggs



- 4 experiments, no significant differences between control and exchanged sediments

Benthic organism experiments

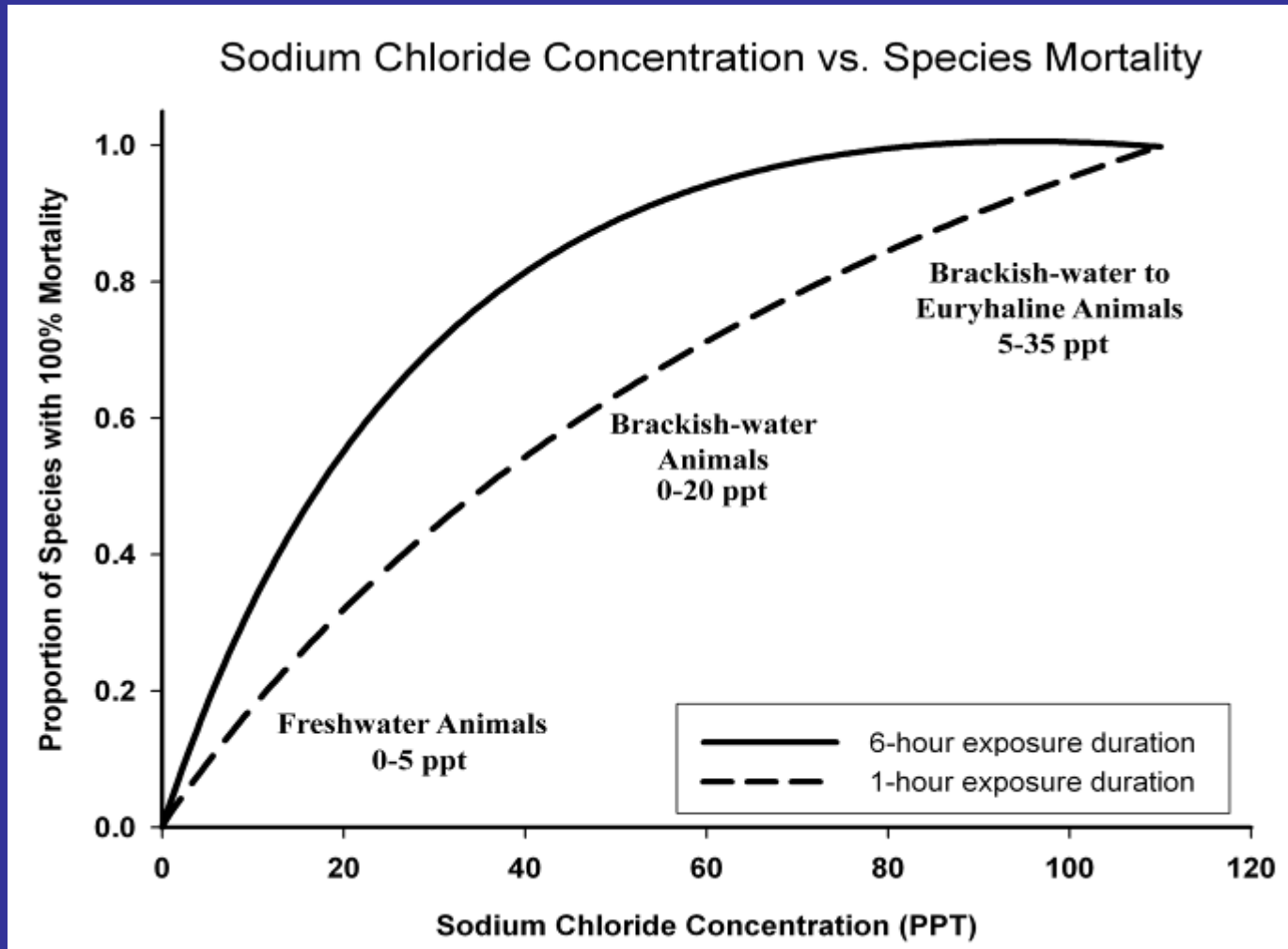
Organism	Mortality (%)	
	Control Tank	Treatment Tank
<i>E. ischnus</i>	51.1	100
<i>B. sowerbyi</i>	12.2	98.9

On-Board (in tank samples) Measurements by Canada DFO

(courtesy of Sarah Bailey & Chris Wiley)

- **Canada DFO/TC sampling NOBOBs since 2006**
- **No live freshwater taxa found**

Use of NaCl Brine as a Biocide (Lab/Field Experiments by SERC & GLERL)



Santagata et al, in review, 2008)

Alternate Treatment for NOBOB Residuals

Recent tests of very high-salinity brines indicate high effectiveness with short duration (≤ 3 h) exposures

Orange = saltwater tolerant	Time (h) for 100% Mortality			
	Salt/Brine Concentration			
	34	30	45	60
<i>Cercopagis pengoi</i>	2	1	1	1
<i>Rhithropanopeus harrisii</i> zoeae	>48	2	1	1
<i>Echinogammarus ischnus</i>	>48	24	3	2
<i>G. tigrinus</i> (Baltic)	>48	24	24	2
<i>G. tigrinus</i> (Ches. Bay)	>48	48	24	3

Santagata et al, in review, 2008)

Summary & Recommendations

- Saltwater can be an effective tool for reducing the risk to the Great Lakes, IF properly carried out (concentration, exposure time), and consistently applied.
- Saltwater exchange or flushing should be completed early in voyage to maximize exposure
- High concentration NaCl brine is a very effective biocide
- Should consider BWE prior to discharge treatment even when on-board treatment systems are implemented

The End!!



Questions??