Alien species in the Wadden Sea – A challenge to act

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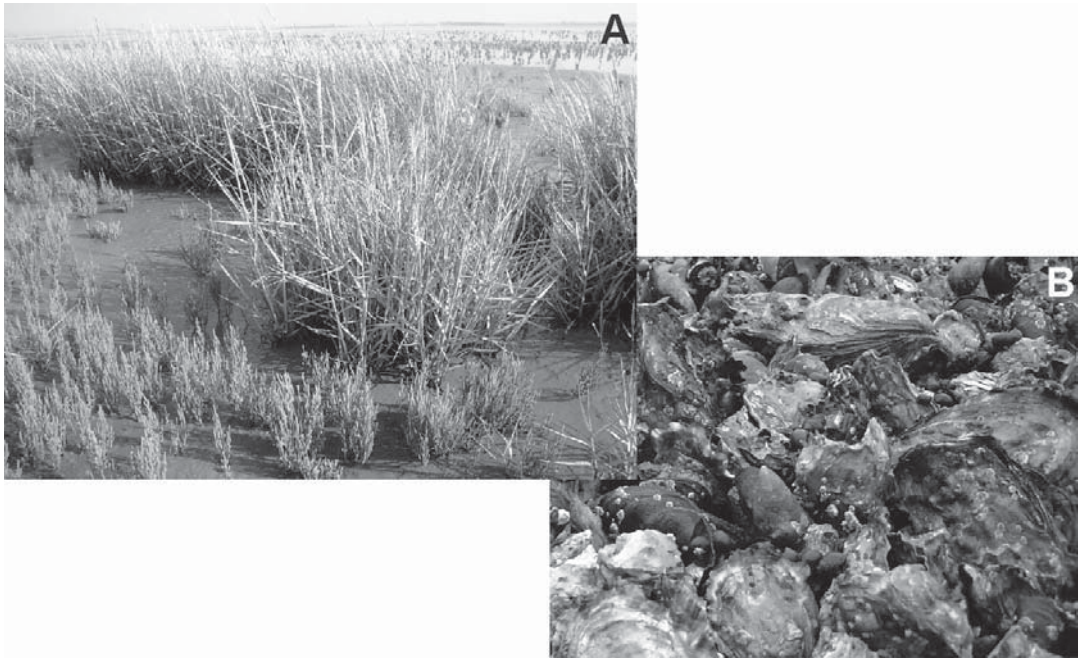

Figure 1:
Invasive alien species in the Wadden Sea.
A: The cord-grass Spartina anglica (at the back), introduced in the 1920s to promote sediment accretion, displaces a.o. the native glass-word Salicornia stricta (in the foreground).
B: The Pacific oyster Crassostrea gigas, imported for commercial production first in 1964, reproduced successfully during the last two decades and uses the native blue mussel Mytilus edulis as habitat and eventually kills individuals by overgrowth.

For centuries, alien species have been introduced to new areas in which they were previously absent and which they have reached through human agency. Because of the increase in global trade, the introduction of alien species, both intentional and unintentional, has increased significantly and has become more complex. The impacts of alien species are often immense, insidious, and usually irreversible, and can have enormous economic and human health consequences. Viewed on a global basis, alien species are one of the key threats to native species and ecosystems and other aspects of biodiversity.

Ship hull fouling, ballast water and aquaculture are the main pathways that have been identified as significant for transporting aquatic alien species into new marine and estuarine systems all over the world. Even in the Wadden Sea area, in fact an ecosystem highly protected by law and actually nominated as World Heritage Site, a diverse range of alien species have established permanent populations.

The worldwide implications of alien species have been identified by non-governmental and governmental organizations alike as well as being emphasized in numerous international conventions and other instruments. Up to now, all of these measures lack extensive efficiency and the rate of alien introductions has clearly increased, especially in coastal waters during the last two decades, with no end in sight. Thus, alien species are still a challenge to act. Therefore, an unlimited observance of existing management initiatives and instruments as well as the implementation of new and purposeful ones are absolutely necessary.

Status of alien species

The number of alien taxa assumed to have been established in the North Sea amounts to about 80 species of which about 52 also occur within the Wadden Sea. A variety of taxonomic groups such as protozoans, macroalgae, crustaceans, molluscs, polychaetes and parasites have contributed to major invasions in recent years. Most invertebrate invaders originate from the Atlantic coast of America and were predominantly introduced by shipping (hull fouling, ballast water), while most algae species are native to the Pacific and were introduced with imports of seed oysters. In contrast to European freshwater systems, in which a mulitude of vertebrate alien species live, particularly fish, no such species occur in the North Sea in self-sustaining populations up to now.

The share of aliens in the North Sea biota increases from the offshore part towards the coast. So the percentage of alien species compared to the respective total species numbers amounts to <<1% in the central North Sea, roughly 1% in the

coastal offshore area, about 6% in the Wadden Sea and up to 20% in the brackish water zones of the estuaries. It seems that low species richness in aquatic communities is a considerable factor for bioinvasions. The frequency and intensity (or size) of inoculation are critical components in colonization success, however. Intense intercontinental shipping and the existence of aquaculture plots, particularly oyster farms, create the highest infection rate for coastal areas in northern Europe. In the Wadden Sea, the biotic communities of mixed native and alien organisms behave in many respects like co-evolved assemblages. Empty niches, however, seem to be an essential basis for this.

While many of the alien species seem to remain insignificant additions to the native flora and fauna, the international focus is on the few invasive species which threaten ecosystems, habitats or species. For the Wadden Sea six benthic species are recognized which have already altered the habitat or have sustain lasting effects on native biota (Reise *et al.* 2005). These targeted species are the cord-grass Spartina anglica, the brown algae Sargassum muticum, the polychaete Marenzelleria cf. wireni as well as the three molluscs Crepidula fornicata, Ensis americanus and Crassostrea gigas (Figure 1). Their occurrence has irreversibly modified the Wadden Sea ecosystem (for review see Reise *et al.* 2005) and there is no indication that these alien species will ever leave the Wadden Sea again.

It is highly probable that in the near future new alien species will arrive in our coastal waters. The current 'tens rule' of thumb of biological invasions in terrestrial habitats will be applicable to European aquatic systems, too: out of 100 established alien species, 10 percent will become invasive. However, this statistical approach says nothing about the next species and its impacts on biodiversity, ecosystem functioning, human health and economy. Every alien species has the potential of unwanted and uncontrollable consequences and their introduction as well as their spreading should be minimized wherever possible.

Regulations

Many conventions, codes of conduct and other instruments reference the subset of alien species, including genetically modified organisms. These range from legally binding treaties to non-binding technical guidance focused on particular pathways to prevent the introduction of alien species. Most instruments are specific to a sector, taxonomic group, type of environment or type of harm (for a review see SCBD 2001).

At global level the only instrument that covers all aspects of invasive alien species as they relate to biodiversity is the Convention on Biological Diversity (CBD), which was adopted in 1992 and entered into force in 1993. Its aims are the conservation of biological diversity, the sustainable usage of biological resources, and the fair and equitable sharing of benefits arising from the use of genetic resources. Article 8h of the CBD requires all Contracting Parties "as far as possible and as appropriate, to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species". This statement was specified by the decision VI/23 "Guiding Principles on Invasive Alien Species" by the 6th Conference of the parties to the CBD in 2002. Its adoption suggests comprehensive national strategies on the basis of a hierarchical approach (prevention, early detection, measures). The CBD became law in Germany in 2002 through the revised Federal Nature Conservation Act (BNatSchG), which includes a permission requirement for the release of alien species (§ 41.2). The permission is to be denied if a risk to the existing flora and fauna cannot be excluded.

In marine environments and inland water systems, alien species can be hard to detect and organisms disperse rapidly. Therefore several international instruments are being prepared for preventive measures against unwanted introductions to aquatic ecosystems. One important example is the guideline of the International Maritime Organization on minimizing current risks and side effects to the environment and human health arising from the transfer of species in ships' ballast water and sediments, which was actually adopted as a convention by IMO member States in 2004. This convention will enter into force 12 months after ratification by 30 States, representing 35 per cent of world merchant shipping tonnage.

The EU Water Framework Directive (WFD), aiming to restore good ecological quality in all inland, transitional and coastal water bodies (e.g., estuaries, Wadden Sea), could be a potentially powerful legislative measure for all kinds of environmental pressures and impacts. However, in the course of meeting discussions about environmental quality standards, it was decided by administrative experts that alien species will not be taken into account as a specific quality criterion, because aliens are not directly involved in the degradation of water quality. During recent months first comments on this decision were announced by scientists to reassess the status of alien species within the WFD. The final summary - to which everyone can still contribute – is expectantly awaited..

Nature conservation and measures

The Guiding Principle of the trilateral Wadden Sea policy is to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way. Invasive alien species in particular pose a serious threat to such nature conservation interests. Up to now the introduction, establishment and spreading of alien species in the Wadden Sea has been perceived only on a descriptive level in some ways, a purposeful strategy in dealing with the phenomenon in regard to the protection and conservation of the Wadden Sea is lacking.

The immense scope of the field of prevention and management of alien species makes it impossible to include all aspects in depth here. Hence, the objective of the paper is to awake interest and to designate potential handling options for nature conservation management in relation to aquatic alien species.

Depending on the species, efforts should target one of the four categories: (a) acceptance of established non-invasive species; (b) prevention of introductions through education and regulations; (c) monitoring of occurrence, impacts and spread by monitoring programs; and (d) minimization of impacts by eradication or control (Figure 2).

a. Acceptance

Many alien species which have already been introduced and established are innocuous and have no relevant ecological or economic effects. These species should be accepted as new components of our native flora and fauna.

b. Prevention

Since it is well known that eradication of an introduced species, once it has become established in the marine environment, will be very expensive, or even impossible, the prevention of introductions is the first and most cost-effective option. During the last decade, first binding and non-binding instruments were adopted for preventive measures against un-intentional as well as for controlled intentional introductions to aquatic ecosystems (see above). However, there are gaps, overlaps and inconsistencies in these instruments and all of them have lacked efficiency up to now. Thus, once invasive species become established within one country, they pose a threat to an entire region through natural dispersal. Further on, climate warming favours the establishment of more cosmopolitan species across wider geographic areas. For these reasons, from the perspective of abating the risks of alien species, more effective actions and instruments with an international focus are warranted.

An important additional field in prevention, which should not be underestimated, is the education of politicians, authorities and business people, scientists as well as citizens about alien species, their risks and the possibilities to prevent further introductions. In addition to specific presentations and discussions in the press and scientific literature, on the radio and TV, web-based information platforms offer a great chance to enhance persistently the awareness of the alien problem on a national (e.g. Handbook of Invasive Alien Plant Species in Germany, www.neophyten.de) and international level (e.g. Nordic-Baltic Network on Invasive Species NOBANIS www.sns.dk/nobanis/).

c. Monitoring

The development of effective monitoring programs is necessary to aid the early detection and determination of the status of newly introduced alien species. This is essential for taking rapid measures of eradication and control especially in the case of newly observed invasive species, because these species can spread quickly and cause unwanted negative effects. However, aquatic environments are much more difficult to monitor than terrestric habitats and measures should be well thought-out and developed.

Additionally monitoring is an important basis for the assessment of impacts and the invasiveness of alien species as well as for the efficiency of eradication and control measures.

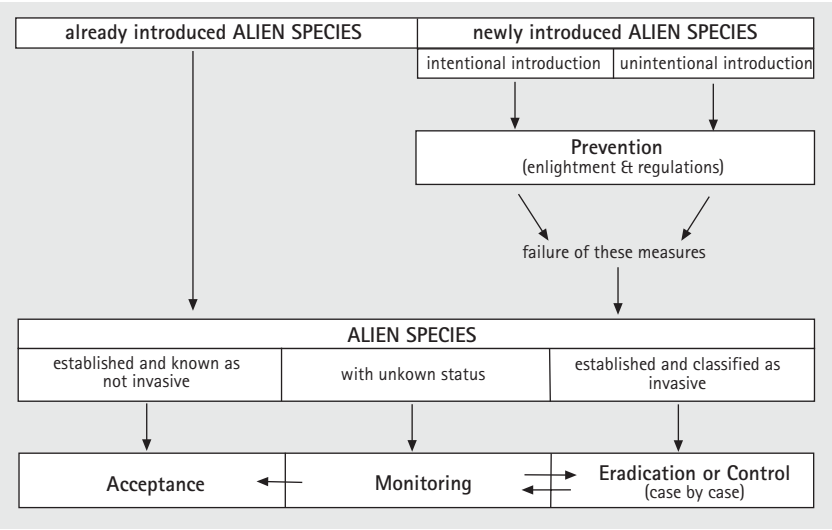

Figure 2:
Handling options for nature conservation management in relation to former and future introductions of alien species (modified after Klingenstein 2004; further explanation see text).

d. Eradication or Control

Where an alien species has become invasive, eradication is an effective action to prevent its spread and to minimize impacts. The best chance for a successful eradication of most unwanted species is during the early phase of invasion, while the target populations are small and/or limited to a small area.

However, in aquatic environments we are often faced with the impact at a very late stage when the species might have been there for several generations and has already spread their offspring to other areas. Thus, in most cases it is impossible to find an efficient method to eradicate aquatic alien species once they have become established.

Once the establishment of an alien species is accepted as irreversible, unwanted species can be controlled by reducing density and abundance to keep their impact to an acceptable level. It worthy of note that probably such measures make sense only for specific species, for which definite criteria exist (e.g. occurrence restricted only to terrestric or intertidal areas). Control methods should be selected taking into consideration efficiency, selectivity and the undesired effects they may cause. This should proceed in accordance with Community regulations and codes.

In principle, every measure should be based on an individual case decision. In order to evaluate the success or failure of a management program, it will be necessary to monitor changes and impacts and evaluate to what extent the targets set at the beginning of the efforts have been met. This will provide an opportunity to change and adapt the program to new perceptions and situations.

Conclusions

Even against the background that continuous climate change will probably influence the biocoenosis of North European coastal waters much more strongly (Nehring 1999), alien invasions in aquatic systems are irreversible and should be avoided wherever possible. These species pose a serious impact to native biodiversity because they have the potential to alter the natural state of an ecosystem into which they were introduced and may enhance the trend of global unification of flora and fauna. Such changes may consequently affect nature conservation interests.

In the highly protected Wadden Sea a multitude of alien species have established permanent populations, at least six of them are of invasive nature. Up to now no management plan exists in which way the preservation or restoration of the Wadden Sea ecosystem in relation to alien species could be guaranteed. Even in the common package of TMAP parameters alien species have not yet been integrated as a specific investigation criterion. At present, most analyses that evaluate patterns of aquatic invasion or test specific hypotheses derive data from existing literature, which is extremely uneven in space and time. Thus, the development of an alien species plan on the level of the Trilateral Cooperation on the Protection of the Wadden Sea is absolutely essential. In this context, for the most recently established invasive species, the Pacific oyster Crassostrea gigas, a coordinated environmental program to document the spreading and impacts should be designed and implemented in the trilateral conservation area of the Wadden Sea. Additionally, the new German "zero-use area" Hörnumtief should de accorded the status of a priority area for alien species research. As a matter of fact a mini Ecosystem Research Program for this area is in preparation and it should be examined as to how far R&D studies on the occurrence and effects of alien species on the native biocoenoses in detail can be integrated here.

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