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Maritime Disasters Working Group

DRAFT Outline for Action Statement
(Prepared for discussion by the Working Group)

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Humans derive many benefits from marine ecosystems. These include: (1) a source of food through aquaculture and wild fisheries, (2) for transportation and commerce, (3) for recreation and aesthetics, (4) for climate modification (for example the heating of Europe by the Gulf Stream), and (5) as a receptacle for human, agricultural, and industrial wastes. Even in the absence of disasters, it is difficult to manage these competing uses. Because of these multiple uses, there are many types of disasters that can prevent full realization of these beneficial ecosystem services. By disasters, we mean events, either natural or human induced, that adversely impact the marine environment. This paper will introduce the concept of marine disasters, discussing different types of causes and impacts. In particular, the issue of bioinvasions (ballast water management) will be singled out for further discussion, as the disciplines required for preventative strategies involve the intersection of many fields such as marine sciences, economics, and international diplomacy.

As described above, maritime disasters can take on many forms. Most people think of maritime disasters as sudden, direct catastrophic events such as an oil spill. However, there can be subtle, indirect impacts such as habitat loss that over time may be equally as catastrophic as a sudden chemical spill. With respect to the types of impacts, one can divide them into direct versus indirect impacts. Direct impacts are those that occur directly as a result of an event, be it natural or human induced. Examples of disasters caused by direct impacts include:

> 1) Chemical spills, such as tanker or barge accidents, or the release of toxic chemicals into the marine environment. The released chemicals will have an immediate direct impact on marine resources, and depending on the environmental persistence of the chemical, may have lasting effects for years.

2) Raw sewage discharges due to an incapacitation of a sewage treatment plant. A sewage treatment plant can fail for a number of reasons, including flooding, electrical power outages, toxicity to bioreactor organisms, amongst others. Of concern is not only the chemicals released to the environment, but especially the release of pathogenic microbes. The impacts are direct in that exposure to the microbes themselves, either through contact with the water or the ingestion of contaminated seafood, will directly cause the adverse outcome.

3) Harmful algal blooms due the uncontrolled release of nutrients to the environment is another type of direct impact. Changes in the amounts or types of nutrients discharged to the water can select for species of algae which produce toxins that are potentially deadly to exposed humans. Examples of harmful algal blooms include red tide blooms (paralytic shellfish poisoning), domoic acid (amnesic shellfish poisoning), ciguatoxins in reef fish, amongst others.

4) A final type of direct impact is the direct physical destruction of property due to storms, floods, or extreme tides.

Indirect impacts are outcomes that do not arise directly from the primary event itself, but rather from a causal chain of events resulting from the primary event. For example, a management decision causing an increase in siltation may not directly harm the environment, but it will lead to the destruction of rooted vegetation such as eelgrass, which in turn removes an important habitat for juvenile forms of commercially important fish species, which in turn will adversely affect fishery productivity. Types of indirect impacts include:

1) Habitat alteration, as mentioned above, is an example of an indirect impact. A healthy, functioning marine ecosystem relies on a delicate balance of attributes such as salinity, temperature, light penetration, etc. Activities that alter this balance may alter ecosystem dynamics in such a way as to remove beneficial ecological services.

2) Bioinvasions are another form of indirect impacts. The introduction of invasive non-native species through ballast water discharge can also alter ecosystem form and function in adverse ways. This issue is discussed in more detail below.

3) Physical alteration, specifically alteration of the hydrologic regime, can also have adverse ecological outcomes. Important attributes of a water body such as flushing times or siltation are a function of the physical form of that body of water. Alteration of physical form through the construction of causeways, bridges, seawalls, or culverts can have unintended consequences. For example, construction of a causeway may cause an embayment to become poorly flushed by tidal action, leading to the trapping of nutrients and contaminants with concomitant adverse effects.

Distinct from the impacts of maritime disasters are the root causes. The root causes of maritime disasters can be both natural and anthropogenic. Natural causes are factors such as storms, changes in oceanic thermohaline circulation patterns, and changes in ecosystem form and function related to global change. Anthropogenic causes can be due to accidents such as barge or tanker accidents, the direct physical alteration of the environment, or other human-induced alterations or discharges to the environment. While we may to a certain extent have greater control on human factors that cause disasters relative to natural factors, if we understand the nature of the disasters themselves we can develop strategies that either prevent or mitigate the effects of these adverse events.

An important consideration in planning for maritime disasters is an understanding of the spatial and temporal scales of adverse outcomes. That is, the duration for which the effects of a disaster will last and the distance scale over which the effects will be felt must be a part of the planning process. Planning for a chemical spill, which will last for days-to-weeks over a distance scale of kilometers, will be much different than planning for bioinvasions, which may persist for years-to-decades over thousands of kilometers. In addition to space and time, dimensions such as severity and reversibility must also be considered.

An interesting case which touches upon many of the considerations discussed above is the issue of bioinvasions. Bioinvasions and the management of ballast water discharge has become an increasingly important issue over the last few years. As is well known, ships often take on extra weight (ballast) to provide stability and improve voyage safety. Ballast is often taken on in times when the ship is not fully loaded. This practice dates as far back to the Phoenicians, who often used rocks and stones as ballast material. Today, water is primarily used as ballast material. Generally, ballast water is added at the port of origin by pumping in water directly from the harbor/bay, and must be discharged before more cargo can be added at a destination port. The ballast water thus contains the full suite of biological organisms and chemical contaminants present at the home port. A problem can (and has) occurred when ballast water is discharged at the port of destination. Some of the biological components of the ballast water can potentially out-compete organisms present in the destination port, severely altering the ecological integrity of the local environment with large socio-economic costs. In response to this, the International Marine Organization (IMO), a specialized agency of the United Nations with 166 member states, established the Ballast Water Management Convention (BWM) in 2004, which if passed by a requisite amount of member nations, will more formally regulate the discharge of ballast water into the environment.

A common method for avoiding the impacts of ballast water discharge is to undergo ballast water exchange (BWE) at sea. That is, once at sea a ship can exchange the ballast water taken up at the port of origin with water taken from the offshore location. The idea is that ‘contaminated’ ballast water discharged at sea will have little environmental consequences, and the ‘clean’ ballast water picked up at sea itself will not have adverse impacts when discharged at a destination port. However, since many ships spend there entire time in close to shore, BWE is not necessarily useful in all situations. In cases, where BWE is not feasible, ballast water must be treated prior to discharge. Treatment technologies include the use of heat, UV irradiation, or addition of chemicals as means to reduce biological contamination.

There are many factors that can affect the adverse impacts of ballast water discharge on the local environment. These include: the nature of the water taken on as ballast (temperature, chemical and biological characteristics, salt content, time of year), the duration of the trip before discharge (survivability), and the nature of the water into which the ballast is discharged (temperature, chemical and biological characteristic, salt content, and time of year). In addition, one must consider more than just the concentration (or numbers) of biological organisms in any individual discharge of ballast water. Knowing the concentration of undesirable organisms in any one discharge may be less important than knowing the total amount of ballast cumulatively discharged from all ships into a single body of water over a given amount of time

In the coming years, the Ballast Water Management Convention will require formalized control of ballast water discharge practices. The issues involved in truly understanding bioinvasions and ballast water management are many, ranging from our basic scientific understanding of the processes leading to a bioinvasion itself, to environmental economics and international diplomacy. That is why the issue of ballast water management is a particularly interesting case study. As with all of the disasters discussed, the crucial requirement for setting preventive strategies is knowledge. For many of these disasters, the collective knowledge required to act upon potential disasters already exists. Unfortunately, this collective knowledge resides in different disciplines, ranging from oceanography, risk analysis, engineering, political science, economics, and diplomacy. Each of these disciplines has their own languages and conventions, and communication across disciplines can be difficult. However, it is precisely such a close interdisciplinary collaboration that is required to truly understand and act upon issues such as marine bioinvasions. Understanding and acting on maritime disasters is indeed a decidedly interdisciplinary undertaking. For intelligent decision making to occur, a setting must be created to allow for true interaction amongst different disciplines.