

# Summary of Biological Efficacy Testing and Certification of Ballast Water Management Systems

Great Ships Initiative

**Great Lakes and St. Lawrence Ballast Water Workshop  
November 16-17, 2016**



# Outline of Presentation

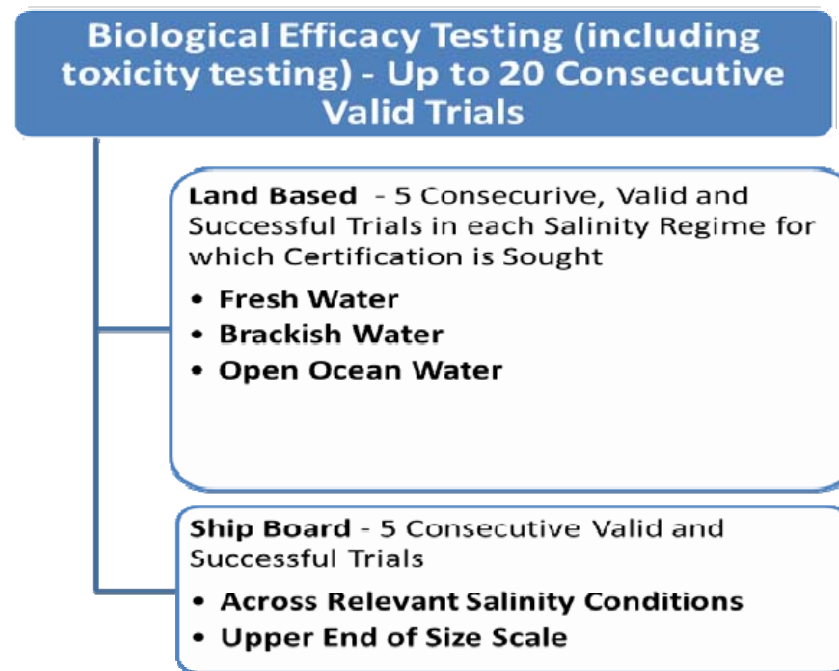
- The ballast water management system (BWMS) regulatory testing framework and freshwater.
- The Status of Freshwater International Maritime Organization (IMO)/U.S. Coast Guard (USCG) Certification Testing.
- Types of BWMS processes and specific BMWS brands have received IMO type approval for use in Freshwater per the IMO/USCG definition.
- Discussion and Conclusions.

# **The BWMS Regulatory Paradigm, Certification Testing Framework and Freshwater**

- Overall testing framework coevolved between IMO, within U.S. USCG and USEPA's ETV Program.
- GSI personnel involved in discussions between 2002-2012

# IMO/USCG Certification Testing Framework

- Environmental Testing (shake-rattle and roll tests) - determine whether the BWMS is ship-worthy mechanically.
- Biological Efficacy Testing – can BWMS meet the regulatory discharge standard?



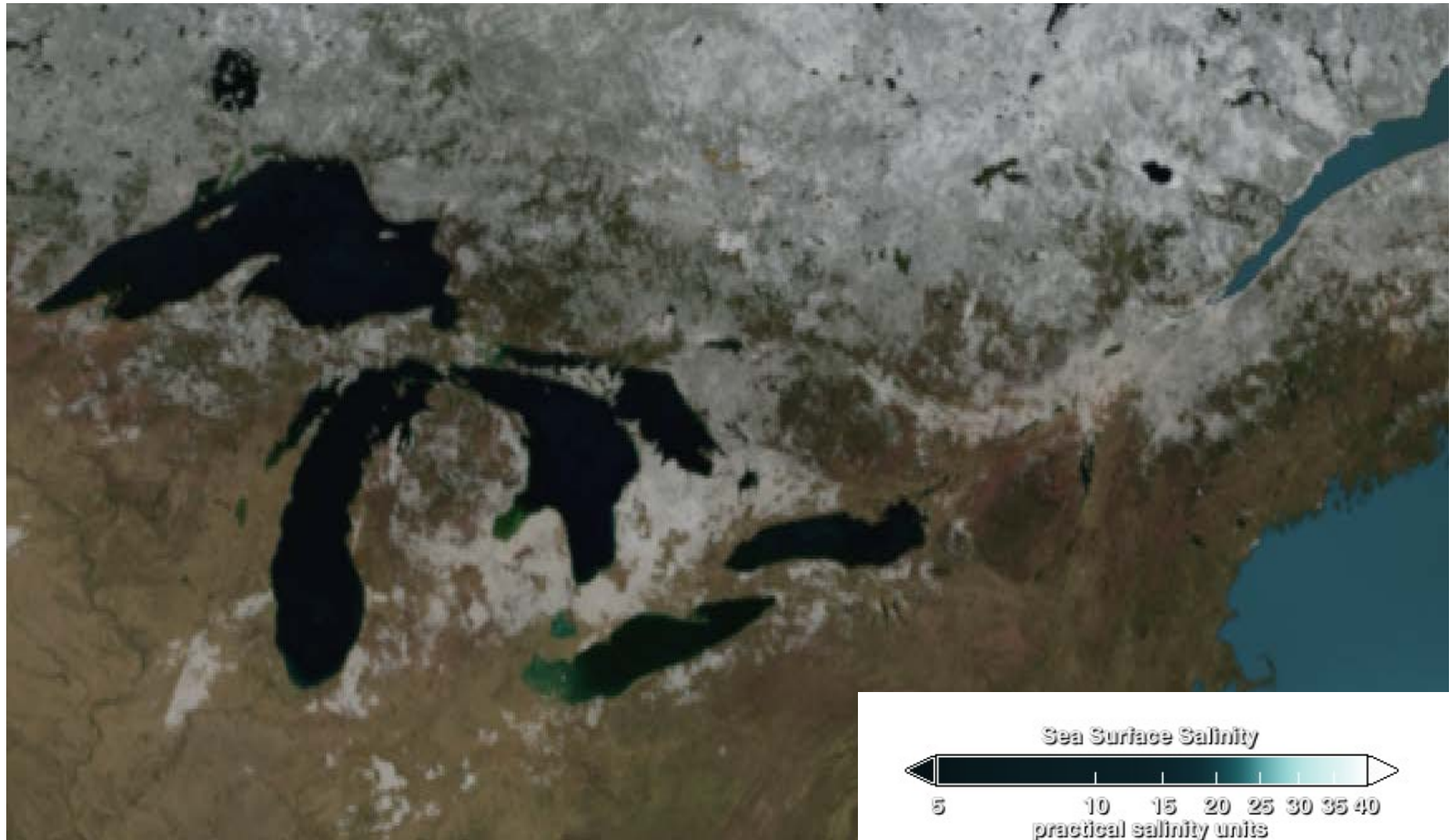
# Meeting Minimum Challenges, Not a “Stress Test”

Parameter	Subcategory	IMO G8	ETV Generic Protocol
Organisms to be Evaluated	Organisms $\geq 50 \mu\text{m}$	Naturally occurring, or cultured species that may be added to the test water.	Ambient assemblage supplemented by the addition of organisms.
	Organisms $\geq 10 \mu\text{m}$ and $< 50 \mu\text{m}$	Naturally occurring, or cultured species that may be added to the test water.	Ambient assemblage supplemented by the addition of organisms.
	Organisms $< 10 \mu\text{m}$	Naturally occurring, or cultured species that may be added to the test water.	Ambient assemblage supplemented by the addition of organisms.
Uptake Organism Diversity & Density	Organisms $\geq 50 \mu\text{m}$	Total density of preferably $10^6$ individuals but not less than $10^5$ individuals per $\text{m}^3$ ; at least 5 species from at least 3 different phyla/divisions.	Minimum of $10^5$ organisms/ $\text{m}^3$ with at least 5 species present across 3 phyla.
	Organisms $\geq 10 \mu\text{m}$ and $< 50 \mu\text{m}$	Total density of preferably $10^4$ individuals but not less than $10^3$ individuals per mL; at least 5 species from at least 3 different phyla/divisions.	Minimum of $10^3$ organisms/mL with at least 5 species present across 3 phyla.
	Organisms $< 10 \mu\text{m}$	Heterotrophic bacteria should be present in a density of at least $10^4$ living bacteria per mL.	Minimum concentration of $10^3$ /mL as culturable aerobic heterotrophic bacteria.
Water Quality of Uptake/Source Water	N/A	Salinity: < 3 PSU (for freshwater); Dissolved Organic Carbon (DOC): > 5 mg/L; Particulate Organic Carbon (POC): > 5 mg/L; Total Suspended Solids (TSS): > 50 mg/L.	Salinity: <1 PSU (for freshwater); Dissolved Organic Matter (DOM): min. 6 mg/L as DOC; Particulate Organic Matter (POM): min. 4 mg/L as POC; Mineral Matter (MM): min. 20 mg/L; Total Suspended Solids (TSS): = POM + MM: min. 24 mg/L; Temperature: 4 – 35 °C.

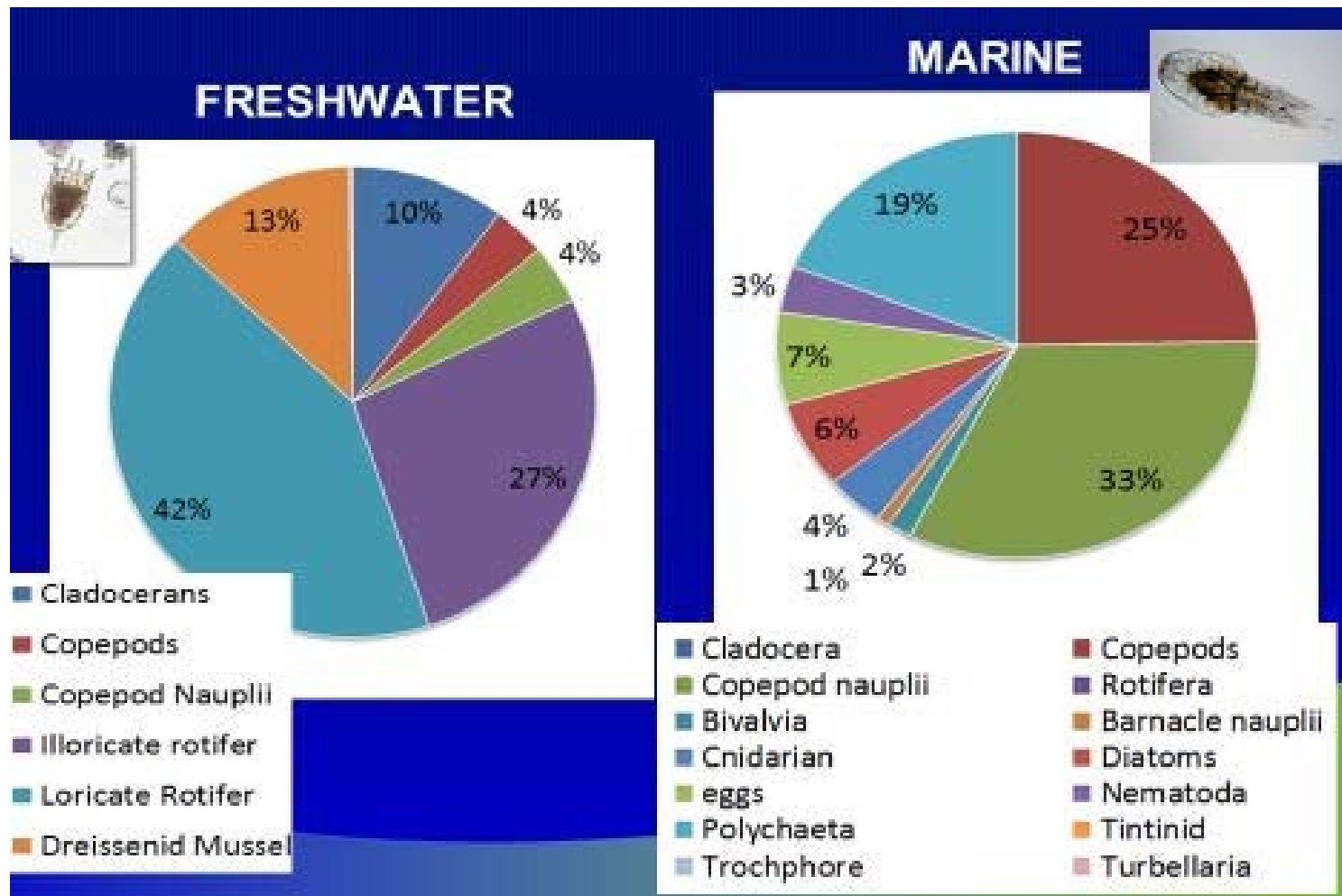
IMO and USCG define freshwater solely on the basis of the salt content.

Aquatic Ecosystem Type	IMO G8 Guidelines	USCG (ETV Land-Based Protocol, v. 5.1)
Fresh	< 3 PSU	< 1 PSU
Brackish	3-32 PSU	10-20 PSU
Salt	> 32 PSU	28-36 PSU

# Great Lakes Salinity Gradient

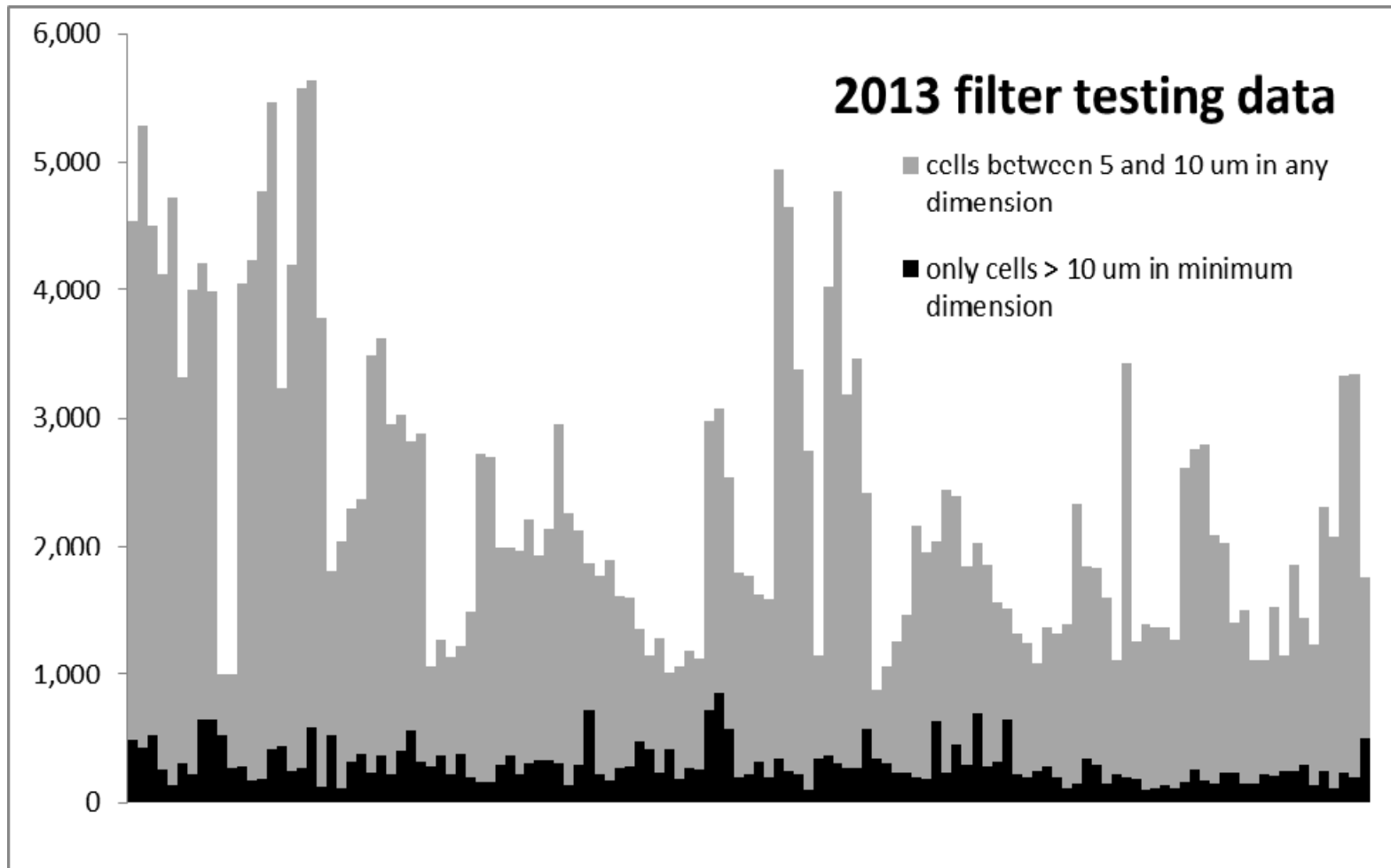


# Composition of Freshwater and Marine Zooplankton Communities (>50 $\mu\text{m}$ min. dim.) in Intake Waters during Testing of BWMSs.





# Stacked Histogram of Protist Cell Densities per mL at GSI.



# ***Does Freshwater Regulatory Testing Have Relevance to the Great Lakes?***

- Quality assurance quality control
- Physical chemical challenge
- Organismal challenge

# Status of BWMS Freshwater Evaluations and Approvals

- More than 60 BWMSs have received national administration approval
  - Some systems from multiple nations
  - Only 14 have accessible information on approval contingencies (e.g. limited to brackish or marine, holding time)
- Of the 14 only 11 have been approved for use in all water types.
- Limited info available on salinity ranges BWMSs subjected to during testing.

# Conclusion

- Designers of current testing framework face difficult task:
  - The challenges of aquatic systems vary spatially and temporally.
  - If all worse case scenarios are combined in a test may results in an over engineered system.
  - Conversely, simply meeting minimum test conditions may not be reflect of real-world conditions.
- Most BWMSs seeking approval claim to perform across all salinities – may or may not have been tested well in natural pure freshwater systems with natural assemblages