

# Results of GSI Bench-Scale (Small-Scale) Tests

**DISCLAIMER:** GSI's bench-scale tests do not by themselves provide adequate information to assess a prospective ballast treatment's ability to meet a particular discharge standard or to achieve environmental soundness under shipboard application. Instead these tests provide initial insights into possible strengths and weaknesses of the treatment concentrations tested under the conditions tested.

For more information on GSI's bench scale testing, please visit:  
[www.greatshipsinitiative.org](http://www.greatshipsinitiative.org).

## GSI BENCH TESTS ON SODIUM CHLORIDE (NaCl)

For the full write-up of GSI tests on sodium chloride (NaCl), i.e., brine, including experimental methods and results, please visit <http://www.nemw.org/GSI/GSI-BS-P-TR-7.pdf>. Please note that the results summary below is intended to provide an overview of treatment characteristics from the bench scale experiments. Results are drawn through interpolation of the quantitative measurements and survivorship observations.

### THE TREATMENT PROCESS

#### What is the proposed treatment process?

Exposing aquatic organisms in ballast to high levels of brine created by adding sodium chloride (NaCl) directly to ballast water in ballast tanks.

#### What is the proposed application?

Emergency application to treat unpumpable residual ballast water and sediments in ships in the "NOBOB" (i.e. no ballast on board) condition which did not undertake mid-ocean flushing.

#### What is the proposed application dose, if any?

Doses up to 75 ppt.

## GSI DOSE EFFECTIVENESS FINDINGS FOR NaCl

Dose effectiveness testing involves evaluation of treatment effectiveness on robust species across freshwater taxonomic categories. Species tested appear in the list below.

**Observation times and lowest dose (0.4, 1.4, 4.5, 15, 50, or 75 ppt) at which there was less than 1 % survival of each test species under the most rigorous environmental conditions tested.**

Major Taxonomic Group	Species	Less Than 1 % Survival		
		2 Hours	24 Hours	48 Hours
Algae	<i>Selenastrum sp.</i>	Never Achieved	Never Achieved	Never Achieved
Zooplankton	<i>Daphnia magna</i>	(15 ppt)	(15 ppt)	(15 ppt)
Zooplankton	<i>Eucyclops sp.</i>	(15 ppt)	(15 ppt)	(15 ppt)
Zooplankton	<i>Branchionus calyciflorus</i>	(15 ppt)	(4.5 ppt)	(4.5 ppt)
Zooplankton	<i>B. calyciflorus</i> cysts <sup>1</sup>	— <sup>2</sup>	— <sup>2</sup>	(15 ppt)
Insect <sup>3</sup>	<i>Chironomus dilutus</i>	— <sup>4</sup>	— <sup>4</sup>	(15 ppt)
Annelid <sup>3</sup>	<i>Lumbriculus variegatus</i>	— <sup>4</sup>	— <sup>4</sup>	(15 ppt)

<sup>1</sup> Measured in terms of percent of cysts hatched.

<sup>2</sup> No observations made because cysts cannot be expected to hatch before 24-48 hours.

<sup>3</sup> Tests conducted in the presence of sediment.

<sup>4</sup> No interim observations made because assessments are destructive of sample.

**Which freshwater species tested was most vulnerable to the treatment, and which was most resistant to the treatment proposed by the applicant?**

Zooplankton and insect larvae were most susceptible to brine. The relatively low dose of 15 ppt significantly reduced numbers of live organisms across all zooplankton groups tested—there was 0 percent survival at this dose after two hours for the cladoceran *Daphnia magna*, the copepod *Eucyclops sp.*, and the adult rotifer *Branchionus calyciflorus*. 15 ppt salinity also resulted in 0 percent hatch of rotifer cysts after 48 hours.

In the presence of sediment, brine treatment 15 ppt salinity range also was significantly effective at reducing live numbers of the insect *Chironomus dilutus* and oligochaete *Lumbriculus variegates*.

The green algal species tested was the least susceptible. There was 99 percent survival at 48 hours exposure for the green alga *Selenastrum sp.* at 75 ppt salinity, the highest dose tested.

**Other observations related to dose effectiveness tests of this treatment.**

These findings track with those of Bradie *et al.* (2008). Follow-up experiments on microbial hitch-hikers would be useful.

(Bradie, J., Bailey, S., MacIsaac, H., and Wiley, C. Efficacy of NaCl brine treatment for limiting spread of non-indigenous species via ballast water. 2nd Annual CAISN General Meeting & Conference, Banff, Canada, April 20-22, 2008. Poster Presentation.)

**MORE INFORMATION**

Entire report available at: <http://www.nemw.org/GSI/GSI-BS-P-TR-7.pdf>.

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