NON-NATIVE SPECIES WORLDWIDE: THE VIEWS AND ACTIVITIES OF ICES

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Abstract
Introduction and spreading of non-native species pose a major threat to ecosystems worldwide. Mariculture and increased trade and shipping are the human activities contributing to the dramatic increase in recent years. Two ICES Working Groups were established to develop the expertise necessary to provide advice on the problem. One of the products is a Code of Conduct for shipping and ballast water.
Keywords : Biodiversity, Species Introduction, Aquaculture.

Global activities in marine aquaculture began to increase dramatically in the 1950s and 1960s. This included the search for fish, shellfish, and plant species whose biology was well known and which already had achieved or could achieve success in extensive cultivation. These species were potential candidates for movement to new locations in the world for the purpose of establishing new fisheries and new aquaculture resources. Such animals and plants that are not native to these new locations are defined as species transported intentionally or accidentally by a human-mediated vector into aquatic habitats outside their native range. In addition to the intentional or accidental introduction of non-native species from aquaculture, the release of exotic organisms via ships (ballast, hull fouling, etc.) has become a pressing issue with profound implications for fisheries resources, aquaculture, and other activities. Global trade has provided a vehicle for many opportunistic and specialist species to vastly extend their range. The shipping vector is probably one of the oldest means for the introduction of marine species. Ballast water management guidance, and for some areas required ballast water exchange, are intended to preclude transfer. However, standards and governance regulation are still lacking on a global scale. Other human-mediated vectors include recreational water activities (boating, diving, fishing), commercial activities including fishing, live seafood discards, etc. [1]. In addition, the extent of the various contributions to overall introductions is poorly documented, although the large number of species with planktonic life history stages suggests that ballast is a significant source of species.

For many years, the economic benefits of aquaculture outweighed concerns about secondary impacts. Unfortunately along with the success of aquaculture, several challenges have surfaced over the past decades relating to the global translocation of species to new regions:
- environmental and economic impacts of introduced and transferred species, especially those that may escape the confines of cultivation and become established in the receiving environment;
- genetic impact of introduced and transferred species, relative to the mixing of farmed and wild stocks as well as to the release of genetically modified organisms;
- inadvertently coincident movement of harmful organisms or pathogenic and parasitic agents associated with the target (host) species.

Molluscan aquaculture species cultured or once cultured in European countries include the soft-shelled clam *Mya arenaria* (introduced by the Vikings), the oyster *Crassostrea gigas* (and *C. angulata*), the Manila clam *Tapes philippinarum*; and the American oyster *Crassostrea virgini*a [2, 3]. These species illustrate unwanted consequences of unmanaged introductions. *Crassostrea gigas* brought with it is own parasites and a host of associated species, including an oyster drill (*Ceratostoma inornatum*) and a parasitic flatworm (*Pseudostylochus ostreophagus*). Diseases have also been associated with several of the species. The Atlantic salmon *Salmo salar* is susceptible to an infectious salmon anemia that spread throughout aquaculture farms in Norway, Atlantic Canada and the U.S. and in Scotland. Although the source of the disease was unknown, the same virus was involved in all the outbreaks.
An example of genetically modified organisms impacting local communities is the introduced smooth cordgrass *Spartina alterniflora* and the native *S. foliosa* which have formed a hybrid that is more aggressive than either species [4]. *Spartina alterniflora* is a native salt marsh grass in the north western Atlantic that was deliberately introduced to stabilize California coastal areas, but has proven to clog channels, outcompete native species, threaten species dependent on native plants, and accelerated the loss of mud flats that serve as a source of food for migrating shore birds.

Ecological impacts: Although the American oyster has not been successfully established as an aquaculture species, at least five species were associated with its introduction, including the slipper limpet *Crepidula fornicata*, a predatory snail *Urosalpinx cinera*, the false angel wing (bivalve) *Petricola poladiformis*, the polychaete *Clymenella torquata*, and the ostracod *Eusariella zostericola*. Of 23 species or taxa associated with *G. gigas* introductions, at least 5 species and 4 possible species or representatives of taxa were present after 15 years [2]. Not included in the previous survey is the alga, *U. pinnatifida* that is believed to have come into southern France and Italy with *C. gigas* and deliberately farmed in northern France where it has spread to the U.K., Belgium, Spain, Netherlands and possibly Portugal by shipping, recreational boats and/or oysters [5]. This large kelp has a wide temperature and salinity tolerance and has become the dominant species in some areas during its growing season.

The Chinese mitten crab *Eriocheir sinensis* has damaged river banks in Europe and the US, threatens native communities as it feeds on native plants and animals, causes a nuisance through mass migrations, interferes with fishing activities by ruining nets, feeding on bait and captured fish, and carries a parasite (lung fluke) that can be transmitted to humans (http://www.nhm.ac.uk/nature-online/life/other-invertebrates/chinese-mitten-crabs/assets/18feat_mitten_crab.pdf). The crab has been reported in several European countries as well as the Russian Federation, Iran, and North America (USA) (http://www.issg.org/database/species/distribution.asp?si=38). ICES has adressed these concerns early through its Working Group on Introductions and Transfers of Marine Organisms (WGITMO), and through its ICES/IOC/IMO Working Group on Ballast and other Ship Vectors (WGBOSV). In 1973, Council adopted the first version of what was to become an internationally recognized "Code of Practice" on the movement and translocation of non-native species for fisheries enhancement and mariculture purposes. The Code (updated last in 2005) takes a precautionary approach to introductions and focuses on principles designed to limit impacts and support environmentally sound introductions and transfers.

References

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