

Protecting Marine Parks and Sanctuaries from Aquatic Nuisance Species Releases from Ballast During Emergency Response Events

Phyllis A. Green

Abstract—Commercial shipping activities that release aquatic invasive species are recognized globally as a dominant transport vector for marine invasions. Aquatic nuisance species (ANS) introductions have resulted in billions of dollars of damages and immeasurable biological devastation within the Great Lakes. National Park Service managers are working with United States Geological Survey scientists to develop and refine emergency response options for ballast from high risk ships. This is to aid Parks in reducing risk from high risk ships either during an emergency response or when de-ballasting as part of ship operations within Park waters. The National Park Service is working on developing a salvors' guide to provide guidelines for emergency treatment of ballast within Park waters if conditions require ballast discharge. Discharges of live non-native species are currently prohibited within U.S. National Park boundaries, but permanent treatment of ballast to comply with this regulation may be as far off as 2021. Having potential tools to treat ballast on a short term basis will allow ship owners/operators to comply with mandatory regulations within Park boundaries or to participate voluntarily. In addition, accidental groundings make it imperative that procedures are developed to (1) assess whether the ballast is high risk, and (2) ensure management as part of an emergency incident in a timely way. This paper will present a review of a prototype draft risk assessment, methods previously used to treat ballast, and a summary of future work designed to address this critical need. Case studies of emergency treatment will be reviewed and lessons learned discussed.

Introduction

Invasive nuisance species are estimated to cost the United States \$97 billion dollars annually. In the Great Lakes alone, environmental and economic harm (both damage and control costs) are annually estimated to be \$5.7 billion dollars (Pimentel 2005). Controlling Aquatic Nuisance

Species (ANS) spread in the fresh water environment has been limited. Many of the ANS are small and their effects may be hidden for years, making detection and response before they gain a biological foothold difficult. Management jurisdictions to address the problem are often fragmented and uncoordinated. Because current mandatory actions like ballast exchange and salt water flushing are less than 100% effective (Johengen and others 2005) and implementation of stringent U.S. or International Maritime Organization (IMO) standards are estimated to be years away, developing some means to significantly reduce risk is critical. This paper highlights National Park Service (NPS) efforts to create cost-effective means to reduce the risk of damaging invasions and determine situations where additional first lines of defense can make a difference in both salt and fresh water environments.

Every year there are over 800 ship groundings in the United States. Risk assessment protocols for dealing with cargo and hazardous man-made chemicals are in place. But one potential risk not often evaluated as part of the emergency response (and one that can permanently alter the aquatic environment) is aquatic nuisance species. In the Great Lakes there has been no successful eradication of any pest or pestilence once it has gained a biological foothold. As a result, this risk needs to become a key consideration for our management of marine and freshwater Parks (Whelan, personal communication).

If a Park has shipping lanes running through or near its boundaries, assessing risk and preparing to interdict when a high risk situation occurs is critical. Some countries have required ballast treatment as simple as pouring chlorine into a ballast vent. For example, Argentina requires chlorine to be added to ballast tanks of ships that are arriving from ports where cholera is present. But data on the efficacy of their methods has not been available. In addition, when the National Park Service required treatment of the Igloo Moon, a stranded ship with a hazardous cargo, many questions were raised relative to the efficacy of treatment and how to improve upon the techniques used (Mearns and others 1999).

Three Case Studies Where Treatment was Required

In February 2009, an owner of a submersible dry dock barge purchased from China with un-exchanged ballast, voluntarily worked with State of Washington Department of Fish and Wildlife to treat ballast water prior to discharge.

Phyllis A. Green is Park Superintendent, Isle Royale National Park, 800 E Lakeshore Dr, Houghton, MI, 49931. Email: phyllis_green@nps.gov.

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Submersible pumps were used to pull the water from separate ballast compartments into the treatment system. Using a treatment facility outside the ballast tanks may have limited applicability, depending on the availability of pumps, timing, and the treatment equipment; but it is reported the manufacturer of the UV system used to treat the ballast water on this barge may develop and size the system to respond to emergency applications in the future (Smith, personal communication).

In the fall of 2007, the NPS vessel Ranger III was first treated with low dosages of sodium hypochlorite to ensure that a targeted ANS species, Viral Hemorrhagic Septicemia (VHSV), a deadly fish virus, was not transferred to Isle Royale National Park. The first method of introducing the biocide (bleach) and neutralizer (ascorbic acid) was simple; both were added at appropriate times through the vent tubes. Because of the properties of the chemicals used, chemical dispersal, and the transit action of the vessel, the chemicals reached the target dosages for toxicity and subsequent neutralization. The Ranger III subsequently installed an in-line pump for the injection of both chemicals for under \$800 and in 2008 treated approximately 72,000 gallons of water for a cost of less than \$80. The biocide only represented 10% of the cost. The neutralizer was the most expensive. Discharges met or exceeded state standards for vessel discharge. NPS staff is evaluating options for a permanent installation to treat the ship and target a broader spectrum of ANS.

In November of 1996, a liquid petroleum gas tanker got stranded in Biscayne National Park in Florida. This case study will be examined in detail as some of the questions raised by the incident team in the Mearns report (Mearns and others 1999) have been addressed through time, and some of the questions may be answered in the future by incorporating adaptive management techniques and monitoring into emergency response actions as they occur and treatment is used.

During the stranding, 1.1 million gallons of ballast was treated at levels of 50-100 ppm of calcium hypochlorite, to prevent the accidental release of an ANS species onto the reef environment. After treatment, the ship was successfully floated off the reef with no loss or release of cargo. In 1996, this event resulted in a test of the newly implemented incident command structure for the USCG and the documented first spill response with ballast treatment. The team raised the following questions after the event:

1. Should ballast water risk assessment be included in response procedures?
2. Was biocide treatment necessary?
3. Can on-site sampling for risk assessment be conducted?
4. If documentation of mid-sea exchange is lacking, how can this be factored into risk assessment?
5. Can probable disease mortality within the tank be calculated and factored in?
6. How important is the distance of the ship to the resource to be protected?

In every event, the best course of analysis will be convening a subject matter expert panel for site specific analysis. Since 1996, there are new tools and studies available to the panels or incident managers to help respond to the questions raised above. There are also opportunities to pre-load risk assessments based on current knowledge through the Net

Environmental Benefits Assessment planning process by identifying and incorporating known high risk ballast origin sites into the analysis. I will provide a response to the incident team's questions from an NPS manager's perspective.

1. Given the current cost of ANS mitigation in the United States and the freshwater environment of the Great Lakes, I recommend that ballast water should always be considered and evaluated as part of the response. For areas with high standards for protection, such as National Parks and marine conservation areas, it is essential.
2. Live ANS are prohibited to be released within NPS jurisdictional areas per both NPS and USCG regulations. If the ship's transit records indicate that the ship took on ballast in an area that has ANS, any release of ballast with live ANS will be in noncompliance with NPS rules and policy, and any release of unmanaged ballast will be in violation of USCG regulation. Treatment will be a critical component of risk reduction, and the ability to implement treatment within the parameters of an emergency response will need to be accounted for. If not, the responsible party could be held liable for the subsequent appearance of an ANS that damages park resources. There is a list of species identified as having the opportunity to become established for the Great Lakes and there are internationally recognized diseases that have the ability to cause significant harm in the event of an accidental release. The spread of these species in particular should be slowed by the most effective method available.
3. VHSV, which is an international disease of concern, is very difficult to isolate from a large ballast water tank and can take weeks of lab analysis for verification. For many species, culturing or finding the species in large volumes of water will not be practical under emergency response timelines. On-site risk assessment can review ballast records and ports of uptake and make their best assessment.
4. Documentation of ballast exchange has greatly improved since 1996. Within the Great Lakes' system, the Great Lakes Ballast Water Working Group reports that 30 percent of the ships arriving within the system still have "minor" compliance issues with ballast management practices including documentation. With increased compliance checks they are seeing a rapid improvement in this area. It is important to note the Environmental Protection Agency's (EPA, 2008) findings that ballast records need to be maintained for long periods of time, because each tank may be managed differently; ballast uptakes, five ports previous and/or last port of uptake, may influence a risk assessment (Johengen and others 2005). The USCG is requiring ballast records to be stored on board for 2 years, which should provide better risk assessment.
5. Though some ANS mortality occurs within the tank during transit, studies have shown residual viability of organisms within tanks. Thus, each situation has to be evaluated with respect to risk of release of viable ANS. The use of treatment against residual ANS measured against the harm to native biota from the subsequent release of either treated (with or without biocide neutralization) or untreated ballast will be critical to address.

6. Distance from the specific resource of concern will require site specific analysis by subject matter experts. Data on this issue may be limited, but should always be considered when available.

In summary, for the Biscayne National Park incident, the natural resources trustees were satisfied that the risk reduction by biocide treatment was warranted and significant. In fact, the current Superintendent has stated that if faced with a similar situation he would follow the same process to determine appropriate risk reduction, and biocide treatment would be considered. Subsequent dye studies have provided data on the dilution effects of direct discharge from a ship which will enable managers to better assess the effects of a direct residual biocide release without neutralization on native aquatic species. Doing a better job of risk assessment should be a focus of all emergency responders, by using adaptive management techniques to learn from each incident.

Protecting Marine and Freshwater Parks in the Future

The effects of the wrong species entering your park at the wrong time can be devastating to natural resources. An invasive species issue can escalate rapidly; the expansion of zebra mussels and quagga mussels in the Great Lakes provides a dramatic example. We are in the process of crashing the deep water fisheries of both Lake Michigan and Lake Huron, having allowed these mussels into the system. In addition to the effect of invaders on natural resources, cultural resources can also suffer.

So how do you become the last place to be invaded by ballast transferred ANS? How would you slow the spread into your park? The NPS assembled a team of scientists from the USGS, naval architects, marine engineers, and industry leaders; to create an *Emergency Response Guide for Handling Ballast Water to Control Non-Indigenous Species* (Reynolds and others 2010) and to test it on the largest of Great Lakes ships. Indeed, the only commercial ships larger in the world are supertankers. The guide addresses two situations: (1) when a ship runs aground in your park; and (2) when you know a ballasted ship is coming in from an area with high risk ANS transfers and you would like to treat it before allowing it to come in.

The techniques are designed to work with equipment that is typically on board a ship, including small pumps, hoses, fittings, and drums. The study gathered the data to be able to rank methods of delivering a liquid into a ballast tank to distribute it evenly. The Argentina vent dosing techniques were ranked with three other techniques. For empty tanks, the easiest and most effective method is in-line mixing. Full tank dosing is more difficult to mix and requires working with the ship owner prior to arrival, in order to encourage or mandate that full tanks be treated before arrival and release.

The emergency handbook can enable managers who have the authority to protect resources to show how ballast can be treated using equipment that is typically found on a ship and is readily accessible. In the case of groundings, the U.S. National Park Service does not allow for the release of live ANS into NPS waters; thus, when the Igloo Moon grounded in Key Biscayne, NPS required that no live ANS be released

and worked with a team to find a temporary solution. The emergency handbook also documents how to approach a ship situation when you know it will want to discharge ballast as it offloads people or cargo within your Park. Some options for treatment are captured in the guide as well as a prototype risk assessment document to help you evaluate and develop a risk assessment tailored to your situation.

Risk assessment should occur before an emergency event occurs, but if ballasted ships are currently visiting your protected area, you should start the analysis right away. Knowing where the ship is coming from and the risks associated with live species in its tanks is critical. Ship information is available from the U.S. Coast Guard and many port authorities have web sites with ship arrival details. You need to identify areas of concern. After you know the area of concern, you need to identify chemicals that can kill the species of concern while meeting regulations related to chemical use in your country.

The result of the first draft on risk assessment is captured in the guideline. This guide documents current options for mixing biocides in ballast tank and their limits and options for neutralization. It is intended to stay as a draft and includes a system for modifying it as new information is obtained.

NPS will continue to work with the development of the salvors' guide in order to develop a process to document (1) how to monitor the treatment efficacy when it occurs; and (2) how to improve future results by incorporating the monitoring information into the emergency response system. Please access this guide at www.nps.gov/isro (search for ballast emergency guide). The intent is to keep the draft updated and current on a web site and to add information and results as the techniques are implemented. This first draft included solid data on how to treat tanks that are empty and promising data on treating tanks that are full. We will be conducting shipboard trials on ways to enhance mixing in full tanks during spring of 2010 and will incorporate the information at that time. We are also taking the National Park Service guidebook to a subcommittee of the U.S. National Taskforce on aquatic nuisance species to be reviewed for adoption by all Federal agencies.

What can you do if you don't have the legal authority to require treatment for park protection? There is no harm in asking for voluntary treatment. At least with this guidebook you can offer the generic means to deliver a chemical and hopefully, after discussions with scientists, offer suggestions for chemicals that would disinfect for the ANS you are most concerned about. At this point, the choice of what chemical to use should always rest with the ship owner/Captain who knows the fittings and coatings of the ship's tanks and piping, and the training and materials handling capacity of the crew.

Summary

Have a marine or freshwater park review your authorities to know if you can mandate treatment, or need to work pro-actively for voluntary treatment.

You can use this guide to outline ways to treat the ballast if one of these scenarios occurs: (1) a ballasted ship runs aground in your park, or (2) a ballasted ship is arriving from an area of concern for ANS transfers. The actual treatment could be (1) conducted voluntarily under the responsibility

of the Captain or ship owner, (2) initiated by your country's emergency response personnel when they have the authority, or (3) required through concession contracts or legal mandates. Enhancing the protection of our salt and freshwater parks from the most common dispersal methods for international aquatic pests is an achievable goal.

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