

Invasive species in aquatic ecosystems: issue of global concern

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The introduction and establishment of invasive species are of increasing global concern. While their establishment and spread are occurring at an accelerated rate, the introductions can be characterized as either deliberate or unintentional. Unintentional introductions are on the rise due to the escape, stowaway, or contamination during the transport goods (see Nordic countries database, Hulme et al. 2007). Once species establish their spread can occur rapidly through the landscape ignoring geopolitical boundaries. Thus the need for describing the extent of invasion, mechanisms contributing to invasion, and future spread are critical.

Ecologists have recognized for some time that biological invasions affect various levels of ecological organization (Elton 1958). It is only in the last few decades that scientists have become increasingly interested in this topic (Hulme et al. 2008). For example, Lockwood et al. (2007) demonstrate a marked increase in the number of peer reviewed citations on this issue from 1975-2005. Much of this research demonstrates that biological invasions impact

ecosystem function, and biodiversity. Furthermore, synthesis studies suggest invasive species are the second major contributor of biodiversity loss and suggest the economic impacts from invasive species can be significant in both developing and developed countries. For example, damage and costs of controlling invasive species are more than \$1.4 trillion per year worldwide which represents nearly 5% of the world economy (Anonymous 2008).

The spread and impact of invasive alien species are of a transboundary (within and across country) nature. While it has long been recognized that the introduction, establishment, and spread of invasive species can be related to pathways of trade, there is increasing concern that the opening of regional and global markets will promote more invasions (Perrings et al. 2005, Hulme et al. 2008). Unfortunately, there are still large gaps in information on the current distribution and impact of invasive species. This information is critical if policy makers are going to develop programs to address future distribution and spread.

In the United States of America there has been a long recognition of the need to prevent the introduction and movement of invasive species of agricultural pests. Recently, state governments (Washington, Oregon, Wisconsin, Minnesota and others) have adopted strong federal policies to control the potential introduction of invasive species into aquatic ecosystems. In contrast the European Commission has recognized the threat of invasive species as an emerging threat (European Commission 2002) calling for transboundary action and launching a European strategy on Invasive Species (Genovesi and Shine 2004).

This special issue presents some of the latest findings on various species invading North America and Europe. One goal is to bring together approaches used by scientists to describe the extent of invasions and provide a forum for presentation. The paper contributions for this issue were originally derived from a special session at the 30th Congress of the International Association of Theoretical and Applied Limnology in Montreal, Quebec, Canada (August 2007). In this session scientists presented topics ranging from the distribution of invasive species to approaches used to forecast their spread. Additional articles (research and short communications) have been contributed after the meeting. This special issue mirrors well the ubiquity of nonnative species invasions in all kinds of freshwater and marine ecosystems by species covering many different taxonomic groups, mostly crustaceans, mussels and fish next to aquatic macrophytes. The issue therefore covers articles from different countries and regions in the world as well as short communications about several first records of nonnative species.

We hope this special issue will bring together the emerging fields of aquatic invasion ecology developing between the continents. Important future research needs in this field might be:

- 1) Conditions of successful settlement after distribution
- 2) Invasion of contaminated habitats with disturbed biocoenoses: replacement of pollution-sensitive species?
- 3) Implementation of invasive species into the European Water Framework Directive, especially, in the assessment methods by development of specific indicator concepts and modules.

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