ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2004

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-mediator 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, neobiota, naturalized, or non-indigenous.

While the Code of Practice was originally developed for marine aquaculture activities, in recent years, by far the largest number of introductions 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 relative 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 ***2004 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 2004

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, 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 (2004) version of the Code reflects the past thirty 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.

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ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2004

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:

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

   ii) 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;

iii) 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 Épizooties (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:

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

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

iii) 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:
   i) 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.
   ii) Characteristics of the ecosystems that the GMO might access.
   iii) 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:
   i) Phenotypic traits associated with the GMO in a simulated natural environment;
   ii) The behaviour of transgenic aquatic organisms in a simulated natural environment;
   iii) The competitive advantages/disadvantages of transgenic aquatic organisms;
   iv) The degree to which transgenic aquatic organisms are capable of mating with a native population, including their reproductive performance in competition with wild conspecifics;
   v) The success of that mating as defined by numbers of offspring;
   vi) The relative fitness of juveniles of pure transgenic crosses, hybrids between native and transgenic crosses, and the pure native crosses.

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:
   i) Mass production of sterile progeny requires the maintenance of fertile transgenic parental stocks. The risk assessment of these stocks should also be addressed.
   ii) It should be noted that many current sterilization techniques are not 100% efficient and that many aquatic species have very high fecundity.
   iii) 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.

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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).

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:

i) 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.
ii) The phenotypic characteristics of the triploid organism.
iii) Characteristics of the ecosystems that the triploid might access.
iv) 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:

i) Phenotypic traits associated with the triploid in a simulated natural environment;
ii) The behaviour of triploid aquatic organisms in a simulated natural environment;
iii) 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 location (= 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 Ozturk, 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 (= transplanted 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

FAO. 1995. Precautionary Approach to Fisheries. Part I: Guidelines on the Precautionary Approach to Capture Fisheries and Species Introductions. FAO Fisheries Technical Paper, 350/1. 52 pp.
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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.

DETAILED APPENDICES TO THE CODE OF PRACTICE

Preamble

The ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2003 provides the main principles on how to reduce the risks of dispersal and negative impact of intentionally introduced species. The Code of Practice includes trade and commercial practice. The Code of Practice should be used together with the Appendices A–F (available only on the Internet) to apply to all new introductions and whenever applicable to transferred organisms.

Although the COP is not legally binding, it is recommended to be used as a precautionary approach, where stricter regulations do not apply in countries involved.

APPENDIX A PROSPECTUS

Information requirements

This information is used to conduct the biological risk assessment of proposed introductions of marine organisms. The information provided should be based on a thorough literature review on the life history of the species proposed for introduction, its habitat and its general interactions with other species and potential interactions with species native to the release site. In addition, information on the potential to spread into other sections of the environment is needed. Included in the prospectus should be precautions and a management plan as well as a monitoring plan.

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

For some proposals, e.g., routine introductions/transfers, the information requirement may be reduced significantly. The regulatory authority of the country and/or WGITMO should be consulted in such cases. It is possible that there may be concurrent proposals taking place or knowledge of a previous attempt in which case this information can be provided and so reduce the time and cost of this part of the project. As introductions are intended to cover a wide range of situations (e.g., aquaculture, fisheries, restoration of habitat, re-introductions of a similar population/species to replace expired populations, genetically modified organisms, biological control) all of the requirements made below will not necessarily apply and additional requirements may be necessary so as to reduce the risk of an unwanted impact and to protect the proponent from not having acted appropriately.

Prospectus outline

A.1 Executive Summary (to be provided by the proponent)

Provide a brief summary of the document including a description of the proposal, the organism(s) being proposed for introduction, the potential impacts on native species and their habitats and mitigation steps to minimize the potential impacts on native species.

A.2 Introduction

1) Name (common and scientific (taxonomic group, genus and species) and commonly used synonyms) of the organism(s) being proposed for introduction or transfer;
2) Describe the distinguishing characteristics of the organism and how it may be distinguished from similar species in its area of origin and proposed area of introduction. Include a scientific drawing or photograph;
3) Describe the native range and range changes due to previous introductions, and describe the ecological effects on the environment of the receiving area (predator, prey, competitor, and/or structural/functional elements of the habitat, mass occurrences);
4) Describe the nature of the planned activities using the candidate species and alternate strategies should the original plan not achieve the expected results;
5) Describe the objectives and rationale for the proposed introduction, including an explanation as to why such an objective cannot be met through the utilization of an indigenous species;

6) What is the geographic area of the proposed introduction? Indicate if the proposed area of introduction also includes contiguous waters that may have suitable habitat. Include a map;
7) Describe the numbers of organisms proposed for introduction (initially, ultimately). Can the project be broken down into different sub-components; if so, how many organisms are involved in each sub-component?
8) Describe the source(s) of the stock (facility) and genetic stock (if known);

A.3 Life History Information on the Species to be Introduced or Transferred (For Each Life History Stage)

1) Describe the physiological tolerances (water quality, temperature, including turbidity, oxygen, and salinity) at each life history stage (from early life history stages to adult, and for reproductive development) including any resting stages. What factors limit the species in its native range?
2) Describe the habitat preferences and tolerances for each life history stage in the currrent distributional range, including water depth, substrate types and adaptability to different habitats;
3) Describe the mode(s) of reproduction (including any asexual stages, i.e., fission) and natural triggers and artificial means for conditioning and spawning, or other forms of reproduction. Include duration of the pelagic stages (if present);
4) Describe how the species becomes dispersed and if there is any evidence of local or larger scale seasonal or reproductive migration(s);
5) Describe the feeding methods and food preferences for each life history stage. In case of algae describe the light and nutrient preferences;
6) Describe the growth rate and lifespan and where possible extrapolate likely rates of growth in the introduced area based on information from its native range and where it has become introduced;
7) Describe the known pathogens and parasites of the species or stock including epibionts and endobionts. Are there specific taxonomic groups that pose a risk? Is it a known carrier of pathogens or life history stages of harmful stages? Will it act, in its new environment, as an intermediate host for unwanted species?
8) Are any other species required for the presence of the introduced species to be successful?
9) List nearest populations and indicate why the potential source population is being considered over other sources (e.g., disease-free status of source population).

A.4 Interaction with Native Species

1) What habitat(s) will the introduced species be likely to occupy in the proposed area of introduction?
2) Will it compromise the existence of any protected species/species population?
3) Which native species are likely competitors or have a similar ecological function? Is local extinction of any native species or stocks possible as a result of the proposed introduction?
4) What will the introduced species eat/consume in the receiving environment? Will this predation/consumption cause any adverse impacts on the receiving ecosystem (e.g., impacts of the introduced species on the spawning substrata of local species)?
5) Will the introduced species establish itself in the proposed area of introduction or will annual stocking be required? (This question applies to species in open culture systems);
6) Can the introduced species hybridize with native species?
7) What is the potential for survival and establishment of the introduced species from closed culture systems should it escape?

A.5 Receiving Environment and Contiguous Waterbodies

1) Provide information on the receiving environment and contiguous water bodies such as hydrodynamics, seasonal water temperatures, salinity, turbidity, dissolved oxygen, pH, nutrients, pollutants, substrate and other relevant variables. Do those parameters match the tolerances/preferences of the species to be introduced, including conditions required for reproduction?
2) List species composition (the principal aquatic vertebrates, invertebrates and plants) of the receiving waters;
3) Are any of the species in the receiving environment known to be susceptible to the diseases and parasites found to affect the introduced species in its native range?

4) Describe the natural and/or man-made structures relied upon to prevent or enhance the spread of the introduced organisms to adjacent waters. Include flow rates and direction of flow that might distribute the introduced species;
5) Will the introduction compromise aquatic protected areas?
6) Are there any potential impacts on habitat or water quality as a result of the proposed introduction?

A.6 Precautions and Management Plan

1) Describe the management plan for the proposed introduction or transfer. This should include, but not be restricted to, the following information:
   a) details of the disease certification status of stock to be imported. Include information on stage of introduction (e.g., eggs, sperm, juveniles, etc.);
   b) setting-up of an independent national scientific advisory team;
   c) disease monitoring plan proposed for the introduced stocks following introduction or transfer;
   d) precautions taken to ensure that no unnecessary associated biota accompany the shipment;
   e) the nature of the pilot and pre-commercial phases including a contingency withdrawal plan;
   f) description of the quality assurance plan for the proposal; and
   g) precautionary measures that need to be met for each phase of development.

2) For closed contained systems, describe the chemical, biophysical and management precautions being taken to prevent accidental escape of any target as well as non-target taxa to recipient ecosystems. Provide details of the water source, effluent destination, effluent treatments, local drainage and proximity to storm sewers, predator control, site security, precautions to prevent escapes.

3) Describe contingency plans to be followed in the event of an unintentional, accidental or unauthorized liberation of the species from rearing and hatchery facilities or an accidental or unexpected expansion of the range deduced at the pilot or later stages. Also, describe a contingency plan to address the finding of a disease agent of significance (e.g., exotic disease agent to the area of introduction).
4) If this proposal is intended to create a fishery, give details of the objective. Provide an assessment of the socio-economic impact of such a fishery. Give details of a management plan, and, if appropriate, include changes in management plan for species, which will be impacted.

A.7 References

1) Provide a detailed bibliography of all references cited in the course of the preparation of the Proposal and Appendices.

2) Provide a list of names, including addresses, of scientific authorities and fisheries experts consulted and listed in the information provided.
3) Include taxonomic identification literature.
4) Refer to web-pages and other sources of information for further information (further reading).

APPENDIX B – RISK ASSESSMENT

The spreadsheet below was developed to assist in the review and final assessment of risks associated with introductions and transfers. Each box of the spread-sheet is linked through the numbers (e.g., A.3.6) to the information requested in the information requirement (see Appendix A Prospectus).

WGITMO recommends that the final conclusion of the risk assessor(s) (group of experts to be formed according to the proposal) be presented as a narrative report giving details justifying the conclusions reached.

Based on the information provided by the proponent of the request, the risk assessor(s) can rank the **risk estimate** as:

3 = high probability
2 = medium probability
1 = low probability

ND = no data

In addition the quality of the available data is assessed as **uncertainty estimate**:

4 = very certain
3 = reasonably certain
2 = reasonably uncertain
1 = very uncertain
ND = no data

Table 1. Risk assessment table outlining the risk estimate and the uncertainty estimate (* Number and letter code refers to information requirements of the Prospectus (see Appendix), nis = non-indigenous species).

Assessment parameter	**Risk estimate**	**Uncertainty estimate**
Estimate of probability of the organism successfully colonizing and maintaining a population in the intended area of introduction		
Adequate food resources, A3.6*, A.3.7		
Habitat suitability, A.3.3		
Biotic resistance, A3.9		
Abiotic resistance, A3.2		
Can reproduce, A.3.2, A.4.5		
If organism escapes from the area of introduction, estimate the probability of its spreading		
Ability for dispersion, A2.6, A.3.5		
Estimated range of probable spread, A.2.6, A.3.5		
Human intervention to retard, enhance spread, A.5.4		
Likely areas of further colonization, A.5.5		
Ecological magnitude on native ecosystems both locally and within the drainage basin		
Predation effects on native species, A.4.4		
Prey availability, A.4.4		
Habitat availability, A.4.1		
Does nis (non-indigenous species) enter or alter native habitats, A.4.4, A 5.5		
Does nis affect quantitatively or qualitatively the availability of food for native sp., A.4.4		
Does nis prey on species of concern, A.4.2		
Genetic impacts on self-sustaining stocks or populations		
Does nis encounter or enter species of concern, A.4.3		
Does nis affect the survival of local species A.4.3, A.4.2		
Does nis affect the reproduction of local species, A.4.2, A4.4, A 4.6		
Does nis affect the genetic characteristics of local stocks, A.4.6		
Probability of establishment estimate of a pathogen or parasite		
Estimate probability that a pathogen or parasite may be introduced and may encounter susceptible organisms or suitable habitats, A.3.8, A.5.3, A5.10		
Ecological impacts on native ecosystem		
Impacts within drainage basin, A.5.1, A.5.2		
Disease outbreak, A.5.3		

Assessment parameter	Risk estimate	Uncertainty estimate
Reproductive capacity reduction, A.5.7		
Habitat changes, A.4.4, A.5.7		
Mitigation factors (Note: Risk is lowered if the following are achieved)		
Health inspection certification, A. 6.1 a		
Pre-treatment for parasites, diseases, and parasites, A.6.1a		
Inspection for fellow travellers A.6.1d		
Disinfection prior to discarding water in which organisms arrived, A.6.1.c		
Vaccination, A. 6.1.a		
Disinfection of eggs, A. 6.1.a		
Importation as milt or fertilized eggs only, A. 6.1.a		
Use of quarantine for incoming organisms, (used as broodstock). Release F1 progeny only, provided no pathogens, parasites, or fellow travellers appear (Appendix C)		

Summary and final conclusions (narrative report) to be provided by risk assessor(s).

APPENDIX C – QUARANTINE

Quarantine

Quarantine is the separate holding, rearing, or both, of taxa in a facility or site, under conditions which prevent the escape or other movement of these taxa and associated organisms (i.e., disease agents, pathogens, epi-/endobionts) out of the location. Different periods of quarantine and security level may be required depending on the risk of introducing reportable disease agents or previously undetected disease agents of concern. Although most quarantine systems target only the containment of disease agents and parasites, non-pathogenic epi-/endobionts may also require that a target species is held in quarantine, because such organisms may still pose a threat to the ecosystem. This makes it necessary to keep a target species in quarantine long enough to detect all non-target species, even if no pathogens or disease symptoms are found.

During the quarantine period, the imported/transferred aquatic organisms are held in a quarantine unit. To accomplish this, general principles which apply to all quarantine units for aquatic species are given below. The individual construction and approval of the unit and the length of the quarantine period remain with the operator and the jurisdiction into which the introduction or transfer takes place. The quarantine duration needs to take into account the life history of the imported aquatic organism.

For the operation of an effective quarantine unit, the operators will need to take the topics below into account when constructing and maintaining the quarantine unit.

Effluent and Waste Disposal

All effluent and wastes generated within a quarantine facility should be treated in a manner that effectively destroys all disease agents and associated organisms/taxa. To ensure continuous operation and complete containment, quarantine effluent treatment systems should be equipped with fail-safe backup mechanisms.

Treated effluent and waste may contain substances deleterious to the environment (e.g., active disinfectants). The discharge should therefore be disposed of in a manner that minimizes environmental impact.

A detailed documentation of effluent and solid waste treatment should be prepared, listing the operational personnel responsible for treatments and timing; monitoring of the system to ensure effective operation and act as early warning system for possible failures is useful.

Physical Separation

Quarantine for aquatic organisms requires that the imported/transferred organisms are separated from other organisms in a system to ensure containment of animals and disease agents, to prevent entry by birds and other animals, to prevent entry by unauthorised personnel, and to prevent disease agents and contaminants from entering the quarantine unit.

Personnel

Access to a quarantine facility should be restricted to trained, authorised personnel. Footwear, hands, and any material used within the facility need to be disinfected (presented below under heading Disinfection) before exit from the facility.

Equipment

Upon receipt, all life-stages, tanks, water, shipping containers, and equipment in contact with the imported species—including the transport vehicles—should be handled to ensure that there is no escape of the individuals or associated disease agents and/or fellow travellers from the facility. All shipping and packing material should be disinfected or burned.

All equipment and supplies used within a quarantine facility should be disinfected in a manner that will effectively destroy disease agents before removal from quarantine.

Mortalities and Disposal

Daily records of mortalities should be maintained and be available for inspection, where required.

All mortalities should be kept on site. No mortalities, body parts or shells should be discarded without approved treatment to ensure complete disinfection. Heat treatment such as autoclaving or chemical sterilization can be employed.

The cause of mortalities should be determined in a timely manner by a veterinary practitioner or laboratory trained to investigate diseases and parasites of the imported aquatic organism.

Inspection and Testing

Regular inspections for reportable disease agents should be carried out. If a reportable disease agent, or previously undetected disease agent, is identified in any life-history stage of animals in a quarantine facility, actions necessary to control the disease should be taken. These actions may include destruction of all animals in the facility and disinfection of the facility.

Following removal of all life stages of the taxon from the quarantine facility, further monitoring and testing of the aquatic organisms for reportable disease agents or non-pathogenic epi-/endobionts and imposition of additional restrictions is recommended. As outlined in the ICES Code of Practice, “only progeny of the introduced species may be transported into the natural environment” and then only under certain conditions.

Duration

The required duration of quarantine will vary according to the aquatic taxon, seasonality of pathogens of concern, rearing conditions, and reason for quarantine containment.

Record Keeping

All quarantine and isolation facilities and sites should maintain accurate records of the following:

- entry/exit times of personnel, all of whom should have authorization for access;
- numbers of mortalities and method of storage or disposal;
- effluent and/or influent treatments and monitoring of residuals;

- sample submissions to a laboratory to test for diseases and parasites of the imported organisms as well as for non-pathogenic epi-/endobionts; and
- any abnormal conditions affecting quarantine/isolation operations (power outages, building damage, serious weather conditions, etc.).

Disinfection

The general principles pertaining to disinfection of aquaculture facilities (hatcheries, holding facilities, land-based ponds, etc.) involve the application of treatments in sufficient concentrations, and for sufficient periods of time, to kill all harmful organisms which otherwise would gain access to surrounding aquatic ecosystems. Since the inherent toxicity of disinfectants prohibits safe use in open-water or in flow-through systems, disinfection can only be applied with reasonable control within hatcheries, tank or isolated pond-holding facilities. It is recommended that all disinfectants be neutralised before release into the surrounding environment and facilities based on seawater deal with the residual oxidants produced during chemical disinfection.

The disinfectants and concentrations should be based on complete seawater sterilization and are applicable to routine disinfection for facility maintenance, as well as quarantine disinfection.

In case of an emergency such as the finding of an imported disease agent or parasite, sufficient disinfectant should be available to enable a treatment of the entire facility.

The World Animal Health Organization (Office International des Epizooties) has provided information on the disinfection of fish farms (see: International Aquatic Animal Health Code, 2002, Office International des Epizooties 2002 - www.oie.int).

A model for quarantine for both freshwater and marine systems can be found in the Australian AQIS system. (The import conditions for live fish may be found on www.aqis.gov.au/icon).

APPENDIX D. MONITORING

The purpose of the monitoring program is to verify that the introduction is performing according to the proposed prospectus for release of the organism. Thus, the monitoring needs to address issues related to three separate levels during the introduction process: 1) a "pre-baseline" review, 2) monitoring during pilot release phase, and 3) subsequent monitoring.
The following is adapted from Managing Troubled Waters, the Role of Marine Environmental Monitoring, National Research Council, Washington, D.C. published in 1990.

The monitoring report must identify resources at risk.This information should have been included in the Prospectus (Appendix A). Information on select species most likely to be impacted (prey, competitors, potential species for hybridization) and/or physical alterations (changes in current light etc.) must be part of the pre-baseline review and must be re-visited in the subsequent two reports to ensure that the impacts were accurately predicted or if there were additional or different impacts.

The proponent should develop a conceptual model appropriate to each pilot project (e.g. use the *Patinopecten yessoensis* in Appendix F as an example) and highlight the issues of concern with an endpoint of acceptability or unacceptability, see Box 1 for some examples. The monitoring will result in caution levels and warning levels depending on the findings/results of the studies undertaken.

A caution level recognized during the monitoring phase may result in the need for additional studies to be carried out, with acceptable results, before the next stage of the introduction into the environment is acceptable.

A warning level: a decision from the regulatory agencies in the importing country is required before the project can proceed to the next step (e.g., further releases, or expansion of the project) or if the project is to be discontinued.

1. Establishment in nearby areas: the requirement is to monitor nearby areas at appropriate time frame after spawning.

2. Competition with other species for food/habitat: Laboratory studies are needed (e.g., re-circulating tank studies to examine behaviour, stomach contents and habitat preferences as juveniles and adults).

3. Spread of pests and diseases: The information on the presence of pathogens in the source population, the initial introduction phase, and/or the population investigated during the pilot release phase may lead to a caution level or a

warning level, depending on the type of pathogen detected and the stage of the introduction.

4. Mass mortalities: Because the use of mass mortalities may be related to cultivation practices, the culture practice itself should be self-monitoring and part of the pilot project proposal. If mass mortalities occur, they should be examined for pathogens, pest, and diseases to elucidate whether a) there was an escape of a pathogen or whether b) it was a native causative organism likely to endanger the project. The caution level is an occurrence of a mass mortality in the field (and triggers an analysis of the reasons both environmental and potential surveys of pathogens). A warning level is the presence of pathogens (native or not) that would require a delay in continued culture until satisfied that the disease/pathogen was not released. Thus no additional monitoring is needed if there are no mass mortalities.
   The warning level comes into effect at any significant mortality event.

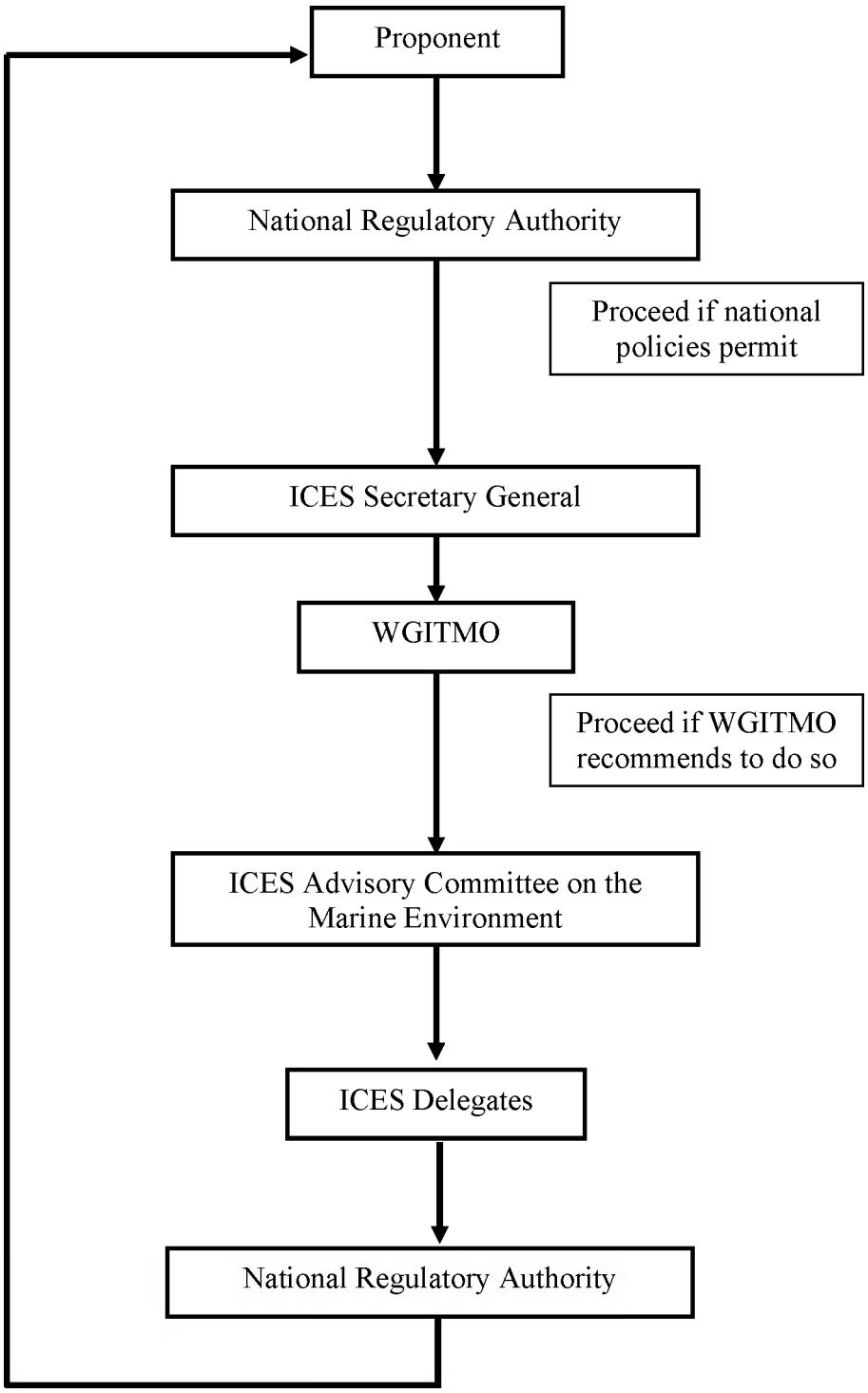
5. Potential for hybridization: Monitoring of spawning periods of native and introduced species. The caution level is (a) evidence of spawning outside the predicted range during the pilot project or (b) that there is evidence of hybridization with local species in lab studies. If there was hybridization in the lab then there is a warning level and a decision would be required before proceeding.
6. Ability to live in conditions of the receiving environment: this is based on known physiological information (taken from initial prospectus).
   Also, there should be water quality monitoring on a regular basis that examines (1) dissolved oxygen, (2) changes to benthos outside acceptable zone. The caution levels come into effect when a given level is exceeded (e.g., dissolved oxygen at the country level of acceptability (5-6 mg/L in MA), no shift to pollution tolerant species (e.g. capitellids, spionids etc.) outside modelled zone of impact as the caution level and additional monitoring to see if it is a transient occurrence or long term occurrence.

   The monitoring will be increased in scale to accommodate future expansion.

Box 1: Negative hypotheses that may aid direction for monitoring of an introduction.

1. The expected growth is not realised and so the species is unlikely to be profitably used.
2. The species appears outside intended area of introduction
3. The species will significantly alter normal trophic pathways
4. The substratum will be altered
5. The species becomes elusive to capture
6. The species is susceptible to native parasites, pests or/and diseases
7. The species is readily consumed by native predators
8. Reproductive development is not synchronised
9. Species is prone to translocation by natural vectors (i.e. storms)
10. The species acts as an intermediary host for a pathogen/pest
11. Others?

APPENDIX E– FLOWCHART



APPENDIX F *PATINOPECTEN YESSOENSIS*—A CASE STUDY OF A PREVIOUS INTRODUCTION

A CASE HISTORY OF THE INTRODUCTION OF THE JAPANESE SCALLOP FROM JAPAN TO IRELAND USING THE ICES CODE OF PRACTICE ON THE INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

Introduction

The Japanese scallop, *Patinopecten yessoensis* (Jay), was introduced to Ireland following requests by an Irish fish and shellfish processor, the promoter, to cultivate the species on the southeast coast of Ireland. The earliest discussions took place in late 1988 at which time it was agreed to follow the procedure set forth in the revised ICES Code of Practice of 1988. The use of the Code was rigorously tested by Irish Department of the Marine (DOM) and by the ICES Working Group on the Introduction and Transfers of Marine Organisms (WGITMO) and was subsequently modified based on the experience of this introduction. Two meetings of WGITMO in 1989 and 1990 were required before the modified project was deemed acceptable by ICES for the project to proceed. Progress reports were submitted at following annual meetings of the WGITMO and continued until 1994.

This contribution consists of two chapters A, the Management of the introduction of the Japanese Scallop from Japan to Ireland and B, the Scientific Assessments.

Chapter A

MANAGEMENT OF THE INTRODUCTION OF THE JAPANESE SCALLOP FROM JAPAN TO IRELAND

1988–1989: Initial Discussions

In early 1989 a leading processor of fish and shellfish, the promoter, made a formal request for developing a Japanese scallop (*Patinopecten yessoensis*) aquaculture business on the Irish Coast. The project was first discussed with scientists of the Irish Department of the Marine (DOM), in November 1988, at which time the ICES Code of Practice was adopted as the protocol for proceeding with the proposed introduction. The promoter's initial plan was to introduce spat for direct release into the sea at a later stage following clearance from pathogens and parasites. However, the Code does not permit the release of the original broodstock imported. The spat would need to be cultured to maturity to produce an F1 progeny, which then could be released, and only if no parasites or pathogens were associated with this F1 generation. Thus, based on the Code, the initial proposal to introduce spat following a short period of quarantine was rejected by the Irish Minister for the Marine, on the advice of the scientists examining the proposal.

A further proposal based on the introduction of hatchery-reared eyed umbonate larvae (the stage before settlement) to quarantine, which at a subsequent time could be released to culture in the sea, was discussed. There was uncertainty about whether this would be permissible, because the larvae could be classified as the original import (i.e., comparable to brood stock) being released to the sea. This proposal was based on what had become at this time standard practice for the international transmission of the eyed umbonate larvae of the Japanese oyster, *Crassostrea gigas*. Thus, the principle of transferring eyed oysters had already been established but the Irish DOM considered this an unacceptable approach for *P. yessoensis* unless these were to be used as broodstock.

The ICES Secretary General was informed about the intended project to introduce the Japanese scallop to Ireland and the DOM sought the advice on this matter through the Working Group on Introductions and Transfers of Marine Organisms (WGITMO).

1989

At the WGITMO meeting in Dublin in May 1989, the planned introduction of *P. yessoensis* to Ireland was described. A presentation was made by the promoter as to the reason for the introduction, based on economic projections and known ease of culture. The following documents were provided in advance of the meeting:

- Status report on the Japanese scallop, *Patinopecten yessoensis* (Jay), with reference to the Proposal for introduction into Irish waters: with a review of its biology, culture techniques and possible consequences of introduction.
- Information relating to the biology, fisheries and cultivation of scallops, together with supporting documentation on the species to be introduced and for the biology of the native scallop and inspection and certification requirements to evaluate the potential risk of introducing unwanted pathogens.

The WGITMO members wished to discuss the project further with their national experts before commenting, but did not oppose the introduction of adult broodstock to Irish waters provided that the correct quarantine measures were adhered to. A number of questions were raised:

1. Unexplained mass mortalities of scallops in culture in Japan
2. Genetic risk to native commercial scallops
3. Possible competition with other scallops
4. Possible introduction of other organisms with the scallops
5. Would Japanese scallops thrive in Irish waters?
6. Would Japanese scallops become established outside Irish waters?

These questions required further consideration and the DOM endeavoured to answer these questions for the 1990 WGITMO meeting. A study visit to Japan to address these areas of concern took place in advance of the 1990 meeting and at the expense of the promoter.

1990 Assessing Information

In January–March 1990, letters of concern relating to the introduction were published in Irish national newspapers. A United Kingdom agency sought further clarification about the importation. The DOM endeavoured to collate further relevant literature and carry out a risk assessment of such an introduction that included a study visit, by DOM staff, in Japan in March–April 1990. At the same time, a quarantine facility was constructed under the supervision of the DOM by the promoter.

At the June 1990 WGITMO meeting in Halifax, Canada, additional support for information already presented in 1989 and from the study-visit in Japan was presented to address the concerns endorsed by the ICES Council.

In addition further presentations included statements on the layout of the quarantine facility, procedures to be employed

at this facility, health certification of the source facility, histological studies, and administrative matters and policy.

Following two days of discussion, WGITMO reported to the ICES Council (ICES, 1991):

The Department of the Marine, Ireland, has submitted to the Council a request for advice on the introduction of Japanese scallops, Patinopecten yessoensis*, to open waters of Ireland. Steps outlined in the ICES Revised Code of Practice have been followed meticulously by the Department. The following advice is offered by the Working Group to go forward to Council:*

The Working Group,

(1) does not oppose the continued development of Patinopecten *culture in Ireland, in the form of field trials that would assess their survival, growth, and gametogenesis in open waters pending verification of a pathogen-free F1 progeny and hatchery brood, including the stock destined for open release.*

(2) finds that upon careful examination of available scientific evidence assembled by Ireland, commercial-scale development of Patinopecten yessoensis *populations in the open sea will very likely lead to the establishment of natural (wild) populations and possibly their eventual (albeit slow) spread,*

(3) urges that Ireland should provide to the Working Group annual records of release sites, dates, and numbers as part of their national report, and carefully monitor the occurrence, extent, micro habitats, health and concomitant ecological relationships, if any, with native biota, of wild populations if such become established (with a particular focus on any competitive interactions with the native scallops).

While the appraisal of the proposal was in progress, the DOM permitted the importation of the first broodstock consignment to the quarantine facility in April 1990. This was on the understanding that these, and their progeny, would remain in quarantine until such time as definitive advice on the overall proposal was received from ICES. It was necessary to import the broodstock at this time (their normal reproductive period), so that larvae could be produced at the quarantine facility because otherwise the project would be delayed a year. ICES, following the 1990 Statutory Meeting, informed DOM that they did not oppose the development of field trials subject to the condition that there would be status reports of the project presented to the WGITMO for review.

1991 Summary of Report to WGITMO

The main points in the status report submitted to the WGITMO in June 1991 were:

- Histological studies, using 150 Japanese scallops produced in each batch of scallops at the quarantine facility, in the spring of 1990, showed no indication of disease or parasitic organisms. The scallops in quarantine were then released to the wild in pearl nets on longlines.
- Comparative growth between the native scallop *Pecten maximus* and the Japanese scallop, *P. yessoensis,* of the 1990 year-class took place in pearl nets at the longline site at varying densities 20:40:80:160 per pearl net. Both species suffered shell distortions and interrupted growth and had high mortalities (about 90%). There was poor growth with dense fouling of pearl nets from hydroids, tube-building amphipods, sponges, and bryozoa. Some native scallop *Aequipecten opercularis* had settled on the outside of the pearl nets.
- Japanese scallops of the 1990 spawning, released to the sea, did not show any indication of reproductive development.
- Twenty males and 51 female broodstock of *P. yessoensis* were imported in March 1991 from the same source as the previous broodstock. These spawned and produced a settlement after 20–28 days; the higher survival and reduced larval period indicated a better condition than in 1990.

1992 Summary of Report to WGITMO

The 1992 report was as follows:

Three introductions of adult broodstock were brought into quarantine under the supervision of the Department of the Marine. Scallops were released from quarantine in September 1990 and were held in hanging culture near Carnsore Point on the south-east coast alongside native scallops (Pecten maximus). *Of this year class, 118 remain. Samples of these animals taken in April did not show any pathological condition or parasite loading.*

In March 1991 the quarantine facility was re-opened in advance of receiving 20 male and 51 female broodstock. The adults came from Utatsu Bay in Miyagi Prefecture, Japan - the same source as the 1990 introduction. There were five spawnings over a twenty-day period during March and April. All adults, after spawnings, were destroyed. Settlement of larvae took place 20–28 days after spawnings. In June there were noticeable mortalities of spat following strong south-easterly winds that caused large amounts of algal debris to accumulate on the shore close to the sea water intake. At this time scallop mortalities were high and the rate of growth declined. There was a Vibrio infection of the mantle margin and all spat were then destroyed. On no occasion did scallops from the 1991 year-class leave quarantine.

There will be no importation of broodstock in 1992.

In 1994 the project was terminated, the longline holding the F1 broodstock was torn from its moorings in a storm. The longline was recovered but all of the scallops were dead.

Although the project ultimately failed, given different circumstances it could have been successful. The onshore quarantine laboratory was made secure in advance of any consignments. Adult broodstock were imported close to breeding condition. Sufficient numbers of F1 individuals were produced, but their subsequent culture in the sea on completion of quarantine requirements took place in an exposed area on the insistence of the promoter. On account of the exposed culture site, there was entanglement and fouling of the longline system and shell overlapping that resulted in high mortality. Servicing of the cultures could only take place when the sea-state was suitable, limiting the possibilities for practical management. Despite these difficulties, the procedure adopting the ICES Code of Practice was successfully carried out.

Chapter B

SCIENTIFIC ASSESSMENTS

The ultimate objective of introducing the Japanese scallop *Patinopecten yessoensis* to Irish waters was to develop commercial hanging culture. Initially its survival and growth in a pilot culture scheme would be compared with that of *Pecten maximus*, the main commercial scallop species in Ireland, to determine whether the imported species was suitable for large-scale culture. Sites on the south and west coasts were selected for possible ongrowing following quarantine. All parent *P. yessoensis* were introduced to a quarantine facility on the Southeast coast of Ireland, under the supervision of the Irish Department of the Marine.

Introductions of larvae from Japan, intended to eventually act as broodstock, did not survive. Importations of adults took place in April 1990 and March 1991. These were spawned and the subsequent F1 generations settled. All adults were destroyed following spawning. The young scallops remained in quarantine until the F1 generation of the 1990 importation was released to the sea in September 1990. Those spat produced in the quarantine laboratory in 1991 were destroyed following a large mortality during a period of poor water quality. The surviving 2,500 spat of the 1990 spawning were to form the basis of a parental broodstock on which the project would depend.

The main contents of this document were presented to the Working Group on Introductions and Transfers of Marine Organisms to address their concerns and subsequently by the Mariculture Committee of the International Council for the Exploration of the Sea (ICES) at 1989 meetings. Subsequent developments were reported in the following year. The report was based on studies of the literature, a visit to Japan (to meet with biologists, oceanographers, pathologists and fishermen) and correspondence with internationally recognised scallop biologists, affiliated with the International Pectinid Workshop.

Scallops were sourced from Onagawa Bay, NE Honshu Island in Japan. Here the annual sea temperatures range from approximately 6–22°C.Temperatures at the depths of culture range from 6–20 °C, with cooler and warmer temperatures inshore in winter and summer, respectively (Misu, 1990; Arimoto, 1977).

IMPACT HYPOTHESES (taken from the original assessment)

1. THAT JAPANESE SCALLOPS COULD BECOME ESTABLISHED OUTSIDE IRISH WATERS.

The scallops are to be cultivated in intensive hanging culture. Their growth and reproductive development will be monitored based on spat released from quarantine. The project will proceed on a pilot programme in advance of becoming a commercial production with an option of withdrawing all cultivated scallops should any significant and negative effect be predicted or determined.

Japanese scallops, once mature, have the capability of spawning and small initial releases, on account of the small numbers held in captivity, would provide a small inoculum with a low probability of the species becoming established. This is because the moderate to strong water currents in the culture area would result in a high degree of dispersal of larvae. Increased production of scallops would undoubtedly increase this risk. In tandem ecological studies, including dredging of areas near the culture site should provide sufficient information on the extension of the cultured population to the wild. Because the conditions in Ireland are suitable for growth and reproduction, it is likely that the species will eventually become established in the wild. It is probable that a large source population is required before the establishment of a wild self-reproducing population becomes likely. The critical size of the source population required is not known, but will depend on local hydrographic conditions. For this reason, a small adult biomass is recommended in pilot studies so that a full evaluation of scallop growth and reproductive development can be undertaken, to ensure that its expectations for culture can be realised. All stock held in the wild were held in cages so that, should any unwanted effects be noted, the stock could be removed.

In Japan the establishment of cultivation in new areas is thought to have produced some recruitment to the natural populations in nearby regions, but this has not been quantified. Larval numbers will clearly be dependent on population size, and in Mutsu Bay a direct relationship between spawning stock biomass and settlement onto collectors has been found to exist. Annual settlements are known to be highly variable in most scallop species, however.

2. THAT JAPANESE SCALLOPS MAY COMPETE WITH NATIVE SCALLOP SPECIES

Pecten maximus ranges from Norway to the Canaries but is exploited from Spain to Norway from the lowest tidal level to depths of 180 m. It is found on all Irish coasts, particularly within shallow bays. *P. maximus* is found on a wide

range of sediments, from soft mud to coarse gravels, although there would appear to be a preference for sandy mud (Minchin, 1984). These substrata and greater depth range represent a wider distribution than has been described for the Japanese scallop. Should *P. yessoensis* become established in Irish waters, it is expected that it will overlap the range of *P. maximus*. However, it is unlikely that their ranges would coincide. *A. opercularis* is also found over a wide range of substrata, but is more frequently associated with muds and sands to depths of 46 m (Mason, 1983).

P. maximus and *A. opercularis* coexist in European waters with overlapping ranges without apparent detriment. It is expected that *P. yessoensis* would behave in a similar manner should it become established. The only likely competition is expected to be for food, and this may not be significant when compared with the biomass of other filter-feeding organisms present.

It can be deduced from the Japanese literature that the larvae or settled spat of *P. yessoensis* are unlikely to compete with those of Irish pectinids, because spawning takes place in the early spring. However, there may be competition as juveniles or adults, where its distribution overlaps with that of other scallops, but this is not seen in Japan. Studies in tanks, and in the field, of *P. yessoensis* with European native scallop species would be required to determine the interactions, behaviour, and sediment preferences as juveniles and adults.

3. THAT THE INTRODUCTION OF JAPANESE SCALLOPS MAY RESULT IN THE INTRODUCTION OF OTHER ORGANISMS

In NE Honshu, close to the region of the source population of scallops to be introduced to Ireland, movements of coastal and oceanic water masses into the Bay determine the phytoplankton successions (Hashimoto, 1990). In Hashimoto's study in 1989 dinoflagellates did not consist of more than 1.5% of the marine algal counts. Arimoto (1977), who examined the same bay in 1974 and 1975, did find small numbers of *Prorocentrum micans* in the late summer, and recorded the presence of *Dinophysis ovum* and *D. homunculus var. tripos* during the summer and autumn. DSP has occurred close inshore, and scallops (as well as other species) sampled in the summer of 1976 and 1977 were found to be contaminated (Yasumoto *et al.,* 1978). Seed collection areas that supply the cultivation areas also have problems with Diarrheic Shellfish Poisoning (DSP) contamination. Species found associated with this condition are *Dinophysis fortii* and *D. acuminata*, although *D. norvegica, D. rotundata,* and *D. mitra* were all recorded in southern Hokkaido, in 1989 (Hayashi, 1989; Yasumoto *et al.,* 1978). DSP is known to have occurred in this area since 1976, and there were serious outbreaks over the period 1978–1980 (Ventilla, 1982). This species does not appear to interfere with the growth of scallops, and sales can take place provided that the hepatopancreas, in which the toxin accumulates, is removed. Paralytic Shellfish Poisoning (PSP) contamination is not known from the Miyagi Prefecture, but is known in Funka Bay, an area that has sent scallops for adult cultivation on the Sanriku coast. The problems in Funka Bay in southern Hokkaido are serious and sales of scallops can be restricted for most of the year. The causative organisms are *Alexandrium (Protogonyaulax) tamarense*, which was first recorded in the autumn of 1988, and *A. catenella* (Hayashi, 1989). Here scallops are contaminated from May to October, and restrictions on sales of fresh meat for some localities can extend for as much as 290 days.

All water was filtered, in the Irish quarantine facility, in stages down to 5 μm and then treated with ultra-violet light before being used within the quarantine facility. Sterilisation of all used water was by means of an injected solution of sodium hypochlorite. Wastewater was contained within a 500 gallon drainage tank which, when filled to a predetermined level, activated a pump. The pump was linked to the hypochlorite injection system. The treated water was then held within a series of tanks at 250 ppm chlorine before being neutralised at the point of discharge. The required treatment to destroy algal cysts is not presently known, but the precautions were considered to be adequate at the time for treatment. The tanks also acted as settlement traps and will have contained particles for longer than the minimum residence time of 4.5 hours.

There is considerable fouling of the shell surface of scallops held in hanging culture (Arakawa, 1990). He describes 45 species that attach to the shell; the same species are likely to be found on the shell surface of scallops. Scrubbing the shells prior to transportation can control the majority of these species.

First described in 1971 in Mutsu Bay in sown scallops was a rhizocephalan-like parasite to become known as *Pectenophilus ornatus* (Nagasawa *et al.,* 1988). This parasite attaches in the region of the gill or adductor muscle and is claimed to impede growth. It is presently widely distributed in Mutsu Bay and is also found on the Sanriku coast. It can infest all scallops in a locality and can result in marketing problems (Elston *et al.,* 1985). This species cannot be transferred to the F1 generation using standard quarantine procedures; all scallop parent stock will be destroyed following spawnings.

Branchial rickettsiales-like infections are known in *P. yessoensis* and *Tapes japonica* and have been implicated in myodegeneration and mortality (Elston, 1986).

Prior to introductions, *P. yessoensis* adults were selected by size and condition, and their shells scrubbed. The consignment was met on arrival at customs by an officer of the Irish Department of the Marine who brought the scallops directly to the awaiting and supervised quarantine facility. Following unpacking, all waste was burned and dead tissues buried in lime. Living scallops, and their remaining epibionts, remained in quarantine. Wastewater was treated by chlorination at 250 ppm with a minimum treatment holding time of 4.5 hours.

Following spawning all eggs were sieved, washed, and separated from adults and their water. The original broodstock was then destroyed and the quarantine facility was operated until such time as the F1 or subsequent generations were devoid of known pathogens and parasites, determined by histology, and were in a healthy condition. These measures were considered sufficient to control and eliminate the risk of an introduction of known pathogens or parasites to the sea.

4. THERE WAS CONCERN OVER THE MASS MORTALITIES OF JAPANESE SCALLOPS IN CULTURE IN JAPAN

There was no evidence of any direct pathological implication in scallop mortalities in Japan. The most likely explanation for these mortalities would appear to have been physiological stress due to over-intensive cultivation. Saito (1984) suggested diseases as being one of a number of possible contributory causes of decreased production in Hokkaido following the dramatic twelve-fold expansion in production over the years 1971 to 1977. During this period, annual production rose from less that 6,000 metric tonnes to 70,000 metric tonnes. No evidence is adduced, however, to support this hypothesis. No further information relating to diseases was available during the 1990 visit to Hokkaido. Although mortalities still occur from time to time, the levels of losses that took place since 1972 have not been repeated. The following possible explanations for high mortality were offered:

- During grading scallops are exposed to the air and prolonged exposure can lead to mortality (Hayashi, 1988).
- Scallops handled during the day in the warmer months, and exposed to the sun, have higher mortalities. At temperatures >20°C, handling is normally avoided (Anon., 1980).
- High-density cultivation has continued to result in high mortality (Querellou, 1975; Ventilla, 1982). Scallops from one region had a deformity and browning of the shell margin and pallial atrophy (Mori, 1975). More recently, mortalities have declined considerably as a result of modified longline systems and reduced culture densities.
- Scallops can be drilled through the shell auricles ("ears") to take a monofilament which is then attached to a vertical array of hanging dropper lines suspended from a horizontal subsurface longline. Incorrectly drilled shells often perish (Sasaki, pers. comm.).
- In warmer waters, abnormal sexual development in scallops of less than one year can take place (Osanai, 1975). Development may be incomplete and so result in only partial spawnings at the normal time followed by partial adsorption of the remaining sexual products. Should scallops be held at a low temperature for insufficient time, they will enter the spawning period without full maturation, and this may explain the presence of sexual products found during summer months (Mori and Osanai, 1977). At higher temperatures, the maintenance of gonadal tissue is greater (Mori, 1975). These conditions impose stresses that may result in mortality, particularly if exposed to additional handling.
- *P. yessoensis* is a cold-water species tolerating temperatures from −2 °C to 21 °C. Once temperatures exceed 21 ° C to 24 °C, physiological stress results in reduced growth and often death.
- There is some indication that poor food availability as well as effects of wave action, termed "vibration" causing shell and soft tissue damage leading to mantle retraction, result in high mortalities (Mori *et al.*, 1974).
- Pseudofeces, waste matter and fouling organisms that descend to the seabed in areas of intensive off-bottom cultivation can result in a high organic loading, particularly in those areas where there is low dispersion and result in oxygen depletion (Anon., 1980). This can lead to losses.

5. THAT JAPANESE SCALLOPS MAY HYBRIDISE WITH COMMERCIALLY IMPORTANT EUROPEAN SCALLOPS

There are no known hybrids between *P. yessoensis* and other scallop species found within its range. These include *Pecten albicans, P. sinensis, Chlamys swiftii, C. farreri nipponensis* (Kijima, pers. comm.). *P. yessoensis* has 19 chromosome pairs, three of which are acrocentric, whereas in *P. maximus* there are the same number of chromosomes but 14 of these are acrocentric (Beaumont and Zouros, 1991). *A. opercularis* has 14 chromosome pairs (Rasotto *et al.*, 1981) or 13 (Beaumont and Gryffydd, 1975). Recombination with European species is very unlikely. In Japan both *P. albicans* and *Chlamys farerri* have 19 chromosome pairs.

The expected spawning period of *P. yessoensis* in Irish waters (March and April) is unlikely to overlap that of *P. maximus*. In many coastal areas of Ireland, spawning of *P. maximus* occurs form May to August (Gibson, 1956), except perhaps on occasions within the Irish Sea where spawning has been recorded over a sea temperature range of 7.2–13.7 ° C (Mason, 1958). *A. opercularis* spawn predominantly in the autumn, with smaller spawning peaks in the early spring and summer (Paul, 1978), mainly outside the anticipated spawning time of *P. yessoensis*. The opportunity to hybridise, should this for some reason be possible, is thereby considerably reduced.

6. THAT JAPANESE SCALLOPS ARE UNLIKELY TO THRIVE IN IRISH CONDITIONS

All indications are that conditions in Ireland are favourable, sea temperature ranges fall within the optimum range for the species, and all likely cultivation areas have appropriate salinities.

In Japan development of the gonad begins once sea temperatures fall below 10 °C, and it is important that at least two months of temperatures below 10 °C are maintained (Matsutani, pers. comm.). Sea temperatures below 10 °C are found about Irish coastal areas, and those regions within shallow bays may be expected to have lower and higher temperatures, more closely corresponding to air temperatures. With a rise in sea temperature spawning commences, and lasts approximately one month with no further subsequent spawning until the following year. This is unlike the native European species, which in Irish waters have a number of spawning periods throughout the year, but principally over the period late spring to autumn. In *P. yessoensis* the time of spawning depends on the geographical locality, those farther north spawning later. Spawning at the southern end of the range, in Miyagi Prefecture, takes place in March/April (Sasaki, pers comm.) and in Posjet Bay in the Russian Federation in late May to August (Golikov and Scarlato, 1970). Expectations of spawning in Ireland would coincide with a steady rise in sea temperature in March/April.

The temperature for optimal growth in *P. yessoensis* is 15 °C and at some localities in Japan the depth of cultivation is adjusted to coincide with these temperatures (Sanders, 1973). Throughout the range of *P. yessoensis* in Japan there is a greater range of sea temperature, −2 °C to 24 °C, but scallops are very unlikely to be exposed to such a range in Irish waters. It is very unlikely that sea temperatures will rise as high in Irish waters even inshore. Lowest sea temperatures in Ireland are probably about 2 °C in shallow bays during periods of sustained cold in late winter. Conditions in Irish waters would appear to be optimal for good growth rates for *P. yessoensis*.

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