Journal of Great Lakes Research 36 (2010) 199–205

Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

A pound of prevention, plus a pound of cure: Early detection and eradication of invasive species in the Laurentian Great Lakes

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ARTICLE INFO

Article history:
Received 23 June 2009
Accepted 6 October 2009

Communicated by J. Ellen Marsden

Index words
Laurentian Great Lakes
Eradication
Monitoring
Early detection
Ballast water
Risk assessment

ABSTRACT

Ballast water regulations implemented in the early 1990s appear not to have slowed the rate of new aquatic invasive species (AIS) establishment in the Great Lakes. With more invasive species on the horizon, we examine the question of whether eradication of AIS is a viable management strategy for the Laurentian Great Lakes, and what a coordinated AIS early detection and eradication program would entail. In-lake monitoring would be conducted to assess the effectiveness of regulations aimed at stopping new AIS, and to maximize the likelihood of early detection of new invaders. Monitoring would be focused on detecting the most probable invaders, the most invasion-prone habitats, and the species most conducive to eradication. When a new non-native species is discovered, an eradication assessment would be conducted and used to guide the management response. In light of high uncertainty, management decisions must be robust to a range of impact and control scenarios. Though prevention should continue to be the cornerstone of management efforts, we believe that a coordinated early detection and eradication program is warranted if the Great Lakes management community and stakeholders are serious about reducing undesired impacts stemming from new AIS in the Great Lakes. Development of such a program is an opportunity for the Laurentian Great Lakes resource management community to demonstrate global leadership in invasive species management.

Introduction

Invasive species have imposed enormous economic and ecological costs upon ecosystems and the services they provide to humans (Lodge et al., 2006; Pimentel et al., 2000; Vitousek et al., 1996). In the Laurentian Great Lakes, over 180 aquatic invasive species (hereafter, AIS) have been established, making the Laurentian Great Lakes among the most heavily invaded ecosystems on the planet (Holeck et al., 2004; Riccardi, 2006). Though AIS in the Great Lakes have arrived as a result of a variety of pathways and vectors, ballast water of commercial ships is a major vector for AIS introductions (Holeck et al., 2004; Riccardi, 2006). In addition to the direct impacts on the Great Lakes, these systems are also a beachhead for secondary invasions into inland waters of North America (Vander Zanden and Olden, 2008), resulting in additional economic and ecological impacts.

The conventional wisdom among invasion biologists is that 'an ounce of prevention is worth a pound of cure': biological invasions often involve a small number of colonists, such that the cost of excluding colonists is trivial compared to dealing with the problem after populations become established and spread. In line with this, a major focus of management efforts in the Great Lakes has been the regulation of ballast water exchange (Costello et al., 2007; Ricciardi and MacIsaac, 2008). Canada and the United States enacted regulation of ballast water exchange of ocean-going vessels in the early 1990s, yet the rate of ballast-vectored invasions has not decreased in response (Holeck et al., 2004; Riccardi, 2006). This highlights the need for alternative management strategies, and a renewed effort to stem the high rates of AIS invasions into the Great Lakes region (National Research Council, 2008).

In light of the above, we consider the idea of an AIS early detection and eradication program for the Laurentian Great Lakes. There is a fundamental tension between prevention and eradication as management strategies, with prevention being proactive, and early detection and eradication being more reactive. It is possible that directing funding and effort to early detection and eradication would leave fewer resources for AIS prevention, highlighting this as a basic resource allocation issue – how should limited management resources be allocated so as to be most effective in stopping new invasions and minimizing further adverse impacts?

While we believe that efforts to prevent the entry of new AIS to the Great Lakes should continue to be the cornerstone of management efforts, we also believe that complementary management strategies such as early detection and eradication are simultaneously needed to

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doi:10.1016/j.jglr.2009.11.002

effectively address this issue (Fig. 1). Even the most effective prevention efforts are not guaranteed to eliminate new invasions, and some portion of these new invaders will have undesired ecological, economic, and human health impacts. In situations where prevention fails, an early detection program could alert managers to the establishment of a new invader, and a well-coordinated eradication program could contain or eliminate it before it spreads. In the absence of such a program, resource managers have no choice but to simply accept new invaders and the associated ecological and economic impacts. In fact, there are a number of examples of invasive species being detected early, and subsequently eradicated (Simberloff, 2002, 2003). In many cases, a costly eradication may be far preferable to incurring long-term damages and/or control costs. Based on this, we feel that a coordinated program aimed at early detection and eradication of AIS is worthy of serious consideration as part of the broader effort to minimize AIS impacts in the Great Lakes.

Aside from sea lamprey (*Petromyzon marinus*) control efforts coordinated by the Great Lakes Fishery Commission and the stocking of Pacific salmonids (*Oncorhynchus* sp.) to manage nuisance forage fish populations, there has been little interest in AIS control and eradication in the Great Lakes. The prospect of eradicating invasive species has received pessimism from many scientists and natural resource managers (Simberloff, 2002, 2003). Only recently has the issue of AIS control and eradication been formally taken up by the Great Lakes management community, with efforts going towards developing model rapid response plans (Great Lakes Commission, 2006b). As far as we know, there are no coordinated monitoring programs aimed specifically at detecting new AIS in the Great Lakes (Great Lakes Commission, 2006a), highlighting a major gap in our current ability to effectively respond to new invasions.

What would be the core features of an AIS early detection and eradication program? How might such a program allocate limited resources among species, habitats, and management actions to achieve program goals? In this paper, we highlight the key features of an early detection program for Great Lakes AIS """ aimed at assessing the effectiveness of prevention efforts, and maximizing the likelihood of early detection of new AIS. Second, we outline what a Great Lakes AIS eradication program might entail, using examples of successes and failures from other ecosystems, and develop a framework for deciding whether to attempt eradication when a new invader is detected. Finally, we consider the prospects and challenges of such an undertaking in the Great Lakes, and highlight program features that would help such a program to be successful. We hope to encourage discussion amongst scientists, managers, policy makers, and stakeholders on the role of early detection and eradication as part of a broader strategy to reduce the impacts of AIS in the Great Lakes and other inland waters of North America. Beyond this, we feel that an early detection and eradication program based on sound bioeconomic principles (Keller et al., 2009; Leung et al., 2002) would not only be worth the financial investment, but could be a valuable component of a broader program aimed at reducing further impacts of biological invasions in the Great Lakes.

Early detection and monitoring

Early detection and monitoring are key components of a broader invasive species management strategy, as noted in a recent position

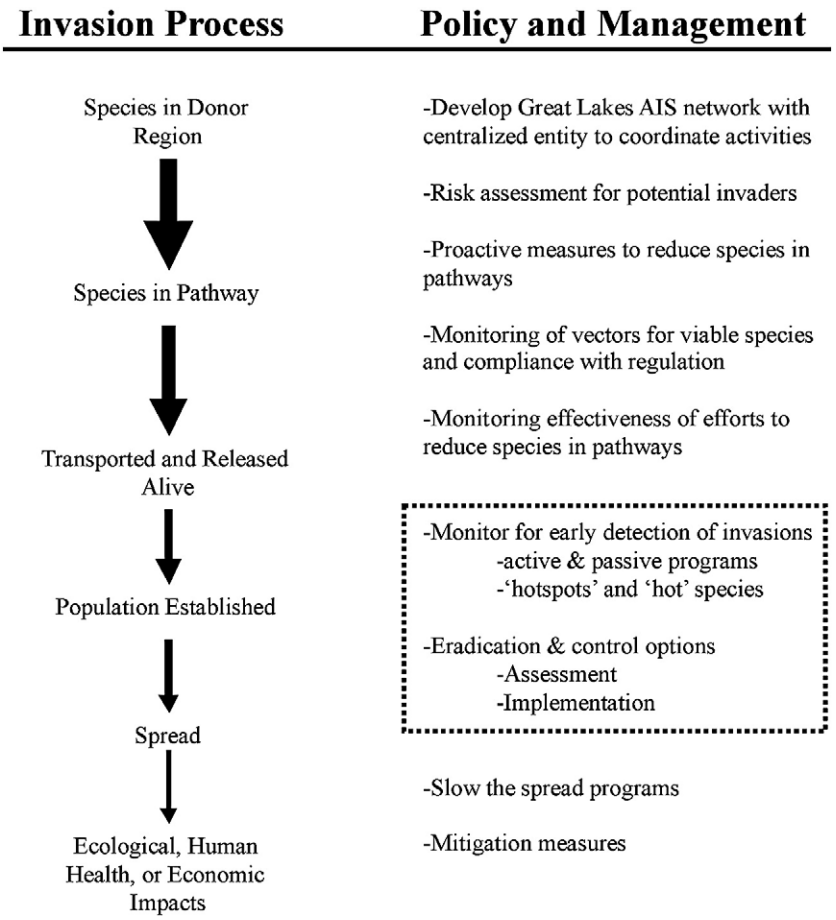

Fig. 1. Multiple stages of the biological invasion process, and the corresponding suite of policy and management actions. This paper specifically addresses the role of early detection and eradication strategies (highlighted in dotted box) for the Laurentian Great Lakes. Modified from Lodge et al. (2006).