Aquatic Nuisance Species releases during emergency response: more permanent harm then the original spill?

Abstract: Aquatic nuisance species (ANS) introductions have resulted in millions of dollars of damages and immeasurable biological devastation to the Great Lakes. National Park Service managers are working with United States Geological Services scientists and the United States Coast Guard to develop and refine emergency response options for ballast from high risk ships. Ballast may require treatment during an emergency response. With over 800 groundings a year and ships arriving from ports with a potential high-risk ANS cargo, agreed upon procedures to assess whether the ballast is high risk and thus needs to be managed as part of the incident are imperative. This paper will present a review of risk assessment, current methods of treating ballast, and a summary of the National Aquatic Nuisance task-force's work to create standard operating procedures and best management practices for ballast treatment of high risk ships. A case study of the grounding of the Igloo Moon in 1996 will be reviewed and lessons learned discussed.

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Invasive nuisance species are estimated to cost the United States $97 billion annually. In the Great Lakes alone, environmental and economic harm (both damage and control costs) are annually estimated to be $5.7 billion dollars[i]. Controlling Aquatic Nuisance Species (ANS) spread in the fresh water environment has been limited, perhaps because ANS are generally small, their effects may be hidden for years, and related management jurisdictions are often fragmented and often uncoordinated. Because current mandatory actions like salt water exchange are less than 100% effective and implementation of stringent U.S. or International Maritime Organization (IMO) standards remains years away, developing some means to significantly reduce risk is critical. This paper is presented to fresh water spill symposium members to highlight National Park Service (NPS) requirements and 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.

Every year there are over 800 ship groundings in the U.S[ii]. 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. Knowing that there has been no successful eradication of any pest or pestilence once it has gained a biological foothold into the Great Lakes, this risk needs to become a key consideration for our management of Great Lakes vessels [iii]

The newest Great Lakes' fish disease, Viral Hemorrhagic Septicemia (VHS), is an internationally recognized disease of concern. In 2006 when the disease first appeared in the Great Lakes, Dr James Winton, Chief of the Fish Health Section of the Western Fisheries Research Center of the United States Geological Survey, predicted: "that the presence of Viral Hemorrhagic Septicemia virus (VHSv) may result in significant disruption to restoration efforts for important populations of threatened or endangered species in the Great Lakes. This disease breaks out in hatcheries with open water supplies where fish densities are high and stressors present or in open waters where anthropogenic factors predispose fish to disease."[iv] His predictions have started to come true as in 2007 when the Michigan Department of Natural Resources (MIDNR) shut down walleye hatchery production, and then in 2008 only operated their hatcheries at 20 per cent of their production capacity to assure virus free walleye.

Once a fish disease enters a wild population it persists, debilitating populations until a disease resistance can build up over generations. There are 58 ANS of concern for the Great Lakes, ranging from fish diseases to crustaceans. Vigilance in preventing ANS introduction is critical. This paper presents some of the opportunities to assess and prevent aquatic nuisance species introductions during emergencies where ballast is present.

Currently the United States Coast Guard (USCG) is monitoring ballast tanks of No Ballast on Board vessels (NOBOB) to document and monitor their ballast when they enter the Great Lakes systems. They report there is no unmanaged ballast entering the Great Lakes system[v] and that 2008 brought a more coordinated effort by the agencies managing the seaways waters with increased compliance for salt water flushing. However, NOBOB ships present a significant risk as even with salt water exchange, aquatic nuisance species can remain viable within the tanks[vi]. Since most Ballast on Board (BOB) and NOBOB vessels have to exchange ballast when they exchange cargo at ports in the Great Lakes, individual circumstances will determine whether additional efforts to treat ballast will be effective or futile. Ballast is a known vector for ANS and fish diseases[vii].

Where can the emergency response community make a difference? There are four areas of potential problems and need for additional risk reduction: 1) During transit into or out of the Great Lakes' system, a NOBOB ship with a retention order (not allowed to release ballast) could have a stranding or emergency situation during which they would want to release ballast as part of ship recovery or emergency management. 2) In the future when on-board treatments are installed, there may be a failure of the treatment during or before an emergency event that will require emergency managers to treat ballast prior to releasing it from the ship to meet current State or future federal regulation. 3) Regardless of status, NOBOB or BOB, a stranding in a special management area may result in the natural resource trustee requiring no direct release of ballast without treatment. 4) A natural resource trustee may have an epizootic event within their jurisdiction where they may want to quarantine and disinfect boats and ballast prior to the vessels leaving the area. The trustee may call upon the emergency response community for skills and expertise in dealing with the situation. Following is a brief summary of what is being done via voluntary or mandatory actions to meet the needs of these four situations. After presenting these case studies, NPS collaborative work on integrating adaptive management techniques for ANS prevention into incident management will be provided.

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

In the fall of 2007, the NPS vessel Ranger III was first treated with low dosages of sodium hypochlorite to ensure a targeted ANS species, Viral Hemorrhagic Septicemia virus, was not transferred to Isle Royale National Park. The first method of introducing the biocide 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 then $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 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 [ix] 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, and 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) I would suggest given the current cost of ANS mitigation in the U.S. and the fresh water environment of the Great Lakes 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) ANS are prohibited to be released within NPS jurisdictional areas. If the ship's transit records indicate the ship took on ballast in an area that has ANS, any release of untreated ballast will be in violation on NPS 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 on an incidental 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 USCG report 30 per cent 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) 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 or in the last port of uptake may have an influence on your risk assessment[x].

5) Though some ANS mortality occurs within the tank during transit, enough studies show residual viability of organisms within tanks, so that each situation has to be evaluated more on risk of release of viable ANS. The ability to use treatment to cause mortality of the 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. In the case of VHSv, we evaluated distances used in Europe when they quarantined areas of the ocean around contaminated hatcheries as a guideline. 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.

The Future: In the upcoming year, if you have an incident to respond to, you will have to work with the natural resource trustee to decide the appropriate response. You should be aware of the following collaborative efforts to develop a salvor's guide for emergency response which will list options and a decision tree to guide in the analysis. There are three primary efforts occurring concurrently to make this information available as soon as possible.

The author, in her duties as Midwest Viral Hemorrhagic Septicemia Prevention Coordinator for NPS, is working with United States Geological Survey scientists and a Naval Architectural firm to develop an inline delivery system that can be applied to the worst case ballast system in the Great Lakes in terms of ballast volume and tank pump configuration. The first round of results will be documented in a draft salvors' guide to ballast treatment during emergency response by mid summer of 2009. This guide will document current options for mixing biocides in ballast tank and their limits and options for neutralization. This draft guide will be available for review and comment by the USCG, members of this conference and salvor associations, and will include a system for modifying it as new information is obtained.

In the fall of 2007, the Great Ships' Initiative issued a call for proposals for biocide treatments to combat VHS. Both NPS and USGS staff who have combined efforts on the delivery work above submitted commonly used chemicals to undergo rigorous bench testing for efficacy against VHS and other problematic ANS. The results were promising for both chemicals. When released by GSI, the results will be used to evaluate the use of these biocides for 1) long-term treatment (via permanent shipboard installation tested through the Great Ships' Initiative), and 2) short term interdiction during emergency events. The two efforts above will be integrated with the following effort.

The National Aquatic Nuisance task-force has convened a subcommittee to review emergency treatment options (from chemicals to delivery systems) at the request of the USCG and NPS ANS leadership. Currently, a review of the toxicology for the list of the 58 identified problematic ANS issues for the Great Lakes is being initiated by the NPS. This list of known lethal interdiction chemicals or treatments will be presented to the subcommittee to be evaluated and ranked for their efficacy and ability to be mitigated prior to release by a team of subject matter experts. Additionally these chemical's effects on ships' safety and costs to implement will be estimated. How to deal with biocide demand from ambient water characteristics will be discussed. Compliance options for the Federal Insecticide Fungicide and Rodenticide Act for emergency events will be outlined. The team will provide this information to the salvors' guide development process.

NPS will continue to work with the development of the salvor 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. We would like to work within the frame-work of the oil-spill response community to improve the response to emergency events and to prevent or mitigate their consequences.

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[i] Predicting Future Introductions of Non-indigenous Species to the Great Lakes, National Center for Environmental Assessment Office of research and development US Environmental Protection Agency Washington, DC 20460 EPA/600/R-08/066F November 2008 p.4-5

[ii] United States Coast Guard Marine Safety Performance Plan FY2009-2014 May 2008 p. A-4

[iii] Gary Whelan, Fish Production Manager MIDNR 2/13/09 and EPA/600/r-08/066F November 2008

[iv] James Winton, personal communication 5/9/08

[v] "2007 Summary of Great Lakes Ballast Water Management", May 2008 GL Ballast Water Management Working Group

[vi] Assessment of Transoceanic NOBOB Vessels and Low-salinity ballast water as vectors for non-indigenous species introductions to the Great Lakes", Thomas Johengen, David Reid, Gary Fahnenstiel, Hugh MacIssac, Fred Dobbs, Martina Doblin, Greg Ruiz, Philip Jenkins, University of Michigan and NOAA final report April 2005 revised May 20,2005 (April 2005 Johengen et al)

[vii] See i above EPA/600/R-08/0666F November 2008 and "Shipping and the spread of infectious salmon anemia in Scottish aquaculture", Alexander G. Murray, Ronald J. Smith, and Ronald M. Stagg. Emerging infectious disease, vol 8. No.1 January 2002

[viii] Scott Smith, Invasive Species Section Leader, USGS Western Fisheries Research Center, Personal communication Smith 2/5/09

[ix] Mearns, A., B. Benggio, and T. Waite. 1999. Ballast water treatment during emergency response: the case of the M/T Igloo Moon. Pages 1463-1468 *in* OCEANS '99 MTS/IEEE. Riding the Crest into the 21st Century, Div. of Hazardous Mater. Response, NOAA, Seattle, WA, Seattle, Washington, USA.

[x] Assessment of Transoceanic NOBOB Vessels and Low-salinity ballast water as vectors for non-indigenous species introductions to the Great Lakes", Thomas Johengen, David Reid, Gary Fahnenstiel, Hugh MacIssac, Fred Dobbs, Martina Doblin, Greg Ruiz, Philip Jenkins, University of Michigan and NOAA final report April 2005 revised May 20, 2005).