

Environmental Studies FACT SHEET



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Exotic Species

Exotic species can be introduced into new aquatic habitats throughout the world when ocean-going ships discharge their ballast water. If environmental conditions are favourable, these alien species will thrive, with serious ecological, economic and health consequences. This Factsheet explores the nature and scale of the threat, as well as the solutions being devised.

Definitions :

Exotic/alien species

a species which is not native to a country i.e. one that has been introduced from abroad, e.g. grey squirrel from North America or pheasant from Asia.

Native/endemic species

a species which has evolved in response to ambient abiotic and biotic conditions and co-exists harmoniously within the local food web e.g. hedgehog or water vole.

Other scientists define native species as those which re-colonised the B. I. after the retreat of the last (Quaternary) ice age.

Exotic species are often regarded as invaders, possessing aggressive characteristics, out-competing native species for food, and/or habitats, or preying on them, or introducing viruses, with consequent impacts on food webs.

Sea trade and marine exotics

More than 120 aquatic species have been introduced into marine and estuarine ecosystems and inland seas, mostly as a result of canal building and, more recently ships' ballast water. Since the building of the Suez Canal, more than 30 Red Sea fish species have been identified in the eastern Mediterranean. Following the opening of the St. Lawrence Seaway (to connect the Great Lakes with the Atlantic Ocean) populations of native Great Lakes fish, including lake charr, lake trout and lake herring have been seriously depleted by competition for food from the invading alewife, and predation by sea lamprey. Since these greatly-reduced species are of commercial importance, the Great Lakes Fishery Commission spends US\$1 million annually to control sea lamprey with chemical pesticides.

Ships' ballast

Ships need ballast when they are not carrying sufficient cargo to maintain stability and structural integrity. Rock was used during the days of sailing ships, but since the late nineteenth century, when steel began to be used for ship's hulls, water has been the preferred ballast. Today shipping moves over 80% of the world's commodities and 10 billion tonnes of ballast water are estimated to travel around the world per year.

Natural barriers like land masses and temperature differences (e.g. cold ocean currents) prevented species colonising new areas. Once discharged into new environments, alien species thrive if there are no natural predators or pests and environmental conditions are favourable.

The four greatest threats to the marine environment :

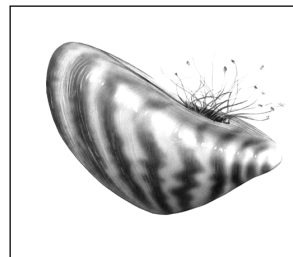
- land-based marine pollution
- over-exploitation of marine resources
- physical destruction/alteration of marine habitats
- invasion of alien species

The difference from the first three is that invasion by marine species is usually irreversible.

Effects of exotic invasions

1. Displacement of native species.
2. Disruption of food webs.
3. Introduction of diseases/viruses.
4. Damage to economic activities like fisheries and tourism.

Case study 1 – Zebra mussel



*Within two years of its first appearance in the Great Lakes in 1988, the European zebra mussel (*Dreissena polymorpha*), a small, striped shellfish from the Black and Caspian Seas, had reached densities of 70,000 individuals per metre squared in parts of Lake Erie, displacing native mussels in the process. It has now infested more than 40% of US rivers, as well as clogging the cooling water intakes of power stations and industrial plants. Since 1989, US\$1 billion has been spent on control measures.*

Case study 2 - Chinese mitten crab



*The Chinese mitten crab (*Eriocheir sinensis*) was first discovered in the R. Thames in 1935. There being no native freshwater crabs in the UK, without competition or predators, this aggressive species has bred very successfully and infested the river from Woolwich to Windsor. Species such as swan mussel and crayfish have been displaced and its deep burrowing undermines muddy river banks.*

*As this crab can cross dry land to colonise new river systems its invasion is further threatening populations of our native crayfish (*Austropotamobius pallipes*), already in rapid retreat to remote upland streams in the face of the larger white-clawed or Canadian crayfish – an escapee from commercial hatcheries.*

In Europe the mitten crab has spread from Finland to Portugal and, so far, all attempts to control its numbers have failed.

The global response

In 1992, the UN Convention on Biological Diversity, in Rio de Janeiro, called upon the International Maritime Organisation (IMO) to address the issue of exotic invasions.

IMO has since :

- developed voluntary guidelines to control ships' ballast waters
- maintains a Global Ballast Water Management Programme web site
- introduced a ballast water and sediments management plan in 2004

In the UK the Maritime and Coastguard Agency is funding research into the problem.

Solutions to limit species transfer

1. Re-ballast out at sea, far from biologically rich coastal waters
2. Filter ballast water
3. Sterilise it using ozone, uv light, electricity, heat or biocides to kill organisms
4. Conduct biological surveys around ballasting areas

Questions/activities

1. Why can some species be destroyed e.g. coypu, whilst others e.g. mink cannot? (5 marks).
2. Little owl (*Athene noctua*) was introduced from North America in the nineteenth century with no discernible impact on native species. What can be concluded from this? (3 marks).
3. The ring-necked parakeet, now breeding in established wild colonies in the south of England has been placed on the R.S.P.B's list. Is it still an exotic? (3 marks).
4. As global climate change progresses new species will colonise the B.I. Are these to be classified as native or exotic species? (3 marks).
5. Research then construct a food web for a typical British lowland river. Insert the mitten crab into the appropriate trophic level(s) in the diagram. What niche does it occupy? Which organisms will it impact upon and how? Identify negative and positive feedback responses. What is the likely overall effect of the mitten crab on the food web? What might be done to control its numbers?
6. ESC6 coursework : Investigate the impact of an exotic species on a local environment e.g. marsh frog invasion of a local wetland nature reserve.
7. Research one of the UK exotics listed above.

Conclusion

The IMO estimates that 7,000+ different species are being transported around the world in ships' ballast water. Survival rates are low due to the ballasting process, the hostile environment inside the tanks and, on arrival, competition from indigenous species, predation and different abiotic conditions. But where they thrive and impact upon native ecosystems and food webs their life-cycles must be studied so that they can be destroyed.

Links to the specification. AS Module 3 : 12.3 = food chains and webs, diversity and ecological stability; 12.4 = population dynamics; 12.5 = conservation. Also AS Module 1 : 10.2 global climate change.

Some UK exotics : mink, coypu (extirpated by 1992), rabbit, pheasant, grey squirrel, little owl, red-legged or French partridge, white-clawed or Canadian crayfish, Chinese water deer and ring-necked parakeet.

Answers

1. Coypu inhabits a specific habitat; was restricted to the Fens and Norfolk Broads; is a larger mammal; therefore easier to catch; than the smaller, more widely distributed mink; coypu damage to crops and dykes necessitated extirpation; extirpation assisted by population crashes in severe winters.
2. B.I environment similar to ones it occupied in N. America; not competing with native species for food/nest sites; filled a vacant niche; hasn't introduced any diseases/viruses which native species susceptible to; impact upon native species not yet detected.
3. Yes; because although it has adapted to B.I. environment and now breeds in established colonies in s-e England; it was introduced by Man – escaped from aviaries.
4. Native; because colonised without human help; in response to changing ambient environment; in the case of golden oriole (*Oriolus oriolus*) in response to climate change.

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