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Review of ballast water management policy and associated implications for Alaska

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ABSTRACT

Transport of invasive species in the ballast water of ships threatens marine ecosystems globally. Policy in the United States to control unwanted introductions began over 25 years ago with the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, later the National Invasive Species Act of 1996, and has now expanded to include oversight from multiple federal agencies and state governments. Simultaneously, the International Maritime Organization has directed attempts to regulate ballast water on the global scale. Management priorities have shifted from mid-ocean ballast water exchange toward quantitative standards of allowable organism density upon discharge. However, critical management exemptions are resulting in unnecessary risk, particularly in ports that receive primarily coastal vessel traffic. For example, in the United States, exemptions for crude oil tankers engaged in coastwise trade have existed since 1996. When management and recordkeeping requirements went into place for these vessels in 2008 the result was an apparent 440% increase in ballast water discharge to Alaska in the following year. Our review of ballast water management policy suggests that a precautionary approach to exemptions coupled with scenario-specific risk assessments may reduce risk of invasion in ecosystems, like those of coastal Alaska, that are susceptible to further, or new, invasions.

1. Introduction

Aquatic species have been anthropogenically dispersed worldwide since the days of sailing vessels [1]. As shipping expanded into a prominent means of transportation and exploration in the 15th century and earlier, the number, size and speed of vessels rose dramatically, increasing opportunities for intentional and unintentional nonindigenous hitchhikers [2]. In the 19th century, steam technology and steel-hulled vessels became increasingly common [3], along with the use of water as ballast and the potential for broad-scale relocation of nonindigenous species (NIS) [4]. The ensuing establishment of introduced NIS has had biological, economic and social consequences on ecosystems worldwide [5–7].

Despite more than a century of concern about the role of ballast water in the transport of NIS, the development and implementation of ballast water management (BWM) policy has been a mostly reactionary process [8,9]. However recent events (e.g., the development of ballast water management systems, implementation of globally recognized discharge standards, and acknowledgement of critical policy gaps) suggest a cautiously optimistic future [10–12]. As global and national awareness of the hazards associated with the transfer and establishment of NIS has escalated, so has the strength and reach of BWM requirements for the shipping industry.

During the past 25 years regulations governing BWM in the United States have mirrored this trend, evolving from limited and voluntary to widespread and mandatory (Fig. 1). Some vessel types and routes, however, have been provided exemptions from BWM requirements. Exemptions allow vessels to discharge unmanaged or coastally exchanged ballast water, which may adversely influence risk of invasion in affected ports [13].

The state of Alaska has seen firsthand the implications of policy exemptions, and historic ballast water analyses suggest a relationship between policy and vessel practices. For example, pre-2008 efforts to assess Alaska bound vessel traffic patterns and ballast water management were hindered by reporting exceptions (e.g., [14]). Verna et al. [15] conducted a statewide risk assessment of ballast-borne marine invasive species following mandated ballast water reporting (post-2008) and found that 80% of the over 54 million metric tons (MT) of reported ballast water discharged between 2009 and 2012 in Alaska waters was sourced on the west coast of North America. A relatively small portion of the ballast water (38%) was managed prior to discharge, and most of the ballast water (86%) was discharged in the port of Valdez from crude oil tankers engaged in coastwise trade. These authors

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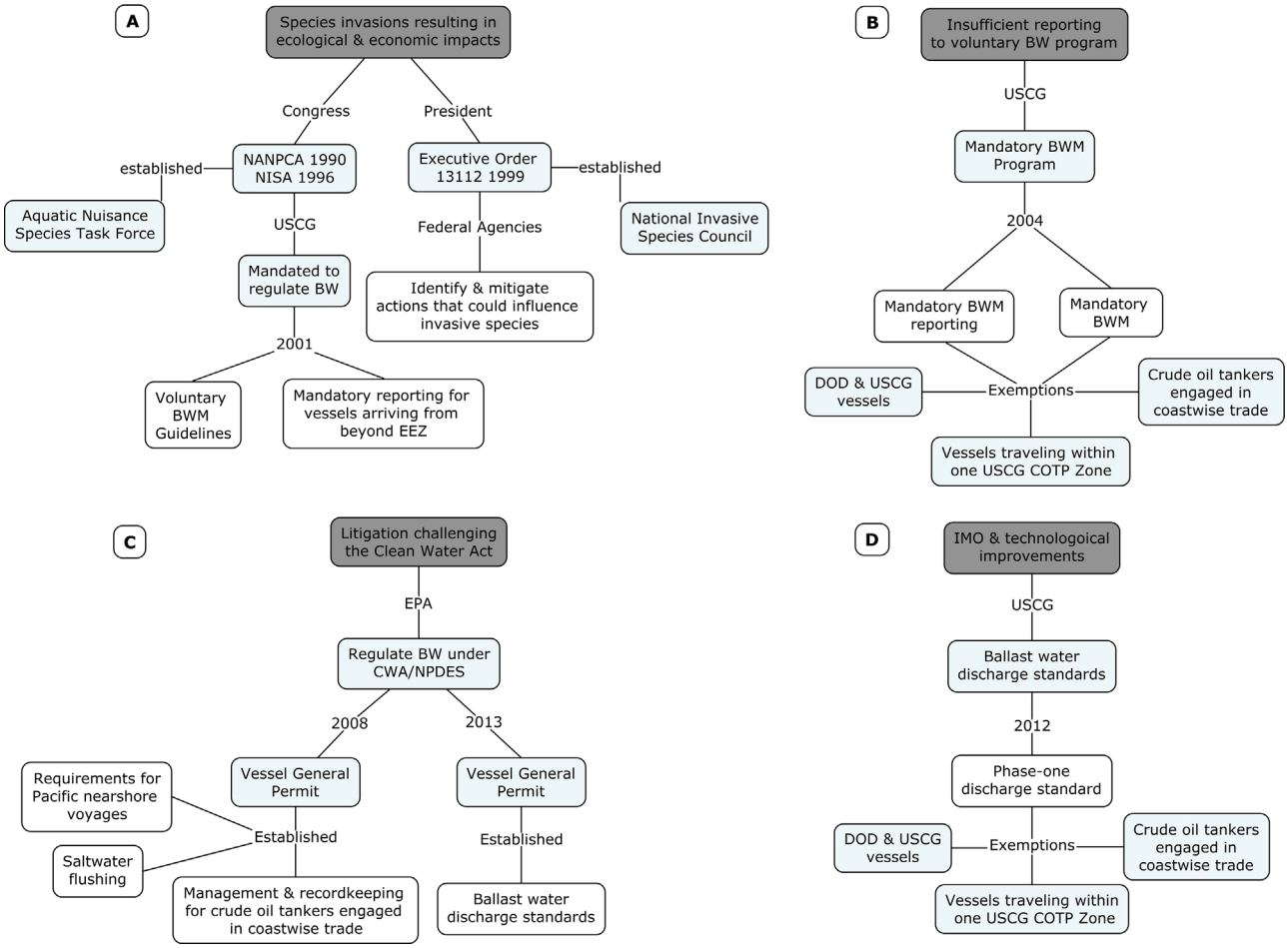

Fig. 1. A 4-step concept map depicting drivers of ballast water management policy in the United States. Dark grey boxes depict drivers of policy and white boxes depict outcomes or implementation of policy.

suggest that the relatively uninvaded coastline of Alaska currently faces a heightened risk of novel biological introductions as a result of increasing regional traffic, climate change, emerging Arctic trade routes, and development.

Following a brief review of international BWM policy as it relates to domestic regulations, this paper examines the history of BWM policy in the United States from its inception to present day, and further assesses the implications of policy changes and vessel exemptions to BWM and reporting in Alaska. The aim of this study is to inform BWM practices towards minimizing invasion risks and influencing relevant future policy actions.

2. International policy review

At the global scale, initial efforts by the International Maritime Organization (IMO) to combat aquatic NIS occurred at roughly the same time as those by the United States. The first attempt at such guidelines began in 1991 with the Marine Environment Protection Committee's (MEPC) voluntary "Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships' Ballast Water and Sediment Discharges" [50]. The IMO adopted the MEPC's guidelines in 1993. In 1997, these guidelines were updated and re-adopted by the MEPC and IMO as the "Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens" [51]. Out of practicality and a realization of the limitations of management options available at the time, between 1993 and 1997 focus shifted from preventing to minimizing species transfer via ballast water [9]. The IMO recommended that the new guidelines be used by all maritime nations and included advice on methods of avoiding the transfer and discharge of NIS [8].

These initial IMO efforts also resulted in a similar outcome as those in the United States. Although an important first step, the voluntary nonbinding Guidelines were insufficient and continued invasion impacts warranted stronger action. For example, the invasion of the comb jelly (*Mnemiopsis leidyi*) in the Black Sea and the northern Pacific seastar (*Asterias amurensis*) in Australia each had devastating effects on natural biota and wreaked havoc on local economies [16,17]. On February 13, 2004, the IMO adopted the "International Convention on the Control and Management of Ship's Ballast Water and Sediments" (BWM Convention). The purpose of the BWM Convention was to further prevent and minimize the risk of aquatic NIS transfer via ballast water [9]. To achieve this goal the BWM Convention required all vessels to implement a Ballast Water Management Plan and adhere to clearly defined management standards. The BWM Convention established two standards of management: (1) Regulation D-1, the ballast water exchange standard, and (2) Regulation D-2, the ballast water performance standard. D-1 required a minimum ballast water exchange volume of 95%, while D-2 established a concentration threshold for ballast water discharge. The D-2 standard requires ballast water discharge to contain:

- Less than 10 viable organisms per cubic meter greater than or equal to 50 μm in minimum dimension.