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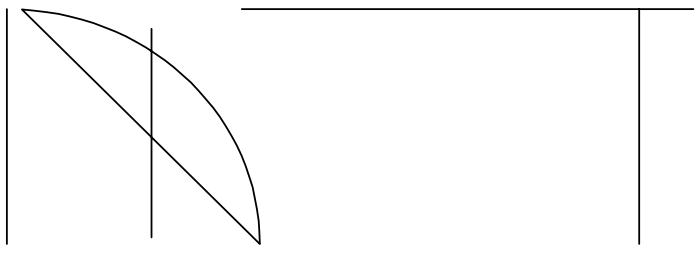
Dear US Coast Guard:

Thank you for the opportunity to participate further in the process of determining the goals and setting the standards for addressing ballast water as a vector for invasive species into this country (and our obligation to keep the same standards when addressing outgoing ballast water). I was a participant in the GLOBALLAST IMO workshop in March 2001 and a supporter of Standard 2 (in the Federal Register) during that workshop. Although the basic premise set up by that standard is still valid, my thinking about it has evolved It is evident also that the Coast Guard workshops, since that IMO meeting, have provided additional avenues for thought relative to standards.

It is clear that there is and should be only one goal in this process; that is, to eliminate ballast water as a mechanism for introducing invasive species. That said, the costs of this process do need to be weighed against the long term benefits.

General Comment:

The assumption throughout the discussion of these standards is that a percentage reduction in abundance is directly and linearly related to reduction in successful invasion probability. This assumption is not necessarily valid and its assumption introduces a potential disconnect between the suggested standards and their potential impact on our goals. Reducing an organism's abundance by 95% does not necessarily reduce the likelihood of successful invasion by 95% A successful invasion may have almost as likely a chance of occuring with either population introduction (100% or 5%) if 5% is a sufficiently high density.



$$\frac{0.05X}{\text{Population Size}} \quad X$$

For this reason, I strongly encourage the Coast Guard to follow the approach used for federal water quality standards and use an absolute concentration standard. This will also make enforcement evaluation simpler. Agents will not have to measure untreated waters in foreign ports to determine compliance, as they would with percentage standards.

The Goals (G1-G3)

It is evident from evaluating the comments to date that some are taking the goal as law and therefore are trying to interpret it verbatim, rather than addressing its intent. Therefore, let me try an alternative goal:

Goal 4 - Ballast water needs to be affected in such a way as to minimize the potential for introduction of invasive species.

This goal is clear and not subject to misinterpretation. In the statement of the goal, there is no need to address what can be done today (Best Available Technology) or the long-term benefits and costs. These can be addressed by the particular standard adopted.

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Standards

The most important question is, what minimum standard should be required as soon as possible by the Coast Guard, given 1) the need to produce an effective reduction in successful invasion probability, 2) available technology to attain this goal, and 3) the long-term costs and benefits to society of imposing these standards.

I propose that we use the strategy of engineers when building structures. That is, build to the standard conditions expected and then add a factor for system fatigue and extreme conditions. This was the intent of S1 as endorsed by most of the working groups at the GLOBALLAST workshop. However, more time was needed at that workshop to consider implementation of S1, and evaluation of comments indicates that this is the major problem identified. Below I suggest an alternative standard.

Evaluation of Approach

Bacteria Standards:

For bacteria (and viruses, not addressed here, but assumed to be satisfactorily affected to attain the bacterial standards), the current federal standard appears workable (i.e., indicated in S3 and S4). At first disregarding the utility of this standard to achieve a sufficient reduction in invading propagules, I am completely in favor of a density standard. It eliminates most of the problems associated with verifying percentage reductions in ballast water at the receiving port, thus making it a standard that can be easily (relatively) assessed by the monitoring agency (Coast Guard). Will a reduction in bacterial concentrations to this level via treatment or **no** treatment (if concentrations are less than the standard) eliminate invasion by bacteria and viruses? The answer is no, but this is a not a bad interim standard. However, there are suites of organisms (protists, fungi, and other infection causing organisms) that could be at high concentration in water with relatively low concentrations of the standard test bacteria. Therefore, I propose a revision to the bacterial standard proposed in S3 and S4.

Revised Bacteria Standard:

E. coli or enteric cocci must be reduced by 95% and must be below the federal limit before ballast water can be discharged.

By imposing this revised standard, ballast water treatment systems will be required to affect bacteria (and viruses) even in waters that do not contain specific pathogenic bacteria for humans., but which contain other biologically important organisms of this type. This revised standard invokes the use of percentages. which is difficult (impossible) to verify in the field, but in BWT systems, tests can be shown to generate these results and the ship logs should show that the treatment system has been used. Thus, I propose that the percentage standard be used in testing, while the absolute standard (federal limit for conatct water) be used in enforcement. This revised standard requires active treatment and thus helps to fill the loophole of potential invasion by organisms whose abundance is not correlated directly with the federal standard.

Standard 1 (GLOBALLAST PROPOSAL A): This is the standard supported by at least 4 of 5 working groups at the GLOBALLAST workshop primarily because it was functional(i.e., it would have an impact on likelihood of invasion success), appeared practically possible, and it matched some of the best estimates for BWE. In addition, if the treatment system worked to this standard over the entire range of environmental conditions than it likely would be even more than 95% effective under most conditions (i.e., the engineering strategy).

As for organisms, the intent of S1 was correct. That is, organisms across sizes and taxonomic groupings are differentially vulnerable to varying technologies. Thus, it was deemed essential (by the GLOBALLAST working groups) to test representative organisms from all these taxonomic groups and at different life stages. However, given the permutations needed to test all these organisms (at high density) over the worst environmental conditions expected and for all these abiotic variables seems extremely unlikely, unless some of the environmental variables and organism types can be controlled.

Therefore, I propose a directed strategy by the Coast Gurad to identify a small set of test organisms (possibly only 2-4 taxa/life stages) that will be models for BWT effectiveness. Scientists should be directed (via Coast Guard/ Sea Grant funds) to develop this set of organisms by conducting experiments to correlate surviovorship of these test organisms with other important resistant taxonomic groups under varying treatments and environmetal conditions.

For example, *Artemia* sp. is a taxon that 1) cannot invade most habitats (i.e., it will not become an invader if tested in outdoor facilities, 2) is easy to culture for various life stages and sizes (about 200 microns up to several mm), 3) can potentially be tested in freshwater and marine habitats (if transferred to favorable conditions after testing), and 4) is known to be resistant to many known treatments. This taxon could be used in the lab to develop survivorship correlations with other representative taxa (e.g, from the list presented in S1) and treatments under varying environmental conditions. Then, *Artemia* or other standard taxa could be used in standardized platform or shipboard testing studies.

In addition, I propose that the Coast Guard establish testing sites where conditions are known to be harsh to known technologies. For example, in the Great Lakes, testing in Duluth has shown that dissolved organic matter levels are high, while sediment loads are high in the Toledo harbor area. Test sites are clearly needed at which environmental conditions can be reliably expected or generated for both platform testing and shipboard demonstration.

Test organisms could be maintained at designated test facilities and companies could pay to use the facility and organisms to test their products. This is an aspect of the intent behind the current call for Sea Grant proposals to conduct shipboard demonstrations using MARAD vessels. However, the locating of these vessels at strategic locations with specific test organisms would help the Coast Guard certify specific treatments.

Standard 2: Size Criterion

Too many potential invading species have life stages than are near or less than 100 microns in size. Dinoflagellate cysts, copepod eggs, and a complete suite of bacteria would not be affected with this criterion. The hope that we would affect these smaller organisms by

treating ballast water for the larger organisms, was not an argument entertained at the GLOBALLAST workshop and it would not work, especially with certain technologies.

Standard 3: Coast Guard Workshop Proposal A

No justification is given for having a 99% reduction criterion for zooplankton and only a 95% criterion for phytoplankton. Is it suggesting that phyoplankton including dinoflagellates are more difficult to kill and thus realistic treatment (BAT) outcomes necessitate this? Given the need to reduce the transmission of small organisms that can encyst (e.g. dinoflagellates and *Pfiesteria*), will an acceptance of 95% for phytoplankton (collectively) have the desired effect of eliminating ballast water-based invasions? Also, I have worked with samples in which 99% of the copepods were nauplii, and which should be considerably easier to kill that adults. Would we be satisfied with a standard that allowed a few million adult zooplankters (1 per liter?) with eggs to enter a water body from a single ship, even if we had killed millions of indiviuduals at the vulnerable life stage? I think not. This was the rationale for choosing specific taxa as representative test organisms. The use of percentages also is problematic here in field verification..

Standard 4: Coast Guard Workshop Proposal B

This is the absolute criterion for all organisms greater than 50 microns, but like S3 it assumes that treatment (or none if below standard thresholds), to reduce bacteria concentrations to the federal standard, will deal with all species less than 50 microns. At this size, dinoflaggelate cycts and potentially stages of *Pfiesteria*, along with protists and many phytoplankton could be found in acceptable ballast water. As in the comments to S1, I suggest that a 95% reduction rule be imposed for testing bacterial concentrations as a means of impacting these 'other' organisms.

Proposed Interim Standard:

Use the Revised Bacterial Standard in conjunction with S1 (from the GLOBALLAST workshop) with the following modiifcation to S1.

1. As under S1, identify a small set of taxa and life stages (n=2-4) that can act as surrogates for the most difficult organisms to kill in ballast water, including organisms associated with sediments (to affect organisms in NOBOBs). Note that there should be different organisms for freshwater and marine certification (i.e., using freshwater or marine ports of call). Demonstrate the specified percentage reduction (95% as an interim requirement?) of these organisms (with limited confidence intervals) in shipboard mesocosm testing (or in ballast tanks) under the following environmental conditions for incoming ballast water:

Temperature: Both < 8C, and < 25C(but greater than 20C)

pH: Median for freshwater or marine conditions ($\pm$ 0.5 pH units)
Dissolved Oxygen: at least 60% saturation
Dissolved Organic Matter: at least the upper 80th percentile for this variable found in the literature for harbors (TBD – to be determined)
Particulate Organic Matter: : at least the upper 80th percentile for this variable found in the literature for harbors (TBD – to be determined)
Suspended Sediments: at least the upper 80th percentile for this variable found in the literature for harbors at mid-depth (TBD – to be determined).

DOM, POM, and SS conditions do not have to be tested concurrently.

These variables and their conditions place a reasonably high standard for most recognized technologies being developed.

There is still information that needs to be gathered to generate numbers for this standard, but the Coast Guard can put together a team of scientists to identify the appropriate test organisms and a thorough literature review or sampling foray can determine the range of environmental variables. If individuals can find potential invading species that have better survivorship than the test organisms, then the standard can be revised. If technology improves beyond what we have observed to date, which it surely will, then the standard can be revised upward. In addition, field assessment by enforcement officers needs to be considered.

Sincerely,

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