Marine Life Topic Note

ALIEN, NON-NATIVE AND INVASIVE MARINE SPECIES

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Definition - An invasive, non-native, alien or exotic species is one that has been intentionally or accidentally released into an environment outside its native geographical range of habitat (Olenin et al., 2002). In the UK, according to Eno et al. (1997) the term ‘non-native’ is used to indicate a species that has been established in UK waters, whilst ‘alien’ species are those that have been introduced via human activities but which have not become established and are incapable of establishing self-sustaining populations without deliberate intervention by ‘man’ (Eno et al., 1997). ‘Alien’ species are also referred to as ‘non-established’ species (Eno et al., 1997).

HISTORY

The problem of invasive species has existed on a global scale for millennia. However, it has only gained real attention during the last twenty years or so (McNeely, 2001). Historically natural barriers, such as rivers, oceans, mountains, deserts and climatic conditions, have provided the isolation essential to allow unique species and ecosystems to evolve, resulting in a much greater species richness across the planet (McNeely, 2001). Globalisation and growth in the trade and tourism industries have rendered these natural barriers ineffective. As a result, species have been able to travel vast distances to new habitats where they can become ‘invasive alien species’ (SSC, 2000).

IMPORTANCE

Described as ‘biological pollution’, some invasive species can have a detrimental effect on the environment into which they are introduced (Olenin et al., 2002). These effects can range from the displacement of native plants and/or animals as a result of competition for space, light and/or food, to a more direct effect where some introduced species prey on local wildlife. Following habitat destruction, ‘alien invasions’ are the second most important threat to loss of biodiversity (SSC, 2000) [see Biodiversity].

Human populations may also suffer from severe economic and possible health effects. In 1991-1994, an epidemic of cholera broke out in Latin America, resulting in 9600 deaths (Tortora et al., 1996). The origin of the outbreak was probably seafood contaminated by the ballast water of ships, picked up in Asia and emptied into harbours in Peru (Tortora et al., 1996). This demonstrates the ease with which species can be transported unwittingly from one area to another.

HOW DO WE KNOW IF A SPECIES IS NON-NATIVE?

It is the historical biogeographical framework (natural barriers) that provides the basis for defining concepts of native and ‘alien’ species (McNeely, 2001). The process of establishing whether or not a species is non-native is riddled with problems. In principle, a species is non-native if it has been introduced into an area from which it previously did not exist in historical times (i.e. 5000 years before the present time). This means that much evidence relies on historical records. Wherever people have moved they have also taken other species with
them. Such movement occurred long before taxonomic records of species even existed. A lack of historical evidence makes it difficult to assess which marine species are native and which were introduced in the past (Eno et al., 1997). For example, some species of Bryozoa occur only around ports and harbours in Britain, which may indicate that they were introduced during historical times (Eno et al., 1997). However, there is not enough evidence to classify them either as native or introduced species. Not all introduced species will become established.

In order to be deemed 'invasive', an introduced species must be ecologically and/or economically harmful (Williamson & Fitter, 1996). Once introduced to a new habitat an invasive species will act as a new key structural or key functional species; having either a strong impact on the native key structural or key functional species or completely taking their place (Boudouresque & Verlaque, 2002). At current rates of introduction, it is thought that approximately 80 new species will be introduced to the Mediterranean over the next 20 years and it is predicted that 5-10 of these will become invasive (Boudouresque & Verlaque, 2002).

**INVASIVE SPECIES**

Not all species that are introduced survive - some are unsuited to their new environment, while others can be out-competed by native populations. There are about 65 non-native established species in Britain (www.marlin.ac.uk). Examples of species that have specifically affected local ecosystems are shown in Table 1.

At an international level, there are hundreds of aquatic and non-aquatic invasive species causing major impacts around the world. The International Maritime Organization has identified 10 species which are having serious impacts (IMO, 2004) while the Invasive Species Specialist Group (ISSG), part of the World Conservation Union (IUCN), has listed the world's top 100 worst invasive species (ISSG, 2004). 'Biosecurity', aimed at preventing the introduction of non-native species, is increasingly becoming a major activity in some parts of the world.

**Means of invasion and prevention**

Non-native species find their way into our coastal waters by a variety of means, e.g. floating debris, aquaculture activities, aquatic imports and careless disposal of aquarium species (GlobalLast, 2002). However, the most significant mode is through shipping by attachment to hulls and in ballast water. Ballast water imports have been identified as one of the four greatest threats to the world’s oceans (GlobalLast, 2002) (see Figure 1.).

"Shipping moves over 80% of the World’s commodities and transfers approximately three to five billion tonnes of ballast water internationally each year" (GlobalLast, 2002). Coupled with the planktonic life stages of many organisms, transfer via ballast water of ships poses a real and immediate threat.

Steps to minimize the introduction of non-native species include the following:

- Controlling which species to import/export, especially for mariculture.
- Sterilizing ship's ballast water.
- Changing ship’s water ballast by controlled and appropriate means.
- Proper disposal of aquarium species.
- Limiting sport fish release.
- Using native species in restoration and mitigation programmes.
### Table 1. Examples of established non-native species in Britain.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>COUNTRY OF ORIGIN (METHOD OF INTRODUCTION)</th>
<th>IMPACTS</th>
<th>MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>American oyster drill</td>
<td>East coast of the USA (unintentional with American oysters)</td>
<td>Preys on native oysters and devastates commercial oyster beds through predation. However, susceptibility to TBT (Tri-butyl tin) has depleted populations.</td>
<td>No specific management technique exists, although in some areas ‘tile traps’ have been used during the summer months. Removal of the whelk from the Essex oyster beds was driven with financial reward.</td>
</tr>
<tr>
<td>Slipper limpet</td>
<td>America (unintentional with American oysters)</td>
<td>Competes with other filter feeding invertebrates for food and space. Considered a pest on commercial oyster beds.</td>
<td>Dipping infested culch and oysters in saturated solutions of brine for a short period is the cheapest, safest and most effective method of control.</td>
</tr>
<tr>
<td>Chinese mitten crab</td>
<td>South-east Asia (introduced by adult crabs clinging to ships’ hull or via transport of small crabs and larvae in ballast water)</td>
<td>Increased erosion caused when crabs burrow through soft sediment banks during breeding season. Preys on native invertebrate and fish species possibly leading to local population extinctions. Considered a pest by commercial eel fisheries due to damaged nets and degraded river beds.</td>
<td>Those caught in fishing nets are killed immediately. Possible to use biological controls by maintaining fish populations to increase predation.</td>
</tr>
<tr>
<td>Wire weed/Jap weed</td>
<td>Pacific (associated with unintentional introductions with commercial introductions of oysters from Canada or Japan to France)</td>
<td>Out-compete native species due to its rapid growth. Interferes with navigation especially when floating in large masses (can block propellers). Can be a fouling organism on oyster beds and fouls the nets of commercial fisheries.</td>
<td>No effective method for its permanent removal has been found. Cutting and suction is preferred method. Chemical methods and trawling have both been used but with little success.</td>
</tr>
<tr>
<td>Codium fragile subspecies atlanticum</td>
<td>Pacific around Japan (introduced unintentionally to Ireland via shellfish)</td>
<td>Displaces the native species Codium tomentosum.</td>
<td>None in place.</td>
</tr>
<tr>
<td>Codium fragile subspecies tomentosoides</td>
<td>Pacific around Japan (introduced unintentionally with oysters or as spores in ballast tanks and attached to ships’ hulls)</td>
<td>Displaces the native species Codium tomentosum, however some recent signs suggest that this native species is making a come back.</td>
<td>None in place</td>
</tr>
<tr>
<td>Cord grass (Spartina anglica)*</td>
<td>Originally introduced from east coast of North America. Planted throughout Britain to stabilize soft sediment.</td>
<td>Exclusion of native fauna and loss of habitat for feeding and roosting of large wintering populations of waders and waterfowl. Altered the course of succession, leading to monoculture which has less intrinsic value to wildlife than the naturally species diverse marsh.</td>
<td>Chemical methods used, along with attempts to dig up seedlings.</td>
</tr>
</tbody>
</table>

*Spartina anglica* is actually the result of the cross breeding between the introduced smooth cord-grass (*Spartina alterniflora*) and our native small cord-grass (*Spartina maritima*) (Clark et al., 1997).

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CONTROL MEASURES

An Invasive Species Specialist Group (ISSG) exists as part of the Species Survival Commission (SSC) of the World Conservation Union (IUCN) (ISSG, 2001). The ISSG consists of 146 scientists and policy experts on invasive species for 41 different countries (ISSG, 2001). The group provides advice on threats from invasive species, control and eradication methods to a host of organizations, with the main focus on invasive species that cause biodiversity loss. A little closer to home, legislation has been introduced by the Council of Europe, under the Convention on the Conservation of European Wildlife and Natural Habitats. The convention states that each country that has signed the convention must strictly control the introduction of non-native species (Council of Europe, 1999). This includes preventing the introduction of, and controlling or eradicating those alien species that threaten ecosystems, habitats or native species (Council of Europe, 1999). Prevention is better than cure, and initiatives are underway. The IMO, for example, has conducted technical co-operation projects to minimize the carriage of non-native species in the ballast water of ships (IMO, 2000-2002).

In Britain a variety of control methods have been used (physical, chemical and biological) on ‘nuisance’ species such as japweed/wire weed (Sargassum muticum) (Figure 2) and the slipper limpet (Crepidula fornicata) (Figure 3). However, no non-native marine species has ever been eradicated from British waters using a directed approach (Eno et al., 1997).

In March 2001, DEFRA set up a Review Group to review policy and legislation on non-native species throughout Great Britain. The report (DEFRA, 2003) made a number of recommendations including:

- Designation or creation of a single lead coordinating organization to undertake the role of coordinating and ensuring consistency of application of non-native species policies across Government.

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Figure 2. *Sargassum muticum* as first discovered at Bembridge, Isle of Wight. Photographer: Dr Gerald Boalch. Image width ca 2.5 m.

Figure 3. Stack of individual *Crepidula fornicata*, Poole Harbour. Photographer: Steve Trewhella. Image width ca 6 cm

- Development of a comprehensive, accepted risk assessment procedure to assess the risks posed by non-native species and identifying and prioritising prevention action.
- Develop codes of conduct to help prevent introductions for all relevant sectors.
- Develop a targeted education and awareness strategy involving all relevant sectors.
- Revise and update existing legislation to improve handling of invasive non-native species issues.
- Establish adequate monitoring and surveillance arrangements for non-native species in Great Britain.
- Policies to be established with respect to management and control of invasive non-native species currently present or newly-arrived in the wild, and operational capacity be developed to implement these policies.
- Full stakeholder consultation and engagement in development of invasive non-native species policies and actions through a mechanism such as a consultative forum.

MARINE ALIENS PROJECT

MarLIN is currently working as part of a new consortium of research institutes, university departments and statutory agencies. Funded by the Esmee Fairbain Foundation, the Aliens Consortium will provide information on invasive species biology and distribution, rates and methods of dispersal and impacts on biodiversity, so that species and habitats listed under the UK Biodiversity Action Plan can be protected. The information will be publicised and made accessible on the Internet in order to aid decision-makers and promote conservation of marine and freshwater biodiversity (http://www.marlin.ac.uk/marine_aliens/).

CONCLUSION

The environment in which species exist is dynamic, continuously changing and hence, under natural circumstances, species expand and contract their ranges as a result of factors such as climate change (McNeely, 2001). The effect that non-native species have on local populations can also depend upon the health and environmental conditions that native species are subject to. For example, oysters are susceptible to very cold winters and in the past have suffered great losses (1928-29, 1930-40 and 1946-47) (Elton, 1958). The effect that the American oyster drill has had on UK oyster populations was worsened in the past due to extremely cold winters (Elton, 1958).

Although in other parts of the world the introduction of non-native species appears to be increasing with time, it would appear that there is no trend in the number of non-natives that have become established in Britain (Eno et al., 1997). This may be in part because we are unaware of their presence. Many volunteer recording projects are in operation throughout Britain and Ireland, which are invaluable to scientists studying changes in marine ecosystems. Biologists are still trying to characterize the capability of non-native species to invade, with hope of predicting and stopping such invasions (ISSG, 2002). It may not be long before an organism is inadvertently allowed to become established with disastrous consequences to our native plants and animals.

REFERENCES


Visit the ‘Learning Zone’ at http://www.marlin.ac.uk/learningzone


LINKS

Global Invasive Species Programme (GISP) jasper.stanford.edu/gisp/home.htm
International Maritime Organization www.imo.org/home.asp
Global Ballast Management Programme globallast.imo.org/index.asp
The World Conservation Union www.iucn.org
Council of Europe http://www.coe.int/DefaultEN.asp
Joint Nature Conservation Committee www.jncc.gov.uk/marine
Environment Agency www.environment-agency.gov.uk
The Centre for the Environment, Fisheries and Aquaculture www.cefas.co.uk

Visit the ‘Learning Zone’ at http://www.marlin.ac.uk/learningzone
Centre for Marine Conservation  cmc-ocean.org
Department for Environment, Food & Rural Affairs  www.defra.gov.uk/environment/index.htm
Environmental Action Fund (Defra)  http://www.defra.gov.uk/environment/eaf/
Ernest Cook Trust  www.ernestcooktrust.org.uk

CITATION

Funded by the Environmental Action Fund of Defra