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Marine Aquaculture Code of Practice

Draft

Background

1. Invasive non-native plant and animal species are the second greatest threat to biodiversity worldwide after habitat destruction. They can negatively impact on native species, can transform habitats and threaten whole ecosystems causing serious problems to the environment and the economy.

2. The Invasive Species Ireland project which began in May 2006 aims to reduce the impact and threats from invasive species on the island of Ireland. This is a joint initiative between National Parks and Wildlife Services and the Northern Ireland Environment Agency. Preventing the spread and new introductions of invasive species is an issue of shared responsibility and requires the involvement of all relevant government agencies, academia, private and voluntary sectors.

3. Many non-native species do not become invasive but provide considerable benefits to society and industries such as horticulture, agriculture, forestry and aquaculture. Therefore, management of the problem requires engagement and consultation with commercial interests. The development of this code of practice is aimed at reducing the risk from, and impacts of, invasive species and protecting native biodiversity. It is not seeking to stop the use of non-native species or impede the development of the aquaculture sector on the island of Ireland.

The need for a Code of Practice

4. The UK and Irish Governments are contracting parties to a number of international conventions and agreements which require them to take account of invasive introduced species. The Convention on Biological Diversity (CBD) aims to prevent introductions, control invasive species and develop legislation. Other legislative drivers are European Directives (Birds Directive, Habitats Directive, Water Framework Directive and Plant Health Directive) and national legislation (Wildlife (Amendment) Act 2000 and the Wildlife (Northern Ireland) Order 1985). Both countries are also committed to the EU target of halting the loss of biodiversity by 2010.

5. This Code also takes into account the requirements of Council Regulation (EC) No 708/2007 concerning the use of alien and locally absent species in aquaculture. This regulation establishes a framework governing aquaculture practices in relation to alien and locally absent species to assess and minimise the possible impact of these and any associated non-target species on aquatic habitats and in this manner contribute to the sustainable development of the sector.

6. Analysis of the pathways by which species are arriving in Ireland and spreading has identified key sectors whose activities can contribute to the spread of invasive species. These sectors are also part of the solution and the aquaculture sector can play an important role in invasive species management.

7. The risk assessment element of the Invasive Species Ireland project identified a number of species that are high risk invasive species to the island of Ireland. A number of these organisms are associated with aquaculture installations and stock species, fouling of coastal and ocean going vessels, capable surviving in bilge water or foul ropes and chains used as mooring lines. Some of these mechanisms are quite obvious to the casual observer whereas others can go unseen and unnoticed until an impact is observed in a new area. The Invasive Species Ireland project is aiming to reduce the threat from these species through different mechanisms including recommending legislative provisions, development of the Code of Practice for the aquaculture sector and targeted education and awareness initiatives (see www.invasivespeciesireland.com for more details).

8. The code of practice has been developed in response to the need for measures to address the risk of spreading invasive species by the aquaculture sector. Species of concern include *Didemnum* species* (a species of invasive tunicate), wireweed* (*Sargassum muticum*), clubbed tunicate* (*Styela clava*), the vase tunicate# (*Ciona intestinalis*), wakame# (*Undaria pinnatifida*), slipper limpet# (*Crepidula fornicata*), and the Asian rapa whelk# (*Rapana venosa*). Adherence to the guidelines in this code of practice will reduce their opportunity of spread.

* Species known to occur in Ireland
# Species currently not known to be present in Irish coastal waters

How can a Code of Practice reduce risk?

9. The ability of species to contaminate aquaculture equipment and stock species, foul the hull of boats and stow away in bilge water has and can continue to deliver non native species to new areas where they can impact on the biodiversity and economy of the region. Therefore, the marine aquaculture sector has a vital role to play in preventing movement of species through preventing the contamination of transported equipment and product, reducing fouling of vessels and equipment by use of an appropriate antifouling method (e.g. antifouling paint), removing fouling in a responsible manner where it cannot return to the marine environment, draining all water from the vessel/craft before transferring to another water body, preventing fouling of ropes and chains by drying them on a regular basis and not disposing of live material in the ocean. The impact invasive species exert on native species, endangered species and on the conservation goals of designated areas are costly to control and mitigate against. Good practice therefore has the potential to deliver significant benefits in terms of preventing introduction and spread of non-native species, where these are likely to cause problems.

10. The Invasive Species Ireland project is striving to increase awareness of the issues associated with the aquaculture sector and invites discussions with industry and relevant interest groups with a view to developing a code of practice, aimed at encouraging best practice and avoiding unwanted introductions.

11. The code of practice is a voluntary code promoting types of behaviour but compliance with the code of practice will prevent the introduction and spread of invasive species and ensure compliance with legislation as identified in paragraphs 4 and 5. A positive outcome of the development of this code will be increased awareness of the potential impacts from invasive marine species that will hopefully lead to the sector voluntarily adopting the practices outlined in the code to limit the introduction and spread of high impact species now and in the future. Increased awareness will also contribute to surveillance for potential invaders and better information on the distribution of species already established in Ireland.

Scope of the Code of Practice

12. The code of practice applies to all marine aquaculture owners/operators (e.g. fin fish farmers, shellfish growers and seaweed aquaculture). The code provides advice and guidance on the appropriate methodologies to prevent the spread of invasive alien species in the aquatic environment. The code will also take into account the use of boats and equipment by the sector and recommend guidelines to tackle this vector.

Key messages

13. **Promotion of native species and biodiversity.** Ireland's biodiversity has been put under pressure in recent years due to threats such as increased construction and development, intensive farming, inappropriate habitat management and the introduction of non-native species. Promoting native species will contribute to the efforts to halt the loss of biodiversity by 2010. Further information on biodiversity in Ireland can be found on the Notice Nature (www.noticenature.ie) and the It's in our Nature websites (www.biodiversityni.com).

14. **Ensure compliance with the ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2005.** The ICES code aims to reduce the ecological, environmental, economic and genetic impacts associated with the transfer of species utilised in aquaculture activities. While Government is responsible for some of the actions in this code others lie solely with the aquaculture sector for implementation. Familiarise yourself with this code and its requirements for new species introductions and species already utilised in aquaculture. See Annex 4 to access the ICES code of practice.

15. **Inspect – remove – dispose – Report.** Removing build up of plant and animal material from equipment or the hull of boats is effective at preventing further colonisation by invasive species. Prevent the spread of invasive species when moving equipment and culture material to a new area by always following these guidelines:

a. Clean all parts of equipment, boats and trailer that come into contact with the water.
b. Remove any visible plant, fish, animal material and mud.
c. Use damp cloths and vacuum sanders to keep paint, debris, and cleaners out of the water.
d. Do not allow rinse water to return to the marine environment. Many organisms can remain viable even in small (sometimes microscopic) quantities.
e. Do not move fouled vessels or equipment from one area to another.
f. Keep good records or when equipment and boats are due to have antifouling renewed.
g. Report any organism you suspect may be a high risk species. More information on these species can be found on www.invasivespeciesireland.com.
h. Watch out for hitchhikers on ropes and chains.

16. **Audit your activities.** Aquaculturists are encouraged to introduce a risk assessment system to help identify risks, action points and procedures to limit the opportunity of non target species transfer when relocating aquaculture species and equipment (See Annex 1 for details on the proposed risk assessment system).

17. **Biofouling control on aquaculture equipment.** Biofouling is a costly problem for the aquaculture sector. Uncontrolled biofouling on aquaculture infrastructure and stock leads to increased maintenance costs and production losses (low growth/poorer quality). During the normal course of farming operations, naturally occurring biofouling including: mussels, barnacles, marine plants, and other marine invertebrate animals can collect on culture equipment and on cultured species themselves. However, invasive alien species can also foul aquaculture equipment and species. These species can increase costs, reduce yields and also use the installation as a stepping stone to colonise natural ecosystems.

There are strong economic incentives for the sector to develop management practices that reduce the impact and requirement to discard non-target species on their product/s and equipment, while ensuring their site can be operated in a long-term sustainable manner. Actions include:

a. Minimise the potential for over settlement of non-target species by selecting sites and culture methods which avoid fouling in high densities.

b. Adopt operating and maintenance practices such as regular cleaning which reduce the potential for non-target species to become a significant factor.
c. If possible, facilitate probiotic control measures such as the polyculture of native sea urchins and other native grazers to reduce fouling impact.
d. Where biofouling must be washed or removed, attempt to reduce its impact and potential for colonisation on natural ecosystems by disposing of the debris in rubbish bins or onland composting. Remember that if fouling paints have been used that debris must be disposed off at a licensed landfill site.

For more information on antifouling strategies used in aquaculture please see www.crabproject.com.

18. **Prevent fouling of vessels and mooring lines**. Fouling of ocean going vessels is known to reduce efficiency, increase drag and increase fuel consumption. Also, the increased weight to mooring lines caused by fouling organisms may hinder the ease end users have of handling them. It is in the interest of owners to keep fouling off vessels and lines and thereby protecting the marine environment from harm caused by translocations of invasive alien species.

a. Keep boats in water for as short of time as possible.
b. Treat your boat with appropriate antifouling techniques that adhere to the craft manufacturers recommendations and prevent build up of organisms.
c. Submit to yearly inspections and removal of fouling
d. When treating a vessel 100% surface cover with the chosen method is essential. Small areas left available for plant or animal growth can give species the opportunity to colonise new areas.
e. Antifouling paints are designed to present marine organisms with a barrier to prevent settlement. These compounds are sometimes toxic to humans, aquatic organisms and terrestrial species and care should be taken to follow the guidelines stipulated by the manufacturer at all times.
f. If mooring lines become fouled remove them from the water, dispose of fouling in a dustbin or skip (do not allow fouling to return to the marine environment), and leave the ropes to dry out for a period greater than 48 hours.

For more information on antifouling methods please consult The Recreational Water Users Code of Practice and The Royal Yachting Association guide to antifouling (http://www.thegreenblue.org.uk/tradetalk/documents/RoughGuidetoAntifouling.doc).

19. **Always remove fouling prior to long distance journeys.** If travelling to or from Britain, Europe or further afield remember that the hull and mooring lines may have potentially damaging hitchhikers present. We have a responsibility to protect not only our environment but that of the areas we visit. Before undertaking such a trip, remove all hull fouling, renew antifouling treatments if required and attempt to dry all mooring lines completely.

20. **Consider the use of triploid *Crassostrea gigas* for aquaculture in Ireland**. *C. gigas* is known to settle in dense aggregations, and exclude other intertidal species. Pacific *C. gigas* is now firmly established in the European Wadden Sea. Here in Ireland, there is evidence to suggest that the species has settled in the wild in Strangford Lough, Co. Down. This is a concern not only for the aquaculture sector but to the conservation goals of this designated site.

The technology now exists to allow the production of triploid and tetraploid *C. gigas* (polyploid) in commercial quantities. Triploid *C. gigas* are sterile (cannot reproduce) and are often referred to as “all season oysters”. Growers may prefer to use triploid *C. gigas* as they do not go “milky” (do not spawn) which is preferred under current market trends. Efforts should be

made to reduce the use of diploid *C. gigas* in preference for triploid stock.

21. **Remove unused equipment and stock.** Equipment and seed stock should not be left in the environment if it is no longer used by the grower or the grower is no longer able to maintain the installation.

22. **Take action,** the success of this code will depend on the level of uptake by the various stakeholders that are engaged in marine aquaculture activities. There are specific actions which should be undertaken to reduce the risk from invasive species and raise awareness of the issue, these include:

- Auditing your actions to identify if you can reduce the risk of transporting or spreading an invasive alien species.
- Displaying information materials.
- If appropriate, stocking leaflets on invasive species that can be given to customers.
- Sign up to the Invasive Species Ireland network and keep up to date with developments.

23. The implementation of the code will be supported by a range of measures which will be provided through the Invasive Species Ireland project. These will include:

- Provision of education and awareness materials such as posters and leaflets.
- A dedicated section on the website where information can be found on high risk invasive marine species in Ireland.
- Provision of this information in hard copy upon request.
- Provision of training materials on invasive species and training can be provided upon request.
- A programme of stakeholder engagement to get uptake of the code by the sector and in local and central Government procurement.
- A publicity campaign to raise awareness of the code and its aims.

Annex 1: Risk assessment protocol system for the transfer of mussel seed

This template has been designed to help you identify opportunity points for spread of invasive alien species. The protocol requires that organisations audit their activities, identify all stages in the process, identify potential risk points in relation to invasive species and identify where measures can be put in place to prevent spread of invasive species. This can be considered by individual farmers or on a Bay/Lough scale in co-operation with other operators. Liaison withy local inspectors will be required.

	Organisation name:	
	Address:	
	Species:	
Method of transportation, distribution and storage of crop, gear, boats, etc:	Methods:	
	Intended use:	

Operation procedure

List the steps involved in your activity. Only a simple, but complete, description of the procedure is needed. It is important to include all the steps undertaken. Use as many steps necessary to define your procedure.

Step 1	
Step 2	
Step 3	
Step 4	
Step 5	
Step 6	
Step 7	
Step 8	
Step 9	
Step 10	

Potential invasive alien species hitch-hikers

List all relevant species

Examples: *Crepidula fornicata* and *Rapana venosa*	Invertebrates
Examples: *Alexandrium catanella*	Phytoplankton
Examples: *Undaria pinnatifada, Sargassum muticum* and *Spartina anglica.*	Plant/seaweed
Examples: Bacterial or virus pathogens	Pathogens

1. Activity Aquaculture procedure	2. Risks Potential invasive species risk associated with this procedure	3 Significant Risks deemed significant (yes/no)	4. Resourcing Justify your decision in step 3	5. Exclusion What control measures can be implemented to minimise risk	6. Action Is this step where action is required (yes/no)?
Operation procedure step:__	Vertebrate				
	Invertebrate				
	Phytoplankton				
	Plant/seaweed				
	Pathogen				

Operation procedure step: ____	Vertebrate				
	Invertebrate				
	Phytoplankton				
	Plant/seaweed				
	Pathogen				

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Action point Each row answered “yes” in column 6 on the Hazard Analysis Form	1.		
Significant risks as determined in column 3 of the Risk Identification	2.		
Limits for each control measure	3.		
Monitoring Describe what is being monitored.	4.		
How will monitoring take place	5.		
Frequency	6.		
Person responsible.	7.		
Corrective actions Actions taken when control mesaures are not met	8.		
Verification Method of Verification	9.		
Records List what is recorded at each critical control point	10.		

This proposed Risk Assessment Protocol is based on the HACCP: Hazard Analysis and Critical Control Point Training Curriculum developed by the National Seafood HACCP Alliance for Training and Education.

Annex 2: Some high impact invasive alien species

Most Unwanted: ***Didemnum vexillum***

Didemnum vexillum

Habitat: Marine

Threat: Fisheries, protected species and marine ecosystem functioning

Status: Established

A colonial sea squirt from the Didemnum (pronounced die-DEM-num) group has recently been found fouling boats and marina structures in Ireland. This species *Didemnum vexillum* is fast-growing and has the potential to out compete and smother a large number of native species. The threats posed are of concern to conservationists, aquaculture managers, and fisheries.

What is it?

Exact identification of this species is very difficult and can only be undertaken by a trained expert. However, in general native species are not found in large colonies and do not form the candlewax-like dripping structures, as seen in the photographs. Please see the Habitas website on Sponges of Britain and Ireland for more info on native species.

The invasive form can be describes as long, ropey or beard-like hanging from hard surfaces such as docks, aquaculture facilities, and ship hulls, or may be found as extensive mats covering rocky sea beds (pebbles, cobbles, boulders, and rock outcrops).

Impact

Alter marine habitats.

Interfere with fishing, aquaculture, and other coastal and offshore activities.

Increased fouling of manmade structures such as docks, moorings, and boat hulls.

Overgrow other organisms such seaweed, scallops, mussels, and oysters that depend on the seafloor for habitat.

May impact on underwater archaeological sites such as ship wrecks.

Produce noxious substances that deter most fish and other animals.

The colonies have been found at water depths ranging from intertidal to continental shelf depths of 65m (213 ft).

Where is it from?

Uncertain at present. The species is known from The Netherlands and France in Europe while worldwide the species is now recognised in Asia, Australasia-Pacific, Europe, and North America.

Where is it found in Ireland?

Currently confirmed present in Carlingford Lough, Co. Louth, Malahide Marina, Co. Dublin and Galway Bay, Co. Galway.

How did it get here?
Uncertain at present. Likely vector is fouling of ocean going vessel and/or contamination of aquacultre produce.

How is it spreading in Ireland?
Once the species becomes established in an area, it can spread rapidly by both sexual reproduction and asexually by fragmentation of the colonies. Species is known to grow on mobile organisms such as crabs. Fouling on sea going vessels is a key vector in dispersal of this species. The species may also establish itself with movement of shellfish for the aquaculture industry.

What you can do?
Do not interfere with colonial tunicates. These species can spread more rapidly when a section of the colony becomes detached and carried with currents to new areas. If you can do so safely, photograph the species.
Everyone is urged to thoroughly wash and dry all equipment that was near an infestation of this species. This is essential to avoid contamination of new areas. It is important to do this where the rinse will not return to the marine environment. New infestations may result if you do not undertake this.
Report all sightings at the Alien Watch page of www.invasivespeciesireland.com.

Most Unwanted: Slipper limpet
Crepidula fornicata
Habitat: Marine
Threat: Threatens native ecosystems and species
Status: Potential

This is a species of mollusc that was introduced to Europe in the 19th century. The slipper limpet has also been introduced to Ireland accidentally along with imported oyster spat but so far has failed to become established.

What is it?
This species of mollusc inhabits the area around the low water mark and into the shallow subtidal. It is often found attached to shells of mussels and the native oyster. MarLin describes this species as possessing an oval shell, up to 5 cm in length, with a much reduced spire. The large aperture has a shelf, or septum, extending half its length. The shell is smooth with irregular growth lines and white, cream, yellow or pinkish in colour with streaks or blotches of red or brown. Slipper limpets are commonly found in curved chains of up to 12 animals. Large shells are found at the bottom of the chain, with the shells becoming progressively smaller towards the top.

Impact
In shallow bays where the slipper limpet has been introduced in France, it can completely smother the sediment creating beds with several thousand individuals per m2. Dense aggregations of slipper limpet trap suspended silt, faeces and pseudofaeces altering the benthic habitat. Where slipper limpet stacks are abundant, few other bivalves can live amongst them. The slipper limpet is a serious threat to oyster beds because of this.

It has also been observed that live maerl thalli, which are a protected species and form an important protected habitat, become covered in slipper limpets and the spaces between the thalli of the bed become clogged with silt; this kills the maerl thalli and dramatically alters associated communities. No management measures have proven effective for this species in this habitat.

Where is it from?
Originally found on the east coast of the Americas between Canada and Mexico.

Where is it now?
Now introduced to British-Columbia, Washington state, Japan and Europe, where it is found on the Atlantic coast between Denmark and Spain, in Sicily and the Adriatic Sea.

How can it get here?
Contaminant of oyster spat.
Hull fouling.

What you can do to prevent its arrival
Aquaculture managers and owners should avoid getting spat material from areas that are known to have slipper limpet present or nearby.
Report all sightings at the Alien Watch page of www.invasivespeciesireland.com.

Most Unwanted: Asian rapa whelk
Rapana venosa
Habitat: Marine
Threat: Threatens marine ecosystem functioning
Status: Potential

Rapana venosa is a predatory marine snail which may impact both natural and cultivated populations of oysters, mussels and other molluscs. In areas where it has been introduced it has caused significant changes to the ecosystem. It has a fast growth rate and reproductive ability.

What is it?
It has a large heavy shell with a short spire. A very distinctive feature is the deep orange colour of the inside of the shell. The outer colour is variable from dull grey to red brown, with more or less conspicuous dark brown dashes on the spiral ribs, which tend to make an interrupted “vein-like” pattern throughout the entire shell.

Impact
The predatory impact of R. venosa has serious implications for both natural and cultivated populations of marine bivalves. R. venosa are very voracious predators and Rapana is blamed in the Black Sea for the decline of the native, edible bivalve fauna. They have caused significant changes in the ecology of bottom-dwelling organisms and have resulted in the near extinction of the Gudaut oyster. Please see the **Global Invasive Species Database** pages on this species for more information.

Where is it from?
Asia

Where is it now?
This species is now present in Europe and the US.

How can it get here?
Ballast water, Aquaculture and hull fouling are considered the main potential pathways to Ireland.

What you can do to prevent its arrival
Avoid hull fouling on your boats.
Never take oyster spat from an area known to have Rapena present and transfer to Ireland.
Report all sightings at the Alien Watch page of www.invasivespeciesireland.com.

Annex 3: Growing techniques for *Crassostrea gigas*

Grow-out is almost entirely sea-based. A variety of bottom, off-bottom and suspended culture methods are used, depending on the environment (e.g. tidal range, shelter, water depth on leases, water exchange rates in bays and estuarine inlets, the nature of substrates, etc.) and tradition.

Growth is rapid between 15–25 °C and at salinities between 25 and 32‰. It is dependent on the rate of replenishment of the natural phytoplankton food supply. Pacific cupped oysters will take from 18-30 months to reach a market size of 70–100 g live weight (shell-on). Yields from extensive lease areas (covering thousands of hectares), which are used for all aspects of grow-out, including seed collection, the nursery and growing phases, and for hardening oysters prior to harvest, can yield 25 tonnes/ha/yr. Much greater yields (>70 tonnes/ha/yr) can be obtained from well spatially separated, small area leases.

Bottom culture
Seed can be sown on suitably firm intertidal or sub-tidal ground, which may be hardened by the pre-application of shell or gravel, at densities of 200–400/m² when 1 to 2 g live weight, with predator-proof protection (fences or net covers). Alternatively, they can be sown without protection at ~200/m² when 10 g live weight. The object is to sow at densities that will require no further husbandry until the oysters reach marketable size.

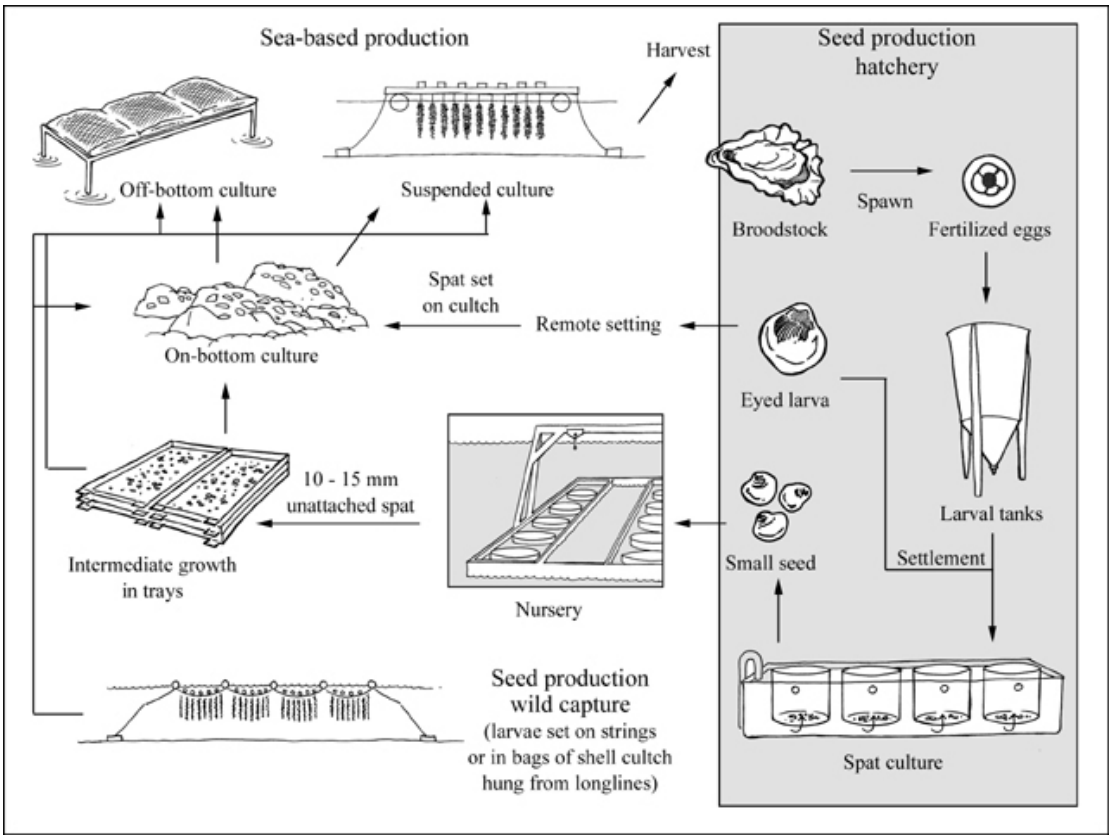
Off-bottom culture
Seed are contained in mesh bags or perforated plastic trays of various types attached by rope or rubber bands to wood frame or rebar steel trestles on suitable ground in the low intertidal zone. Such systems are sometimes located sub-tidally but this adds to handling costs. Off-bottom culture may be used for the intermediate nursery phase of growth or as a method to grow product to market size. 10–15 mm seed can be stocked at 1 000–2 000 per 0.25 or 0.5 m² base area trays and need regular maintenance and servicing to transfer at lower density to clean bags/trays of increasing mesh size as they grow. Growth rate slows substantially once the biomass of oysters exceeds 5 kg/m² tray area in reasonably productive areas.

Suspended culture
Three-dimensional containment units are used in hanging culture, which is from longlines (most commonly) or from rafts. The units can be strings or wires of shells to which spat have attached, or they can be series of nets, mesh bags or plastic trays strung together and suspended vertically from the horizontal lines or rafts. This form of culture is used in deeper waters and the same stock densities per net or tray apply as for off-bottom methods. Care needs to be taken to sink units to water depths where fouling organisms are less prevalent and to avoid them touching the bottom at low water. Regular maintenance and servicing is required, to transfer growing oysters at lower density to clean nets/trays of increasing mesh size as they grow.

Floating Culture
Wood frame trays with mesh bases or perforated plastic trays provided with buoyancy collars (styrofoam) are used in some locations for earlier stages in the growth of seed. The tops of such units need to be covered with a canvas or tightly woven mesh to exclude light.

Hardening
Pacific oysters grown in suspended culture are commonly ‘hardened’ for a period of up to three or four months prior to harvesting. The process of hardening allows daily periods of exposure to air and generally takes place in the intertidal zone or in shallow water where tidal range is sufficient. Aerially exposed oysters have higher meat content and better keeping qualities once harvested.

Figure 1: The Production cycle of Crassostrea gigas (FAO Cultured Aquatic Species Information Programme Crassostrea gigas).



ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2005

Code de Conduite du CIEM pour les Introductions et Transferts d'Organismes Marins 2005

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Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:
ICES. 2005. ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2005. 30 pp.

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Preamble

Global interest in marine aquaculture (mariculture) began to increase dramatically in the 1950s and 1960s. A natural complement to this interest was the search for fish, shellfish (molluscan, crustacean, and echinoderms), and plant species whose biology was well known and which already had achieved or could achieve success in extensive cultivation or which could be of interest in research. Once identified, these species were thus potential candidates for movement to new locations in the world for the purpose of establishing new fisheries and new mariculture 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, including secondary introductions by human-mediated or natural vectors. Other terms used for such introductions are alien, exotic, invasive, foreign, non-native, immigrant, nonindo, naturalized, or non-indigenous.

While the Code of Practice was originally developed for marine aquaculture activities, by far the largest number of introductions in recent years have been for re-stocking or enhancement purposes, but the same principles should apply.

While great successes have been achieved by these activities, leading to the creation of new and important fishery and mariculture resources, three challenges have surfaced over the past several decades relating to the global translocation of species to new regions.

The first challenge lies in the ecological and environmental impacts of introduced and transferred species, especially those that may escape the confines of cultivation and become established in the receiving environment. These new populations can have an impact on native species.

The second challenge stems from the potential 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.

The third challenge is posed by the inadvertent coincident movement of harmful organisms associated with the target (host) species. The mass transfer of large numbers of animals and plants without inspection, quarantine, or other management procedures has inevitably led to the simultaneous introduction of pathogenic or parasitic agents causing harm to the development and growth of the new fishery resources and to native fisheries.

In recent years, for example, the release of exotic organisms via ships' ballast water has become a pressing issue with profound implications for fisheries resources, mariculture, and other activities. These issues are dealt with separately by the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV), and are not considered within this code.

The International Council for the Exploration of the Sea, through its Working Group on Introductions and Transfers of Marine Organisms and in cooperation with other ICES Working Groups and with the European Inland Fisheries Advisory Commission (EIFAC) of the Food and Agriculture Organization of the United Nations (FAO), has addressed these three levels of concern since 1973.

On 10 October 1973, the 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 was set forth "to reduce

the risks of adverse effects arising from introduction by non-indigenous marine species". Subsequent modifications, proposed by the ICES Working Group on Pathology and Diseases of Marine Organisms in 1978 and by the then newly reconvened ICES Working Group on the Introduction of Non-Indigenous Marine Organisms in 1979, led to the publication of a "Revised Code", adopted by ICES in October 1979. The "1979 Code" became the standard for international policy and the version of the Code most widely used, cited, and translated for the next ten years. Minor revisions and additions over the decade resulted in the adoption in October 1990 of a "1990 Revised Code", followed by the "1994 Code" adopted by ICES in September 1994 (ICES, 1995). The "1994 Code" took into account several updates and included genetic issues for the first time.

The 2005 Code, presented here, includes all concerns expressed in the 1994 Code of Practice (ICES, 1995) and follows the precautionary approach adopted from the FAO principles (FAO, 1995), with the goal of reducing the spread of exotic species. It accommodates the risks associated with current commercial practices including trade in ornamental species and bait organisms, research, and the import of live species for immediate human consumption (these are not species that are intended to be released to the environment, so a notification to ICES is neither appropriate nor practical). It also includes species that are utilized to eradicate previously introduced harmful and native species, as well as genetically modified organisms (GMOs) and polyploids (specifically triploids and tetraploids). It outlines a consistent, transparent process for the evaluation of a proposed new introduction, including detailed biological background information and an evaluation of risks.

ICES views the Code of Practice as a guide to recommendations and procedures. As with all Codes, the current Code has evolved with experience and with changing technological developments. This latest version of the Code reflects the past thirty years of experience with the evolution of new fisheries and genetic technologies. While initially designed for the ICES Member Countries concerned with the North Atlantic and adjacent seas, all countries across the globe are encouraged to implement this Code of Practice. Public awareness of the concerns associated with introductions and transfers of marine organisms is essential to assist in the prevention of problems associated with such introductions. Countries are therefore encouraged to ensure the widest distribution of this code.

A brief outline of the ICES Code of Practice 2005

The ICES Code of Practice sets forth recommended procedures and practices to diminish the risks of detrimental effects from the intentional introduction and transfer of marine (including brackish water) organisms. The Code is aimed at a broad audience since it applies to both public (commercial and governmental) and private (including scientific) interests. In short, any persons engaged in activities that could lead to the intentional or accidental release of exotic species should be aware of the procedures covered by the Code of Practice.

The Code is divided into ten sections of recommendations relating to: (I) a strategy for implementation, (II) the steps to take prior to introducing a new species, (III) the steps to take after deciding to proceed with an introduction, (IV) policies for ongoing introductions or transfers which have been an established part of commercial practice, (V–VII) the steps to take prior to releasing genetically modified organisms, and (VIII–X) the steps to take prior to releasing polyploidy organisms. A section on "Definitions" is included with the Code.

The contents of Sections II–VII have been referred to above and in ICES reports (ICES, 1984, 1988, and 1994). Section I provides a strategy for implementation. In recent years, for example, the release of exotic organisms via ships' ballast water has become a pressing issue, with profound implications for fisheries resources, mariculture, and other activities. Sections V–VII dealing with genetically modified organisms (GMOs) have been revised by the Working Group on the Application of Genetics in Fisheries and Mariculture (ICES, 2002). Sections VIII–X, dealing with polyploidy organisms, have been revised by the Working Group on the Application of Genetics in Fisheries and Mariculture in 2004, updating the 2003 version of the Code.

The Code is presented in a manner that permits broad and flexible application to a wide range of circumstances and requirements in many different countries, while at the same time adhering to a set of basic scientific principles and guidelines.

ICES Member Countries contemplating new introductions are requested to present in good time to the Council a detailed prospectus on the rationale and plans for any new introduction of a marine (brackish) species; the contents of the prospectus are detailed in Section II of the Code and Appendix A (see summary below and www.ices.dk). The Council may then request its Working Group on Introductions and Transfers of Marine Organisms (WGITMO) to consider the prospectus and comment on it. The Working Group, in turn, may request more information before commenting on a proposal. Guidelines to be followed are described, with details in appendices on the ICES Website.

If any introduction or transfer proceeds following approval, ICES requests Member Countries to keep the Council informed about it, both through providing details of the broodstock established and the fate of the progeny, and through submitting progress reports after a species is released into the wild. The specifics of this stage are detailed in Section III of the Code.

ICES has published two extended guides to the Code, one in 1984 as Cooperative Research Report No. 130, entitled "Guidelines for Implementing the ICES Code of Practice Concerning Introductions and Transfers of Marine Species", and another in 1988 as Cooperative Research Report No. 159, entitled "Codes of Practice and Manual of Procedures for Consideration of Introductions and Transfers of Marine and Freshwater Organisms". These reports are available in many libraries and from the ICES Secretariat. ICES views the Code of Practice as a guide to recommendations and procedures. As with all Codes, the current Code has evolved with experience and with changing technological developments. This latest (2005) version of the Code reflects the past 30 years of experience with the evolution of new fisheries and genetic technologies.

We are pleased to present the ICES Code of Practice in this fashion for wide consideration, and we welcome advice and comments from both Member Countries and our colleagues throughout the world. Recommendations and suggestions should be directed to the General Secretary of ICES in Copenhagen, Denmark.

Stephen Gollasch

Chair, ICES Working Group on Introductions and Transfers of Marine Organisms

Stig Carlberg

Chair, ICES Advisory Committee on the Marine Environment

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ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2005

All introductions and transfers of marine organisms carry risks associated with target and non-target species (including disease agents). Once established, introduced species can spread from foci of introductions and have undesirable ecological, genetic, economic, and human health impacts.

Introductions of marine organisms occur in the course of many human activities, including but not limited to aquaculture, stocking, live trade (e.g., species used for aquaria, ornamentals, bait, and food), research, biocontrol, and the use of genetically modified organisms. Even species introduced intentionally into closed systems can be released accidentally. Thus, introductions can result whenever live organisms are moved, regardless of the original intent. As a result, a risk of introduction and subsequent impacts exists with any movement and should be considered explicitly.

This Code of Practice provides a framework to evaluate new intentional introductions, and also recommends procedures for species that are part of current commercial practices to reduce the risk of unwanted introductions, and adverse effects that can arise from species movement.

I) Strategy for implementation

a) To protect indigenous as well as previous intentionally introduced species and to meet international obligations (e.g., Convention on Biological Diversity), agencies of Member Countries should fully implement the Code of Practice and apply all regulatory measures possible to prevent unauthorized introductions.

b) To reduce illegal and unauthorized introductions, Member Countries are also encouraged to increase public awareness about the risks associated with importing live products.

c) Countries that are not members of ICES are encouraged to adopt such management measures.

II) Recommended procedure for all species prior to reaching a decision regarding new introductions

a) Member Countries contemplating any new introduction are expected to submit to the Council well in advance a detailed prospectus (see Appendix A) on the proposed new introduction(s) for evaluation and comment.

b) The prospectus should include the purpose and objectives of the introduction, the stage(s) in the life cycle proposed for introduction, the native range, the donor location, and the target area(s) of release. The prospectus should also include a review of the biology and ecology of the species as these pertain to the introduction (such as the physical, chemical, and biological requirements for reproduction and growth, and natural and human-mediated dispersal mechanisms) and information on the receiving environment.

c) The prospectus should also provide a detailed analysis of the potential impacts on the aquatic ecosystem of the proposed introduction. This should include, wherever possible, assessments from previous introductions. This analysis should include a thorough review of:

1) the ecological, genetic, and disease impacts and relationships of the proposed introduction in its natural range and donor location;

2) the expected ecological, genetic, and disease impacts and relationships of the introduction in the proposed release site and projected range, as well as vectors for further distribution;

3) an economic assessment, where appropriate.

d) The prospectus should conclude with an overall assessment of the issues, problems, and benefits associated with the proposed introduction. An evaluation of risks (see Appendix B) should be included.

e) Upon review of the prospectus, the ICES Council will provide comments and recommendations on the proposed introduction.

III) If the decision is taken to proceed with the introduction

a) Using internationally recognized protocols, such as the Office International des Epizooties (OIE), or any other appropriate protocols available at the time, review the health records of the donor location and surrounding area of the organisms to be introduced.

b) The introduced organisms should be used to establish a broodstock for the production of progeny. The organisms should be transferred into a quarantine facility (see Appendix C). This facility should be in the recipient country or other location agreed to by the recipient country.

c) The imported consignment(s) is not to be released to the wild, and should be separated from subsequent progeny.

d) Only progeny of the introduced species may be transplanted into the natural environment, provided that:

1) a risk assessment indicates that the likelihood of negative genetic and environmental impacts is minimal;

2) no disease agents, parasites, or other non-target species become evident in the progeny to be transplanted; and

3) no unacceptable economic impact is to be expected.

e) During the pilot phase, the progeny, or other suitable life stages, should be placed on a limited scale into open waters to assess ecological interactions with native species, and especially to test risk assessment assumptions. Contingency plans, including the removal of the introduced species from the environment, should be ready for immediate implementation.

f) A monitoring programme addressing specific issues (see Appendix D) of the introduced species in its new environment should be undertaken, and annual progress reports should be submitted to ICES for review at meetings of the Working Group on Introductions and Transfers of Marine Organisms until the review process is considered complete.

IV) Recommended procedure for introduced or transferred species which are part of current commercial practice

a) All products should originate from sources in areas that meet current codes, such as the OIE International Aquatic Animal Health Code or equivalent EU directives.

b) Live products destined for consumption, processing, and aquarium or display should not be placed into the natural environment.

c) For organisms to be released into the natural environment, there should be documented periodic inspections (including microscopic examination) of material prior to exportation to confirm freedom from exotic accompanying (non-target) species including disease agents. If an inspection reveals any undesirable development, it must be immediately reported and importation must be immediately discontinued. Findings and remedial actions should be reported to the International Council for the Exploration of the Sea.

d) If required, there should be inspection, disinfection, quarantine or destruction of the introduced organisms and transfer material (e.g., transport water, packing material, and containers) based on OIE or EU directives.

e) Consider and/or monitor the genetic impact that introductions or transfers have on indigenous and previously introduced species or distinct genetic stocks, to reduce or prevent detrimental changes to genetic diversity.

Note: It is recognized that different countries will have special requirements for the inspection and control of the consignment in the donor and recipient countries.

V) General considerations regarding the release of genetically modified organisms (GMOs)

a) Recognizing that little information still exists on the genetic, ecological, and other effects of the release of genetically modified organisms into the natural environment (where such releases may result in the mixing of altered and wild populations of the same species, and in changes to the environment), the Council urges Member Countries to establish strong legal measures[1] to regulate such releases, including the mandatory licensing of physical or juridical persons engaged in genetically modifying, or in importing, using, or releasing any genetically modified organism.

VI) Recommended procedure for all GMOs prior to reaching a decision regarding new releases

a) Member Countries contemplating any release of genetically modified organisms into open marine and brackish environments are requested at an early stage to notify the Council about such releases. This notification should include a risk assessment of the effects of this release on the environment and on natural populations.

b) GMO risk assessment should particularly involve consideration of:

1) The genetic and phenotypic characteristics of the modified organism, i.e., both the traits introduced or modified and other secondary phenotypic changes induced by the genetic modification, such as the construction and/or vector employed. The significance of the introduced or modified trait in relation to the biology of the parental organism should be evaluated;

2) Characteristics of the ecosystems that the GMO might access;

3) Possible interactions of the GMO with species of the ecosystems that might be accessed, in order to determine whether the release of the GMO poses genetic and/or ecological hazards.

c) If possible, experiments in simulated natural environments are recommended. Such experiments should be conducted using secure systems to prevent escapes of GMOs from the experimental facilities at any life stage. The following points should be particularly assessed and reported:

1) Phenotypic traits associated with the GMO in a simulated natural environment;

2) The behaviour of transgenic aquatic organisms in a simulated natural environment;

3) The competitive advantages/disadvantages of transgenic aquatic organisms;

4) The degree to which transgenic aquatic organisms are capable of mating with a native population, including their reproductive performance in competition with wild conspecifics;

5) The success of that mating as defined by numbers of offspring;

6) The relative fitness of juveniles of pure transgenic crosses, hybrids between native and transgenic crosses, and the pure native crosses.

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[1] Such as the European Economic Community "Council Directive of 12 March 2001 on the Deliberate Release into the Environment of Genetically Modified Organisms (2001/18/CE)", Official Journal of European Communities, No. L, 106: 1–39 (2001).

VII) If the decision is taken to proceed with the release, the following action is recommended:

a) It is recommended that initial releases of transgenic (GMO) organisms be reproductively sterile in order to avoid transfer of the gene construct to wild organisms. However:

1) Mass production of sterile progeny requires the maintenance of fertile transgenic parental stocks. The risk assessment of these stocks should also be addressed;

2) It should be noted that many current sterilization techniques are not 100% efficient and that many aquatic species have very high fecundity;

3) Mass releases of sterile organisms could still negatively impact the ecosystem and affect wild populations through competition.

b) Monitoring should be undertaken to ensure that GMOs, due to their nature, do not negatively affect wild populations and ecosystems after their release.

VIII) General considerations regarding the release of polyploid organisms

a) The technology now exists to allow the production of triploid and tetraploid fish and shellfish (polyploid) in commercial quantities. However, little information exists on the genetic, ecological, and other effects of the release of polyploid organisms into the natural environment (where such releases may result in the mixing of altered and wild populations of the same species, hybridization between species, and in changes to the environment). Triploid organisms offer a means of inducing sterility, and can be produced in the laboratory with chemical treatments, heat or pressure shock. Tetraploid organisms when crossed with diploids of the same species are a means of producing triploids through sexual recombination. Triploids and tetraploids pose similar but different threats to the environment from those of GMOs. The procedures recommended for GMOs apply to tetraploids which are fertile and therefore have potential for genetic as well as ecological interactions with wild stocks and ecosystems. By nature of their sterility, triploid organisms require modified procedures.

IX) Recommended procedure for triploids prior to reaching a decision regarding new releases

a) Member Countries contemplating any release of triploid organisms into open marine and brackish environments are requested at an early stage to notify the Council about such releases. This notification should include a risk assessment of the effects of this release on the environment and on natural populations.

b) Triploid risk assessment should particularly involve consideration of:

1) An evaluation of the sterility of the organisms and population (some induction techniques are not 100% effective). This is of particular concern with introducing triploid non-native species;

2) The phenotypic characteristics of the triploid organism;

3) Characteristics of the ecosystems that the triploid might access;

4) Possible interactions of the triploid with species of the ecosystems that might be accessed, in order to determine whether the release of the triploid poses ecological hazards.

c) If possible, experiments in simulated natural environments are recommended. Such experiments should be conducted using secure systems to prevent escapes of triploids from the experimental facilities at any life stage. The following points should be particularly assessed and reported:

1) Phenotypic traits associated with the triploid in a simulated natural environment;
2) The behaviour of triploid aquatic organisms in a simulated natural environment;
3) The competitive advantages/disadvantages of triploid aquatic organisms.

X) If the decision is taken to proceed with the release, the following action is recommended:

a) The mass releases of sterile organisms could still negatively impact the ecosystem and affect wild populations through competition.
b) Monitoring should be undertaken to ensure that triploids, due to their nature, do not negatively affect wild populations and ecosystems after their release.

Definitions

For the application of this Code, the following definitions shall be used.

Aquarium (= ornamental) species

All species imported or transferred into confinement for ornamental indoor or outdoor use.

Bait organisms

Live specimens used (e.g., on a hook or in a trap) to allure target species.

Biocontrol species

The intentional release of an organism that is intended to consume, infect, or debilitate a selected species to decrease its population size. Note: The possible limited specificity of biocontrol species is of concern as native species might be negatively affected.

Broodstock

Specimens of a species in any life stage from which a first or subsequent generation/growth may be produced for possible introduction to the environment.

Current commercial practice

Established and ongoing cultivation, rearing, or placement of an introduced or transferred species in the environment for economic or recreational purposes, which has been ongoing for a number of years.

Disease agent

Any organism, including parasites and prions which causes or contributes to the development of a disease.

Donor localities (= source localities)

Specific localities in a country or zone from which the import or transfer originates.

Genetic diversity

All of the genetic variation in an individual population, or species.

Genetically modified organism (GMO)

An organism in which the genetic material has been altered anthropogenically by means of recombinant DNA technologies. This definition includes transgenic organisms, i.e., an organism bearing within its genome one or more copies of novel genetic constructs produced by recombinant DNA technology, but excludes chromosome manipulated organisms (i.e., polyploids), where the number of chromosomes has been changed through cell manipulation techniques.

Indigenous (= native) species

A species or lower taxon living within its natural range (past or present) including the area which it can reach and occupy using its natural dispersal systems (modified after CBD, GISP).

Introduced species (= non-indigenous species, = exotic species)

Any species transported intentionally or accidentally by a human-mediated vector into aquatic habitats outside its native range. Note: Secondary introductions can be transported by human-mediated or natural vectors.

Marine species

Any aquatic species that does not spend its entire life cycle in fresh water.

Native range

Natural limits of geographical distribution of a species (modified after Zaitsev and Öztürk, 2001).

New introduction

The human-mediated movement of a species outside its present distribution.

Non-target species

Any species inadvertently accompanying in, on, or with the species intended for introduction or transfer.

Polyploidy

An organism or cell having more than two haploid sets of chromosomes.

Progeny

Next generation(s) of an organism. Also included are new stages/fragments of seaweeds, protists, and clonal organisms.

Quarantine

The facility and/or process by which live organisms and any of their accompanying organisms can be held or reared in isolation from the surrounding environment.

Release

Voluntary or accidental dissemination of an organism, or its gametes, outside its controlled area of confinement.

Tetraploid

An organism or cell having four haploid sets of chromosomes.

Transferred species (= translocated species)

Any species intentionally or accidentally transported and released within areas of established populations, and continuing genetic flow where it occurs.

Triploid

An organism or cell having three haploid sets of chromosomes.

Vector

Any living or non-living carrier that transports living organisms intentionally or unintentionally.

Zone

Part of a coastal area or an estuary of one or more countries with the precise geographical delimitation that consists of a homogeneous hydrological system (modified after OIE).

References

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ICES. 2002. Report of the Working Group on the Application of Genetics in Fisheries and Mariculture. ICES CM 2002/F:3. 40 pp.

Zaitsev, Y., and Ozturk, B. (eds.) 2001. Exotic Species in the Aegean, Marmara, Black, Azov and Caspian Seas. Turkish Marine Research Foundation, Istanbul. 267 pp.

Overview of appendices to the Code of Practice

The following provides an overview of the four Appendices referred to in the 2003 version of the ICES Code of Practice on the Introductions and Transfers of Marine Organisms. To ensure that the appendices are current and that the most recent information is included, appendices (with an example of a case study) will only be available on the Internet.

Appendix A. Prospectus

This Appendix provides detailed information on suggested guidelines for the prospectus including, but not limited to:

- potential of transfer of disease agents, parasites, and non-target species;
- review of previous introductions of the candidate species.

This information is used to conduct the biological risk assessment (see Appendix B). To be scientifically valid, the information provided needs to be based on a thorough literature review.

The prospectus also needs to include a contingency plan in case immediate eradication of the introduced species needs to be carried out.

The proponent should design an appropriate monitoring programme that will document impacts in the receiving environment.

Appendix B. Risk Assessment

This Appendix provides a detailed, consistent approach for evaluating the risk of genetic, ecological, and disease impacts in the proposed receiving environment, as well as the potential for introducing non-target species. This review should be based in part on the information provided in the Prospectus (see Appendix A).

There will be an assessment of each potential hazard as to the probability of the establishment and consequences of the establishment in the receiving environment. Mitigation factors and management issues will also be reviewed.

The precautionary principle will be taken into account in the final outcome of the risk assessment.

Appendix C. Quarantine

The intention of the quarantine process is to:

- prevent the escapes of target and non-target species into the environment;
- ensure freedom from disease agents in broodstock and progeny prior to release from the quarantine system;
- protect broodstock.

The size of the facility, and the extent of the quarantine measures, will depend on the characteristics of the species being introduced. Quarantine measures may also be required for some species transfers.

The Appendix provides detailed information on suggested requirements for quarantine facilities including, but not limited to:

- transport of broodstock;
- quarantine facilities;
- stock management in isolation;
- record keeping;
- disinfection.

Appendix D. Monitoring

The purpose of the monitoring programme is to assess the impact of the introduced organisms on the environment, ecosystem function, and biodiversity (including genetic biodiversity). The monitoring should be adjusted according to the type of organism and its potential dispersal range. The vectors responsible for further dispersal need to be identified.

Appropriate monitoring should be carried out in phases:

- initial baseline monitoring study before the introduction;
- continuing monitoring subsequent to pilot study release; and
- continuing monitoring following increases in scale of project.

The results of the monitoring may be reported to and assessed by WGITMO before the next phase is undertaken. Questions outlined in the Appendix should be addressed as far as possible.

invasivespecies Ireland

The Invasive Species Ireland Project is undertaken, in partnership, by EnviroCentre and Quercus.

www.envirocentre.co.uk

www.quercus.ac.uk

and is Funded by the National Parks and Wildlife Service and the Northern Ireland Environment Agency.

www.ni-environment.gov.uk

www.npws.ie

For more information on the Invasive Species Ireland Project please see the website at www.invasivespeciesireland.com

Recommended citation: Kelly, J. and Maguire, C.M. (2009). Marine Aquaculture Code of Practice: Draft. Prepared for NIEA and NPWS as part of Invasive Species Ireland.