COOPERATIVE RESEARCH REPORT

No. 116

STATUS (1980) OF INTRODUCTIONS OF NON-INDIGENOUS MARINE SPECIES TO NORTH ATLANTIC WATERS

(Amendments and Additions to Cooperative Research Report No. 32, 1972)

International Council for the Exploration of the Sea

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INTRODUCTION

The International Council for the Exploration of the Sea has, since 1969, concerned itself with problems associated with introductions and transfers of non-indigenous marine organisms. A Working Group was formed in 1970 to "...consider the principles which might govern the introduction and acclimatization of non-indigenous marine organisms, especially shellfish and anadromous and catadromous fish species ...".

One of the early activities of the Working Group was to assemble information from ICES member countries about the status of introduced species, using responses to an elaborate questionnaire covering many aspects of the subject. The available information was summarized in ICES Cooperative Research Report No. 32 (1972) titled "Report of the Working Group on Introduction of Non-Indigenous Marine Organisms". The report was designed to "...form the basis of a reference work which can be continuously revised to cover omissions and additions".

During the decade of the 1970's there have been significant new introductions, and changes in the status of populations resulting from earlier introductions. It seemed timely and necessary for the members of the current ICES Working Group on Introductions and Transfers of Marine Organisms to update and summarize the present (1980) status of introduced species in member countries. This report is a response to that need; it emphasizes developments since the publication of Cooperative Research Report No. 32 (1972).

The detailed questionnaire used to request information for the earlier report has been used to obtain information for this report (Appendix I). The same section headings have been used in both reports, for continuity and ease of comparison. As with the earlier report, responses were received from many, but not all, ICES member countries. Some responses were detailed, and others were minimal. Countries responding were Canada, Denmark, Federal Republic of Germany, France, Ireland, Netherlands, Norway, Poland, Spain, Sweden, U.K., U.S.A., U.S.S.R.

1.0 RELEVANT LAWS AND REGULATIONS IN ICES MEMBER COUNTRIES

Laws and regulations concerned with introductions and transfers of non-indigenous marine species vary widely from one ICES member country to another. Some still have no relevant legislation, some may have legislation but it is not enforced, some have incomplete coverage of all species, and some have excellent control of all imports, as exemplified by the Republic of Ireland where the law is interpreted to prohibit the import of all living aquatic animals, freshwater and marine, except under license.

There have been changes and in some cases improvements in relevant national laws and regulations since the preparation of ICES Cooperative Research Report No. 32 in 1972. The following paragraphs identify some of the more significant developments.

In Canada, regulations under the Federal Fisheries Act prohibit the introduction of non-indigenous species into all Atlantic provinces and British Columbia except by special permit. For the Gulf and Scotia-Fundy Regions of Nova Scotia, New Brunswick and Prince Edward Island, new regulations concerning "Introduction and Transfer of Aquatic Species in the Maritime Provinces" are in the final stages of preparation. These will supersede those regulations presently in place and give force of law to a number of guidelines currently used to control stocking of all aquatic species.

The 1969 Salmonidae Import Regulations which prohibited the introduction of live or dead salmonids or their eggs suspected of harboring viral hemorrhagic septicaemia and whirling disease were replaced in 1977 by the "Fish Health Protection Regulation". The essential difference between the two regulations is that, under the new, fish culture

facilities rather than shipments of fish must be certified as having no detected diseases or disease agents using approved protocols and procedures. The number of diseases or disease agents which must be found absent has been increased from the two listed above to include furunculosis, bacterial kidney disease, enteric redmouth disease, ceratomyxosis, infectious hematopoietic necrosis, infectious pancreatic necrosis, and any other filterable replicating agent capable of causing cytopathic effects on certain fish cell lines. These regulations apply to all interprovincial as well as international imports.

In the Atlantic provinces there are specific regulations under the Fisheries Act which prohibit the transfer of shellfish or shell stock from elsewhere in the area into Cape Breton and the Bras d'Or Lakes. These regulations include those which require the destruction of shellfish containers in which market shellfish have been imported from outside the Region.

The province of British Columbia has laws that restrict the movement of oysters (Crassostrea gigas) as well as boats and equipment used in the industry within the Province. The intent is to restrict the spread of the imported Japanese oyster drill (Ocenebra japonica).

In Denmark, apart from an order from the Ministry of Agriculture (dated February 23, 1966) on the prohibition of import of eyed ova and fingerlings and an order from the Ministry of Fisheries (dated September 7, 1971) on rules for the import of live oysters, no relevant laws seem to exist.

In the Federal Republic of Germany, legislation referring to aquatic organisms in coastal waters and in fresh water is a matter of the respective federal states. With regard to this paper the two states, Schleswig-Holstein and Niedersachsen, are mainly involved. The "Schleswig-Holsteinische

Fischereiordnung" regulates the introduction of non-indigenous fishes, crustaceans and molluscs. A special permit by the Ministry of Food, Agriculture and Forests of this state is needed, before an introduction can take place. The "Niedersächsisches Fischereigesetz" has provisions referring to the defense against diseases, parasites and other adverse effects arising from introductions. The Ministry of Food, Agriculture and Forests of this state has, e.g., the right to ask for a health certificate, before an introduction can take place.

In France, legislation concerning introduction of non-indigenous marine species is limited to shellfish, with the exception of winkles. For fresh water, the rural code prohibits the introduction into open waters of species which are not already present. The importation of eggs and salmonids for purposes of growout in culture facilities is authorized under certain conditions. Concerning the stocks from North America (all species), the eggs must be accompanied by a sanitary certificate and be given a bath of Wescodyne before shipment.

For marine animals, French legislation is based on the principle of prohibition with regard to importation for planting of all foreign shellfish. However, deviations which the administrative procedure permits can be made by the Maritime Affairs after advice from ISTPM. These authorizations are conditional and dependent on examination of imported shellfish by one of the Institute's shellfish laboratories. The exception for a species of given origin can be suspended in case of unfavorable observations, be it after examination of samples on their arrival in France, or during the period of observation during growout.

With rare exceptions, authorized planting is for the whole French coast. However, for sanitary control (planting of adult shellfish in polluted zones) or economic reasons (the case of denial of business with regard to planting of shellfish in the Thau) certain exceptions, permitted elsewhere, are not granted in this or that location.

It is worth noting the maintenance since 1972 of the prohibition of planting C. angulata from all sources in French waters for genetic and zoosanitary reasons (persistence of gill disease in those areas where the species is indigenous).

In the Republic of Ireland, the coastal Live Fish (Restriction of Import) Order of 1962 is literally interpreted to prohibit the import of all living aquatic animals, with few exceptions, except under license.

In The Netherlands, the Fishery Law of 1963 deals with the subject of management of coastal waters. It includes control and composition of fish and shellfish species, and covers the matter of introductions in Dutch waters, stating that "It is not permitted to increase the number of fish and shellfish species. Exceptions are only allowed under license granted by the Ministry of Agriculture and Fisheries".

In Norway, the Fish Disease Act, on measures against disease in fresh water fish (1968), defines anadromous fish as fresh water fish. The Act controls import of all live stages of fish. Under the provision of the Act concerning quality control of fish and fish products, the import of live shellfish and lobster is by special permission only. Work on a law concerning diseases of marine organisms including ecological consequences of imports, is in progress.

In Portugal, the introduction of non-indigenous marine animals is subject to authorization of the Ministry of Economy. For bivalve molluscs, advance permission must be obtained from the Ministry of Marine, based on advice from the Malacology Section of the Consultative Fish Commission; in the case of oysters a special "Regulation of the Oyster Industry" can be invoked.

In Spain, molluscan imports need a special permit to avoid the possibility of introduction of disease or other species. In order to avoid the introduction of disease, imports of eggs, alevins or adult fishes for population purposes need a special permit.

In Sweden, permission for import is given by the State Board of Agriculture. This refers to living "fish" imported for introduction into hatcheries, cultivation arrangements, and the field. Living fish for consumption can be imported on the same license as for dead fish, provided they go immediately to consumption, or are used for different fish products.

In the U.K., legislation concerning imports of live aquatic animals has undergone considerable evolution during the past decade. In England and Wales existing legislation was revoked and replaced by the 1974 Molluscan Shellfish (Control of Deposit) Order, the provisions of which are explained by Key (1977). Basically, this strengthens the defense against the introduction of new pests by forbidding any proposed deposit of molluscs from outside England and Wales, except under license granted by the Ministry of Agriculture, Fisheries and Food. With regard to limiting the spread of existing pests, arrangements for the control of molluscs taken from one area within England and Wales for deposit in another have been revised to cover all areas. The coast of England and Wales is now divided into 27 separately designated areas so that, although there is no restriction on movements for deposit within the boundaries of any one area, deposits from outside the area must be covered by a license.

Scotland is now covered by the Molluscan Shellfish (Control of Deposit) (Scotland) Order 1978 which forbids the deposit of any molluscs from outside Scotland, and the transfer of molluscs from infected to clean areas within Scotland, except under license granted by the Secretary of State for Scotland.

Under the Salmon and Freshwater Fisheries Act of 1975 the written authority of the relevant Regional Water Authority must be obtained before the introduction of fish or fish eggs into the inland waters of England and Wales. A new law has been passed which applies to Scotland only and is called the Import of Live Fish (Scotland) Act 1978. This restricts in Scotland the import, keeping, or release of live fish or shellfish, or the live eggs or milt of fish or shellfish of certain species. The Import of Live Fish (England and Wales) Act 1980 has just been passed to similarly cover England and Wales.

The laws of the United States, the Black Bass Act and the Lacey Act, provide some measure of national control over transport and introduction of fish and shellfish. The "Black Bass Act", as amended, makes it unlawful to transport to or from States, Territories, the District of Columbia, or a foreign country, any black bass or other fish caught, killed, taken, sold, purchased, possessed, or transported, at any time contrary to the law of the State, Territory, the District of Columbia, or a foreign country where such acts were committed.

The "Lacey Act", as amended makes it unlawful to deliver, carry, transport, or ship by any means for commercial or non-commercial purposes or sell in interstate or foreign commerce any mollusk or crustacean taken, transported, or sold in violation of laws of any State or foreign country or in violation of Federal law or regulation.

At present (April, 1980) there is proposed legislation before the Congress of the United States providing for control of interstate and foreign commerce in fish and wildlife (interpreted as any wild animal or its eggs, vertebrate or invertebrate, whether or not it is bred, hatched or born in captivity). The legislation would replace the Lacey Act, and would make it unlawful to import or export any fish or wildlife taken or possessed in violation of any law or regulation of the United States, any state, or any foreign country.

In the U.S.S.R., strict laws cover the transplantation of fish, invertebrates, marine animals and plants generally, which can only be introduced by permission of a Consultative Board after reference to the Commission of the Ministry for Fisheries and the State Sanitary Inspection. The most important aspect of the system is that the collection, transport and handling of any material is undertaken by special acclimatization units under the control of parasitologists and Sanitary Inspectors. This takes place only after full consideration of the likely consequences of the scheme and then under strict quarantine arrangements.

2.0 OTHER PROCEDURES CONCERNING INTRODUCED SPECIES

For most countries there have been few changes in procedures since 1972, except for a generally broader range of agencies and experts who would be consulted for advice. The responses to the question on procedures governing decisions on introductions generally refer to the demand for health certificates from the exporting country to accompany the introductions, and to advice given by different official bodies when permission for introductions is sought.

In Canada, a system of regional and national committees has developed specifically to consider introductions and transfers. A regional committee will deal directly with matters of strictly local relevance, but where interregional implications exist, the matter is referred to the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC). This body in turn advises the regulatory authorities on the desirability of the proposal and on procedures necessary to minimize risks.

Until 1976, the Resource Development Branch of the Canadian Fisheries Service acted as a general enabling body through which requests for information and authorization could be channeled. In 1977, the Fisheries Service for the Maritimes Region established an Advisory Committee on the Introduction of Non-indigenous Species to review, recommend on, and monitor all introductions. All Regions now have advisory committees which establish policies and guidelines for the management of introductions.

Where the Regional committees recognize a potential for interregional implications in an introduction, the matter is referred to the chairman of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) and

to the appropriate subcommittees of that body for scientific review. CAFSAC then provides Fisheries Management with advice as to the desirability of the introduction and the procedures necessary to its conduct.

Relatively straightforward proposals with limited implications are handled directly and expeditiously by the Regional committees; with more complex proposals, or those with potentially broad implications, both the Regional committees and CAFSAC make use of ad hoc committees to study proposals and prepare recommendations. One, a proposed policy with respect to rainbow trout (Salmo gairdneri) introductions to the Maritimes (N.B., N.J., P.E.I.), and to the transfer from area to area within these provinces, was prepared for the Maritimes Region Advisory Committee on the Introduction of Non-Indigenous Species; the other, a proposed policy for assessing the feasibility of introducing various Pacific salmon species to Atlantic waters, was prepared for CAFSAC. The species under consideration include: sockeye salmon (Oncorhynchus nerka), pink salmon (O. gorbuscha), chum salmon (O. keta), coho salmon (O. kisutch), and chinook salmon (O. tshawytscha).

In some cases, such as the introduction of the bay scallop (Argopecten irradians) to the Maritimes, biological assessments of potential may be published within established Departmental report series.

The Newfoundland Region is also in the process of developing guidelines for the use of rainbow trout by private trout farmers.

On Canada's Pacific coast, all introduction proposals are assessed by a joint Federal-Provincial Interagency Committee on Transplants and Introductions of Fish and Aquatic Invertebrates in British Columbia. As a tool, both in research and considerations related to introductions, Fisheries and Oceans has developed a computerized data bank which contains all historical records of finfish introductions and transplants and of all known disease instances.

In the Federal Republic of Germany there have developed informal arrangements of voluntary abstention by fishermen in importing eels suspected of carrying "red disease"; similar arrangements have been developed for oyster seed.

The first example concerns the import of elvers and fingerlings of the eel Anguilla anguilla. The introduction of young eels for stocking purposes has been commercial practice in Germany for more than 100 years. Today the "Deutscher Fischereiverband", an association of fishermen, abstains voluntarily from shipments from a given source, if there is a reasonable suspicion that eel fingerlings carry the "red disease".

The second example refers to the import of hatchery-reared seed oysters Crassostrea gigas. The states, and the fishermen who cultivate this oyster, rely voluntarily on the expertise of the "Bundesforschungsanstalt für Fischerei" with regard to information about the supply of seed from presumably safe sources.

In France, all imported shellfish stocks are subject to pathological examination; this has led to discontinuation of several imports. In a strict sense, there exists no other procedure in matters of the introduction of non-indigenous species than those stipulated by the strict regulation noted in Section 1.0. However, since 1974, in the application of the "code of practice to reduce the risks of adverse effects from the introduction of marine non-indigenous species" approved by CIEM on 10 October, 1973, all new species or species already introduced but of new origin are subject to preliminary pathologic examination at the same time as inquiries are made to the exporting countries. These proceedings, moreover, constitute only the preliminaries towards the granting of the first authorizations for importation, with a view to monitoring growth of these new species.

Since the beginning of 1980, the introduction of spat from all California hatchery species as well as spat from flat oysters in Greece has been suspended.

Concerning Italian oysters, from the very first the inspection has been augmented by preliminary analyses made on samples; these dealt with, on the one hand, a species identification by electrophoresis of the DNA with a view to eliminating C. angulata, and on the other hand, a systematic monitoring for pathogenic parasites or other organisms. Upon their arrival in France, the lots to be introduced were stockpiled in ponds for testing. By March, 1980, the importation of the Italian introductions had been stopped. From elsewhere, in the case of the importation of Japanese spat (very important between 1971 and 1979 and very limited since then), a dip in fresh water before shipment and upon their arrival in France has been made obligatory with a view to assuring the destruction of the worm Pseudostylochus. In certain cases, notably when eggs are observed, the treatment is carried out in fresh water containing a small amount of formalin. In another case, a quarantine facility has been anticipated in the Oléron Marennes region. At this time it has been used only occasionally and in an experimental manner.

In Spain, when permission or license is sought under existing regulations, the Instituto Español de Oceanografia is required to give advice in every case. A sanitary certificate from the exporting country is needed to obtain an import license.

In Sweden, the import of S. gairdneri (eggs or smolts) now mainly comes from Finland due to the risk of diseases transferred from other places. A few disease-free hatcheries in Denmark also provide S. gairdneri to Sweden.

In the United States, the President issued a Presidential Executive Order in 1977 which instructs federal agencies, within the scope of the law and advisory capacity, to prevent the introduction of exotic species, and to restrict the use of federal funds for export of native species. These restrictions do not apply if the Secretary of Agriculture finds that such imports or exports will not have an adverse effect on natural ecosystems. Also in the US, efforts are being made to organize various coastal states to review inconsistencies in their state law concerning policy on introductions and transfers.

To further the purpose and policies of the Lacey Act and related legislation, the President of the United States has issued Presidential Executive Order 11987 (May 25, 1977) which instructs federal executive agencies to the extent permitted by law, to restrict the introduction of exotic species into the natural ecosystems on lands and waters which they own, lease, or hold for purposes of administration; and, encourages the states, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States.

3.0 DELIBERATELY INTRODUCED ANIMAL OR PLANT SPECIES

For ease of description, this section has been subdivided into three sections: fish, invertebrates, and plants. In each category, where information exists, consideration is given to introductions for (1) fishery enhancement, (2) mariculture, (3) live storage prior to sale, (4) improvement of food supplied for other species, (5) research purposes, excluding use in hatcheries, (6) control of pests, (7) environmental alteration, (8) recreational purposes, and (9) other reasons.

3.1 Fish

During the 1970's there has been an upsurge in activities concerning salmonid introductions and transfers. Gains from fishery enhancement and mariculture have been the principal motives, but recreational motives also enter. The introductions and transfers can be viewed with concern from two aspects, namely the prospect they may introduce non-indigenous disease organisms, or they may be harmful to the ecology of the area of introduction or adjacent areas. On the first point, it is our impression that an increasing awareness of the risks of introducing disease organisms is occurring and that as a consequence measures are being instituted in many countries to ensure that introduced species, almost exclusively as eggs, are free of specified disease. However, it is evident that many countries do not consider the ecological implications of introductions and transfers, and this is reflected in the lack of national legislation authorizing government agencies to prevent or license importations. The complexity of the issues is an important factor here, as is the lack of documented guidance to help in decision making.

3.1.1 For fishery enhancement (establishment of new breeding populations)

Pink salmon (O. gorbuscha) eggs continued to be imported from the Soviet Far East to the Kola Peninsula of the Soviet Union and the Soviet Baltic states for ranching. Strays from these introductions have been caught by the fisheries of several states including Norway, Sweden, Iceland, and Scotland. Outside the Kola Peninsula, it is only in Norway that the straying pink salmon have been observed to achieve spawning in the wild. In the Kola area the Soviets recently reported termination of egg importation from the Far East in favor of stripping returning Atlantic fish and incubating their eggs through the harsh winter of that area, then releasing juveniles at the most appropriate period in the spring. Eggs from some of the fish straying to spawn in northern Norwegian rivers were used in a trial experimental release of fry in two of Norway's southern rivers in 1977.

Success of the Soviet pink salmon introductions is still uncertain, and runs still require augmentation by eggs from Pacific waters. Results of acclimatization of pink salmon differ along two lines. Returns of pink salmon of even years were conditioned by the release of the young reared from eggs which were delivered from the Far East. Natural reproduction of pink salmon of even years in the range of acclimatization was not effective due to late maturation of spawners. Eggs developed under low water temperatures; almost 100% of embryos in early stages of development were lost.

The spawning of pink salmon of odd years occurred two weeks earlier than that of even years. Thus, some of the embryos survived. In recent odd years at least (1971-1979) the returns of pink salmon in the range of acclimatization were conditioned by natural reproduction. Sharp decrease in pink salmon abundance in 1979 was caused by unusual early cold temperatures on the European north coast during the 1977 spawning season. Since 1979, the delivery of pink salmon eggs of odd years was stopped in order to prove whether the population could exist in the new range of distribution without constant augmentation by eggs from the Far East. Hatchery rearing of acclimatized pink salmon is done in very small quantities.

Also in the USSR, steelhead have been released into the Azov-Black Sea watershed. It was supposed that its abundance would be maintained both by natural and artificial reproduction, but there were single returns of spawners to spawning grounds. Steelhead spawners were recorded in several rivers of the Black Sea coast of Caucasus. The spawning stock of steelhead has been relocated to an experimental mullet hatchery (Belgorod-Dnestrovsky, Odessa region).

Before 1974, striped bass (Morone saxatilis) were introduced in different areas of the Azov-Black Sea basin to establish natural populations. In the Black Sea, 20 captures of striped bass were recorded (Dnestrovsky estuary, near Sukhumy, Poti, Evpatoria). The weight of fishes varied between 22 and 2,210 g. In the Azov Sea, 50 captures were recorded (the river Don, Taganrog Bay, southwestern Azov Sea). Fishes weighed 30-650 g. The portion of the young striped

bass was distributed between the hatcheries to establish the spawning stock (Azov cage station, Rostov region; Temryuk, Krasnodar region). The first maturation of striped bass was observed in 1978 (Krasnodar region) and 1979 (Rostov region). Females reached maturation at five years. In both cases juvenile fish were used for the establishment of the spawning stock.

Experimental introductions of Pacific mullet have been made in the northwestern Black Sea. Maturation has been observed but no data exist on the efficiency of natural spawning. Experiments with this species were begun in the Azov Sea (the city of Berdyansk) under controlled conditions. The main obstruction to acclimatization of Pacific mullet in the Azov-Black Sea basin is low water temperature in winter. Extensive information on Soviet introductions and transfers of fish and invertebrates is contained in Appendix III.

Pink salmon were transferred from the Canadian Pacific to southeastern Newfoundland (1959-1966). Reports suggest declining stocks in the areas where transplantations occurred, but observations of spawning at points remote from the introduction areas present a confused picture.

3.1.2 For mariculture

The biggest development in fish introductions has been the sustained annual introduction since 1970 of coho salmon to France, and more recently to Spain, from United States sources. The introductions maintain a sea cage culture industry which produced 51 tons of pan-sized (300-500 g) French coho salmon in 1978, and an anticipated production of 90 tons in 1980. In the early 1970's some live coho

juveniles were also imported. All eggs now come from United States sources with some form of health certificate but all are eggs of wild fish. A greater rate of growth of this industry has been prevented by bacterial kidney disease, vibriosis, difficulties in timing smolt transfer to seawater, and the onset of early maturity in fish. Establishing brood stocks in captivity has been confronted with serious problems, resulting in imports of all eggs. Escapes have occurred and recaptures of fish have been almost exclusively in the vicinity of the culture area.

In Scotland, a single import of 26,000 eggs of coho was introduced to a rigorous quarantine facility in 1978 to establish a disease free source of progeny for mariculture trials (Munro et al., unpublished MS). The disease free progeny of these fish are now subject to a government containment order requiring official approval for their location and use.

Pink and coho salmon have been used in mariculture trials in Poland and the Soviet Baltic states. Norway imported a single shipment of pink salmon eggs from Canada in the mid-1970's for experimental mariculture purposes. In Canada, pink salmon were transferred from Pacific sources to New Brunswick for mariculture trials under the new Canadian Health Regulations and experienced a period of quarantine to ensure their freedom from IHN virus. Accidental escapes were recorded in 1977 and 1979 due to net damage on both occasions (submerged debris and ice respectively).

Late in 1979, a group of pink salmon, introduced into Newfoundland for research into intensive cage culture by the Marine Sciences Research Laboratory, was liberated into the marine environment through

destruction of the net enclosure by heavy ice conditions. The accidental introduction is too recent for any assessment of either beneficial or harmful effects.

There is a large rainbow trout industry in Europe producing annually in excess of 80,000 tons, mainly in freshwater. However, a proportion of fish are produced in sea cages in France, Ireland, Scotland, Norway, Sweden, the Federal Republic of Germany, Poland, and Denmark. A considerable trade in live eggs and live fish occurs between countries. Some countries ban all imports of eggs and fish (Ireland, Norway), others of fish only. A small proportion of the egg imports came from the United States and lesser numbers from Australia, New Zealand, South Africa, and South America.

The rapidly growing commercial culture of Atlantic salmon has resulted in eggs from wild and cultured fish being imported to France and Spain from Scotland and Scandinavia, to Scotland from Norway, live smolts and eggs from Sweden and Iceland to Norway, and eggs from Sweden to the Federal Republic of Germany.

The developing commercial culture of the eel in some countries (France, UK, Federal Republic of Germany) has resulted in a growing trade in elvers, mainly from France and the UK. Most fattening is ongoing in freshwater, but in the UK two commercial units use heated seawater from power stations. The Federal Republic of Germany imported small numbers of sea bass (Dicentrarchus labrax) from France, of rabbit fishes (Siganus spp.) from the Philippines, and of Sparus auratus from Israel, to test the culture potential of each in heated effluents of brackish water power stations.

3.1.3 For live storage prior to sale

Trade in living rainbow trout, and eels, most from freshwater, is extensive within the European area. Imports of live eels from the

United States, Turkey, Japan, and Taiwan to Denmark, the Federal Republic of Germany, and Holland are commonplace as well.

3.1.4 For recreation Purposes

Pacific salmon hatchery rearing of juveniles for release is continuing on a limited scale on the northeast coast of the United States. The state of New Hampshire is releasing coho and chinook salmon annually and the return from one hatchery-supported run was 2.5%.

In France some unauthorized releases of coho salmon occurred in rivers. Some limited evidence of successful spawning (juvenile fish) was found by accident.

In Sweden the sockeye salmon (O. nerka kennerlyi) has been introduced to some Swedish lakes and has established a population there, but fish have not been detected migrating down the river draining the system of lakes. Eggs of Canadian Atlantic salmon were released into two Swedish rivers.

In the Federal Rpublic of Germany, coho salmon have been regularly introduced to a land-locked situation for sport and ornamental purposes.

Rainbow trout introductions to the Maritime Region of Canada have been documented from 1899-1979. Four rivers are listed where self-sustained populations are established. In eastern Newfoundland the anadromous steelhead rainbow trout has maintained self-sustaining populations derived from importations made in the period 1887-1891.

3.2 Invertebrates

3.2.1 For fishery enhancement (establishment of new breeding populations)

Import of small consignments of young oysters Ostrea edulis from Italy to southern France (Etang de Thau) were made. Seed of this oyster were also imported to France from the UK, California (parent stock from Maine), and Greece.

In 1972 and again in 1976, natural sets of O. edulis spat were observed in Canada on collectors placed in the Bideford River adjacent to the Ellerslie hatchery (Prince Edward Island). Near this hatchery from time to time European oysters have been held in suspension.

Two hundred and twenty-five adult European oysters (Ostrea edulis) were imported to Canada from Maine, U.S.A., in August of 1977. The animals spawned in quarantine shortly after arrival and were then returned to their point of origin. A second importation of 125 adults from Maine was made in April of 1978. These too were placed in quarantine and returned to their point of origin after spawning. Very few of the combined F_1 generations of these imports from Maine remain. They are presently housed in holding facilities at Dalhousie University, Halifax.

In June of 1978, 100 adult European oysters were imported to Canada from Wales and placed in quarantine. After spawning these animals were destroyed. The F_1 generation, after various tests, were released from quarantine and are now, together with the Maine stock, held in the facilities of Dalhousie University. None of these animals will be released to the wild without further consideration.

The Pacific oyster Crassostrea gigas was introduced in the Netherlands since 1963 from Japan, British Columbia and France. In the summer of 1976 effective spawning of this species occurred near the cultivation areas of O. edulis. At present, wild C. gigas exist in several places in the Netherlands. There is a risk that C. gigas will be able to compete successfully with O. edulis, especially after the completion of the Easternscheldt's semi-closing dam.

C. gigas has been of great economic importance to France since 1971, when severe reductions of the C. angulata stocks occurred due to gill disease. Between 1973 and 1979 some 3,300 t of juvenile and adult C. gigas were imported, mainly from British Columbia and Japan. Imports came also from California, Italy, and Senegal.

Mercenaria mercenaria juveniles were found on the east coast of England (Essex). They appear to have been spawned by clams from the south coast which were being held temporarily in Essex rivers prior to sale.

3.2.2 For mariculture (growth and fattening)

Imports of the Portuguese oyster, C. angulata, to the east coast of the UK were stopped in 1975 due to the risk of introducing disease organisms. For the same reason introductions of this species by the Netherlands decreased. At present, no C. angulata occur in Dutch waters. Also, France stopped the import of this species from Spain because of the gill disease risk.

Though Ostrea edulis is indigenous to France, sometimes importation of this species from Greece, Italy and other sources is necessary, e.g., when the oyster growers are short of juveniles from their own stocks.

The import of C. angulata, free of the gill disease from Spain for growth and fattening in French waters is not prohibited.

Spain is importing O. edulis juveniles for cultivation.

Since 1971, seed of C. gigas have been imported by the Federal Republic of Germany from UK hatcheries. The seed are grown in specially designed containers mainly for consumption.

Sweden imported 100,000 spat of C. gigas in 1974-76 from the UK, which were transplanted on the northern part of the Swedish west coast. No spreading of the species to other sites has been seen.

The mussel Mytilus edulis from the Bay of Fundy (Canada) has been transferred for growth and fattening (approximately 600 t/a) to Maine waters (USA).

Venerid clams (Ruditapes philippinarum = Tapes japonica) have been imported by France from Japan for cultivation in the areas of Olèron-Marennes, the Vendèe and Bretagne. Spain imported Venerupis decussata, a European venerid clam for cultivation. The American hard-clam Mercenaria mercenaria has been reimported by France especially for rearing in parcs of Normandy. In the Netherlands in 1978 some live M. mercenaria were dredged, probably survivors of an introduction of juvenile clams from the United States in 1965. This clam species has been also introduced in Ireland from British hatcheries, and there is a possibility that a small established population now exists.

The ormer, Haliotis tuberculata has been introduced in Scotland and in Ireland from Guernsey.

The brackish water shrimp Macrobrachium rosenbergii and other Macrobrachium species are cultivated in many states of the United States. The original stock was introduced from Asia. A number of strains from various parts of the Pacific have been tested in Hawaii and California. Release of offspring or hybrids into ponds, rivers or other natural waters has occurred. In the United States, principally in Florida and Texas, cultivation of shrimp of the family Penaeidae is developing, e.g., using Penaeus stylirostris and P. vannamei. One Florida company is importing larvae from Panama for growout.

Various Penaeus species from different sources in Asia, Africa, and the United States have been tested in the UK for hatchery rearing. Offspring of Penaeus monodon from a hatchery were supplied to various organizations within the UK for closed-circuit cultivation.

France imported post-larvae of P. japonicus from Taiwan, Hong-Kong, Turkey, and Japan.

Homarus americanus was brought to Northern Ireland for tank rearing.

The crawfish Jasus lalandii from South Africa was transplanted into French waters (east of the Baie de Morlaix) in 1970 (approximately 13,000 specimens). After numerous recaptures in the years immediately following the introduction, recaptures were made again in 1979 (3 specimens between 1,200 and 1,900 g). It seems possible that they belong to the offspring of the original transplant.

Transplantations of king crabs Paralithodes camtschatica were made by the USSR between 1960-1970 from the Northern Pacific to the Barents Sea (Orlov and Ivanov, 1978). The introductions amounted to 4,300 adults, 6,000,000 eggs, 1,500,000 larvae, and 10,000 juveniles. There were many recaptures by the USSR and by Norway (Varangerfjord). There is no reliable information on natural reproduction of this species in the Barents Sea.

500,000 specimens of Pacifastacus leniusculus DANA had been imported in 1974 into the GDR from the Swedish farm Blentarp. They were distributed to two sites under governmental control to test the feasibility of general introduction for aquaculture.

Range extensions of several gammarid species in European inland waters caused by human activity have been recently summarized. Gammarus tigrinus (Secton) was probably unintentionally introduced to Great Britain at an unknown time, but transplanted to the Federal Republic of Germany in 1957 to the rivers Werra and Weser. It was

also successfully established in the southwestern part of the Federal Republic of Germany. Its occurrence in the Schlei estuary was reported in 1976 giving this species access to the Baltic coast, and in 1976 this species was discovered at several localities in the Ems river system.

3.2.3 For live storage prior to sale

Lobsters and crawfish are commonly stored live prior to sale. Canada is importing Homarus americanus on a large scale from Maine (USA). The lobsters are kept in pounds largely for the purpose of exporting to foreign customers, e.g., in western Europe. Homarus americanus have been also imported for live storage by the UK, the Netherlands, Norway, Sweden, and others. In the Federal Republic of Germany, lobsters and crawfish are often stored in tanks with recirculated artificial seawater.

Homarus americanus, H. gammarus, Palinurus elephas, P. mauritanicus, and Jasus lalandii are kept in "viviers" and basins on the French coast.

Some adult C. gigas were also imported by France in 1979 from Italy. Imports were stopped in 1980. Commercial size oysters, O. edulis and C. gigas, are imported from other European countries and stored for short periods in artificial seawater.

American hard-clams Mercenaria mercenaria from the south coast of England were held temporarily in Essex rivers prior to sale.

3.2.4 For improvement of food supplies for other species

The euryhaline amphipod Gammarus tigrinus, released in 1957 into the German river Werra, has extended its range to the rivers Weser, Ems, and Eider. Those fishes feeding on this crustacean show improved growth and good condition. In 1978 extremely high numbers of this amphipod caused difficulties at a power plant on the Weser by clogging the fine-meshed filters.

3.2.5 For research purposes (excluding use in hatcheries)

The mangrove oyster Crassostrea rhizophorae has been tested by France since 1976 under controlled conditions in different coastal locations. It was shown during winter that this oyster has a low cold resistance, although the spat may be able to adapt to the winter temperatures. France will also conduct experiments in quarantine with Ostrea chilensis.

A new project on the genetics of C. rhizophorae and C. cortezensis and their hybrids has begun in Florida (USA). Experiments in closed systems with C. gigas are going on at several locations on the United States east coast. Canada imported adult O. edulis from Maine (USA) for spawning experiments in quarantine. After spawning, the parent oysters were returned to Maine. Survivors of the F_1 generation are housed in facilities at Dalhousie University, Halifax. The same F_1 were offered by Dalhousie to some countries in Europe.

Bay scallops Argopecten irradians were imported by Canada (390 specimens) for spawning in quarantine at Ellerslie (Prince Edward Island). After spawning the adults were destroyed. The progeny are under strict quarantine.

The American lobster Homarus americanus was introduced in France to obtain larvae and juveniles for laboratory experiments. Cross-breeding Homarus gammarus x Homarus americanus resulted in 1,500 hybrids, which were put in the sea near l'Ile d'Yeu.

3.3 Plants

Rice-grass, Spartina townsendii, introduced from England, was transplanted to German marshes in 1927 and 1928. The introduction was aimed at developing a biological supplement to the various technical means for marshland reclamation. Discussions about the results of this introduction have continued to the present day. A positive aspect of the Spartina introduction is that when ditches are made by machines, the uprooted plant material stabilizes the excavated mud humps. As a consequence of such drainage projects, S. townsendii retreats to the ditches. An argument against Spartina points to the fact of the strandings at the sea dikes of rice-grass after storms and during winter. Such torn-off leaves, stems, rhizomes and roots, when they decay, suffocate the grass-matte, which protects the dike against sea erosion.

4.0 SPECIES INTRODUCED ACCIDENTALLY WITH DELIBERATE INTRODUCTIONS

During the decade of the 1970's there have been numerous reports of new species introduced accidentally with imports, and other reports of the spread of species introduced earlier by accident.

From Canada, there are reports of establishment of a pink salmon population in Saglek Fjord in northern Labrador. The origin of this population is unknown but it could have originated from the transplant from British Columbia to Newfoundland in 1959 or from Soviet propagation experiments. The beneficial or harmful effects of this apparent introduction are not yet obvious. Coho salmon have been found in juvenile stages in the Digdeguash River, New Brunswick, and the Cornwallis River, Nova Scotia, indicating self-sustaining populations. Discovered in 1976, these introductions appear to be the result of introductions in eastern United States waters.

Disease organisms have been associated with imports of lobsters and rainbow trout into Canada. Imported lobsters held for storage are frequently carriers of Aerococcus viridans var. homari, the causative organism for gaffkaemia. This organism is also indigenous to Canadian Atlantic waters. In 1976, Yersinia ruckerii, the causative agent of enteric redmouth disease, was isolated and identified as the cause of a severe disease outbreak among rainbow trout imported to Canada from Wisconsin (USA). These fish were imported before the more rigorous Fish Health Protection Regulations superceded the Salmonidae Import Regulations. One shipment of these fish was in saltwater growout cages, the other in a saltwater acclimating facility. All the imported fish and those, including valuable brood stock,

which they may have contaminated, totalling some 350,000 animals, were destroyed. A monitoring system was set up to assess the effectiveness of this attempt to eradicate this alien pathogen, the results of which make it appear that the attempt was successful.

In the Federal Republic of Germany, the slipper limpet Crepidula fornicata was first seen in 1934, with Dutch seed oysters (Ostrea edulis). The latter were imported for growth and fattening in the Wadden Sea of Schleswig-Holstein. The slipper limpet is thought to be a competitor of the oyster for the same planktonic food. Today, after the disappearence of the flat oysters, because of overfishing and severe winters, Crepidula is mostly observed on the shells of live blue mussels, Mytilus edulis. For the mussel stock, competition for food by Crepidula is perhaps less important, because of the recent trend of eutrophication. The disadvantage of C. fornicata today is that it clings to the mussel, which results in a special cleaning problem for the fishermen or the distributor.

In France, the serpulid polychaete Hydroides ezonensis, the sea anemone, Aiptasia pulchella, the bivalve mollusk Anomia chinensis, the Cirripedes Balanus amphitrite, and B. albicostatus have been introduced on the shells serving as spat collectors for the oysters imported from Japan (Gruet et al., 1976). In 1979, the presence of an encrusting bryozoan (Conopeum sp.) had been observed as well on the collector shells.

The parasite, Mytilicola orientalis, was, without a doubt, introduced during an importation of C. gigas. The copepod was seen for the first time in C. gigas in the Arcachon basin in 1977. The parasite developed rapidly and infected about 40% of the oyster population. It induced a weakening and

emaciation of the most heavily parasitized molluscs, and, in certain areas, produced mortalities in the order of 30-40%. Since that time, the parasite has been endemic in the Arcachon basin. It is also present in the Gironde estuary. It had declined in 1977 in the Bay of Quiberon (South Brittany), then in the Marennes-Oléron pond, at the beginning of 1978 and, in March 1979, in the Thau pond (Mediterranean coast).

The worm Pseudostylochus, present in the C. gigas spat from Japan and which is the reason for the treatment of this spat, has not developed along the French coasts.

A chitinivorous bacterium has been introduced with the American lobster. It is present on this species only and has not yet been observed to attack the European lobster in French waters.

Several algae species have developed in the Thau pond (Mediterranean coast). This development seems to have coincided with the introduction of C. gigas. First of these is Undaria pinnatifida, whose presence was noted in the Thau pond in 1973. This alga, originating in the Far East, found hydrologic conditions in the pond which suited it perfectly, seeing that since 1973 it has reproduced there and grown upon all stable structures between 20 and 160 cm of the surface of the water. First localized around Mèze, it has now spread throughout the entire oyster culture parc. It appeared at the end of December and disappeared at the end of July after the emission of the last spores, without establishing, for now at any rate, a major nuisance. The fact that it is found from the beginning of February, in samples of very different sizes, suggests that the reproductive period is very long and that the growth is rapid. A study has been undertaken to learn more about the biology of this species in this new biotope, with the following objectives:

(1) to be able to restrict the expansion if Undaria should prove to be an insupportable nuisance;

(2) to be able to promote its culture should it appear profitable and compatible with the other activities of the pond, as this algae is consumed by Far Eastern people (170,000 tons annually) and intensive culture has not succeeded in satisfying a growing demand for it.

In 1976, in the Thau pond the presence of another Laminaria with an entire and gondola-shaped flap was seen and classified as being Laminaria saccharina, originating from the Atlantic coasts. In truth, it is a species very close to Laminaria japonica, characterized by its short stipe and its delicate flap. For a long time this species was localized along pontoons. Since 1978 it has been established in the parcs, in competition with Undaria. It is found in as much as two meters of water depth. Mats of it accumulate along the seaboard where it continues to develop in 10-15 cm of water. That presents problems of fermentation during the summer season.

Finally, some Porphyra collected along the pontoons near Bouziques seem also to have originated on Japanese coasts. It could be Porphyra tenera, whose commercial value is known. A more precise determination is underway.

In Norway, with the imports of Homarus americanus, the disease gaffkemia was introduced in several lobster holding facilities. These facilities were closed down for 6 months and disinfected; the disease has not occurred in 1979. The source of the few attacks of IPN in Atlantic salmon in Norway have not been traced; the virus may have been introduced with early imports or it may be latent in the natural fish populations.

In the UK, no new species of economic importance have been reported as accidental introductions. Kornicker (1975), however, has reported the presence of the American ostracod Sarsiella zostericola at Essex, and suggested it was

introduced with earlier importations of the oyster Crassostrea virginica. Developments among species introduced by accident earlier include the following:

(1) Checks on the distribution of the American tingle (Urosalpinx cinerea) have indicated that only limited expansion in the range had occurred, the drill still being restricted to southeast England (Franklin and Pickett, 1974).

(2) The copepod parasite Mytilicola intestinalis has extended its range slightly in southwest England and in Morecambe Bay, northwest England (Davey and Gee, 1976; Dare, 1974). Methods have been developed for the rapid examination of large numbers of mussels for the presence of Mytilicola (Dare, 1977; Drinkwater and Howell, 1977). Licenses are now granted for the relaying of hatchery seed oysters from infected to Mytilicola-free areas, provided the molluscs do not exceed 12 mm (O. edulis) and 25 mm (C. gigas) in any dimension. (Additional restrictions with respect to other pests must, of course, be met).

(3) Brine-dipping techniques have been developed for the treatment of both adult oysters and hatchery seed oysters to allow their transfer from areas infested with the American slipper limpet Crepidula fornicata to non-infested areas (Franklin, 1974, 1976).

No new accidental introductions in this category are known for Ireland. Calyptraea chinensis, the Chinese hat limpet, is now found in Clew Bay and Ballynakill Bay in shallow water and may have been brought to these bays on oysters from Brittany in the 1950's. The limpet had previously been recorded from the east and southwest coasts of Ireland from deep water and is therefore not a new introduction. No noticeable effects have been observed.

5.0 COMPLETELY ACCIDENTAL INTRODUCTIONS

During the decade of the 1970's, a number of reports of accidental introductions have appeared, and undoubtedly many other unreported accidental introductions have occurred.

In Denmark, Remora remora has been found alive recently in the Sound north of Copenhagen. This appears to be the third time this species had been recorded from Danish waters. Also the horseshoe crab Limulus polyphemus has been recorded several times in recent years.

In the Federal Republic of Germany, several species have been introduced accidentally. Included are the following:

(1) Rhithropanopeus harrisii tridentatus. This temperate estuarine brachyuran of the family Xanthidae is indigenous to the Atlantic coast of North America. The mud crab, as it is called, was first seen on the German North Sea coast in 1977, in a sample of polychaete worms, Mercierella enigmatica, from the Emden harbor. This crab first appeared on the German Baltic coast in 1936. At that time it was known from the Zuiderzee, and has since been reported from the Bay of Gdansk.

In Emden the mud crab lives in the harbor and in the eel basins of an experimental installation, where the heated effluent of a power station is used for fish culture. Because of their small size (L_C:1-2 cm) the mud crabs sometimes clog pumps, which supply oxygenated water to the basins. A possible role as prey for eels was established, after two mud crabs were found in the stomach of an eel of roughly 1 kg.

(2) Potamopyrgus jenkinsi. This small gastropod (4.5 mm) of the family Hydrobiidae from New Zealand, has occurred in German Baltic coastal waters since 1887. The snail is now distributed over a wide range in brackish water, lakes and channels.

(3) Mercierella enigmatica. Indigenous to subtropical and tropical brackish waters, this serpulid polychaete was well established in Emden harbor when first seen in 1977. The brackish water of this German harbor on the North Sea is warmed by the heated effluents of a conventional power station. This tube building worm was found in 1968 in the Delta area of the Netherlands. It lives also in the Kiel Canal, and was also sampled in the Schlei, a fjord on the Baltic coast of Schleswig-Holstein.

Additionally, three other species have been introduced accidentally in the FRG, or have extended their ranges because of man-made environmental changes. They are:

(1) Balanus improvisus. This acorn barnacle is widely distributed in the Black Sea, the Mediterranean, the Atlantic, the North Sea and the western Baltic. It can also live in the brackish estuaries of rivers. In 1974 it was found in the "Mittelland-Kanal" which connects the rivers Elbe, Weser, and Ems. The Weser is influenced by the runoff of some potassium and sodium salt mines. Thus the Mittelland-Kanal between the town of Minden and the village of Bergeshövede, where the water of the Weser river mixes with the water of the channel, becomes an oligohaline environment. The salinity fluctuating around 1,500 mg Cl^- per liter is sufficient to support the settlement of this euryhaline barnacle.

(2) Neomysis integer. This transparent crustacean of the family Mysidae lives in the North Sea and the Baltic and also in brackish estuaries. In 1977 it was observed for the first time in the Mittelland-Kanal. The mysids sometimes form dense aggregations of thousands of specimens. The population in the Canal originated very likely from a stock of N. integer (=Mysis vulgaris) living in the lower Weser. The mysids in the Canal are probably used for prey by various fish species.

(3) Gammarus tigrinus. This amphipod, which also prefers oligohaline habitats, was also found in 1977 in the Mittelland-Kanal. At that time, the population, which supposedly originated from the Weser stock of G. tigrinus, was already well established. The population reaches its annual peak in the late summer. As in the Weser river, G. tigrinus in the Mittelland-Kanal is regarded as a valuable fish food item.

In France, Sargassum muticum was noted for the first time in 1973 by J. Kopp (Communication to ICES Shellfish and Benthos Committee, K:34) during a dive off the point of Barfleur, at a depth of 25 m. It was found again in 1974 and 1975, and since that date, the alga is developing preferentially in the intertidal zone in dense pockets 3-4 meters long, progressively eliminating the indigenous algae of this zone: Chondrus crispus, Fucus serratus, Laminaria saccharina. It is now found along all the seashore area between the Ile Tatihou (east of Cotentin) and Saint Malo. It has tended to expand its area of implantation towards the west.

There are animals whose introduction onto French coasts dates from earlier times, which have been observed in great numbers along all of the French seashore -- such as the slipper limpet Crepidula fornicata and others which have appeared episodically, such as the Chinese crab, Eriocheir sinesis, at the entrance to the Seine and at Quistreham, in Normandy.

Finally, coho salmon, imported by fish culturists of Upper Normandy, have escaped into the natural habitat during periods of strong tides.

In Ireland, the slipper limpet Crepidula fornicata was reported from Kilmakillogue Harbor, Co. Kerry in 1960, but this has never been confirmed nor is it possible to say how it might have been introduced. Mytilicola intestinalis was probably introduced in mussels by shipping and is now widespread in

mussels near ports. It has not been known to cause any serious effects. The barnacle Elminius modestus was probably introduced by shipping also and has spread throughout the UK. It settles high on the shore and tends to greatly diminish in winter.

In the Netherlands, the Japanese seaweed, Sargassum muticum, first observed in Dutch waters in April, 1977, is found washed ashore now in increasing mass. It is thought to drift to the Dutch coast from the south coast of England or France. Until now no attached plants have been found, but first observations of attachment are expected to be only a matter of time. Coastal interests are aware of problems that may be caused by this seaweed, if attached.

In Sweden, a number of recaptures of the sturgeons Acipenser güldenstaedti and Acipenser baeri have been made along the Swedish east coast.

In the UK, the immigrant Japanese seaweed Sargassum muticum was first recorded in 1973. It has continued to spread along the south coast of England despite various attempts at control, and attached plants are now found from Brighton to Plymouth. The weed is mainly causing problems on amenity beaches and in harbors; the overall effect on fisheries remains difficult to gauge. Fishing boats, like other fairly small vessels, have reported some interference in navigation in badly affected areas and the weed can be a mechanical nuisance on trawling or dredging grounds. On the other hand, Sargassum appears to support a rich fauna, and young fish and crustacea are reported to be abundant in weed affected areas. Catches of adult fish can also be high in Sargassum stands, presumably due to the increased shelter provided.

A special dredge has been developed for the control of the weed on amenity beaches and in harbors, and research continues on possible chemical and biological control methods. Herbicides have not been found to be effective due to poor penetration of the highly-sulphated Sargassum cell walls. Hand gathering has been abandoned as ineffectual. A summary report has been produced (Franklin, 1979). Knight-Jones et al. (1975) have reported the presence of exotic species of spirorbid worms (Janua brasiliensis and Pileolaria rosepigmentata) on Japanese Sargassum at Portsmouth.

In the United States, the green alga, Codium fragile tomentosoides, was first reported from the east coast in 1957. From an initial focus in waters of Long Island (New York) the alga spread rapidly northward to Cape Cod in 1962 (by oyster introductions from New York), and southward to New Jersey by 1967; a separate population was introduced to Boothbay Harbor, Maine, in 1966, also with oysters from New York. It is now particularly abundant in some parts of the New England coast, where it may occur in dense stands of up to 11,000 grams/square meter. Severe effects on molluscan shellfish beds and fisheries have been reported -- from smothering; from floatation of attached Codium and the subsequent detachment of mussels and oysters; and from hindrance of locomotion of bay scallops attempting to escape starfish predation (see Ramus, 1971; Wassman and Ramus, 1973; Fralick and Mathieson, 1973). Codium has recently been reported from Virginia (Hillson, 1976).

The introduction, probably by boat traffic, of two species of subtropical shipworms, Teredo bartschi and Teredo furcifera, into the vicinity of a power plant thermal effluent in New Jersey has been reported by Hoagland and Turner (1980), who also report Mercierella enigmatica (Ficopomatus enigmaticus) for the first time from the North American Atlantic coast (a polychaete long established in Europe).

6.0 SPECIES INTRODUCED FOR HATCHERY REARING

In parallel with the rapid and steady development of hatchery procedures there has been a significant increase in reported introductions for hatchery rearing and hatchery development research.

6.1 Stock not subsequently planted outside the hatchery

Strains of rainbow trout (Salmo gairdneri) imported from the United States have been established at various hatcheries throughout England and Wales. The migratory form of rainbow (steelhead) trout is being reared at the MAFF Laboratory at Lowestoft to establish a small brood stock for experimental purposes. There is no immediate intention to transplant these outside the hatchery. Rainbows have also been imported to the Marine Sciences Research Laboratory in Newfoundland for experimental purposes. The fish have been confined to aquaria, although the effluent has been discharged to the marine environment.

Dover sole (Solea solea) eggs, turbot (Scophthalmus maximus) eggs, and juvenile sea bass (Dicentrarchus labrax) have been imported from France to the UK. S. maximus has also been exported from the UK to Denmark, where it has been partly kept in basins and partly relaid under controlled experimental conditions near the outlet of a power plant at Asnaes.

A wide range of species of the genus Penaeus have been imported to the Conwy, Wales, hatchery of MAFF for experimental hatchery rearing. A listing of the species and their country of origin follows:

Penaeus monodon from the Philippines, South Africa, Taiwan, Tahiti, and Thailand

Penaeus merguiensis from the Philippines and Tahiti

Penaeus semisulcatus from Kuwait

Penaeus indicus from South Africa

Penaeus japonicus from Japan

Penaeus orientalis from South Korea

Penaeus aztecus from the USA

Penaeus occidentalis from the USA

Penaeus schmitti from the USA

Penaeus setiferus from the USA

Hatchery-reared progeny of P. monodon were supplied by the Conwy Laboratory to various organizations within the UK for controlled closed-circuit cultivation experiments. A summary report on prawn culture research at the Conwy Laboratory has been prepared (Wickings and Beard, 1978).

France has made importations of post-larval stages of P. japonicus from Taiwan, Hong Kong, Turkey, and Japan. France has also introduced the American lobster (Homarus americanus) for hybridization with H. gammarus. The imported American lobsters have not been released from the hatchery, but approximately 1,500 hybrids have been released near l'Ile d'Yeu; none have been reported recaptured.

In the UK, Crassostrea gigas has been imported from Canada, Hong Kong, Israel, and the United States (both Miyagi and Kumamoto races), C. cucullata from the Gulf of Eilat, C. rhizophoras from Brazil, Venerupis semidecussata from the United States, and Haliotis tuberculata from Guernsey to Scotland. A report has been published on the introduction and present status of the Pacific oyster (C. gigas) in the UK (Walne and Helm, 1979). Additionally, a general paper has been prepared on recommended quarantine measures for marine molluscs (Spencer et al., 1977).

The bay scallop (Argopecten irradians) has been imported from the United States to a quarantine facility at Ellerslie, Prince Edward Island, Canada. The effluent from this facility is filtered (100 μ) and ozonated in a two tank system for a minimum exposure of 75 minutes and a final oxidant-residual level of 3 mg/l prior to release to the marine environment. It is ultimately planned to release these scallops or their progeny to the natural environment for experimental culture.

The European oyster (O. edulis) has been imported to eastern Canada from both the United States and Wales, UK, for experimental studies in genetics. The progeny are retained in the hatchery. During the quarantine phase, all effluent was autoclaved prior to disposal.

The arc-shell (Arca noae) has been imported from Yugoslavia to an inland hatchery at Orono, Maine (USA), for research on hatchery methods to eventually enhance the arc-shell fishery of Yugoslavia. Progeny have been transferred to a coastal laboratory at Walpole, Maine (USA), and the original imports returned to Yugoslavia. Effluent at the Walpole facility is contained in a dry well.

Crassostrea rhizophorae and C. cortezensis have been imported to quarantine facilities in Florida (USA) for studies in genetics and hybridization.

In 1978, a hatchery in Normandy imported 100 C. rhizophorae from Guyana as brood stock; all died rapidly before being spawned.

Ireland has imported small numbers of the abalone (Haliotis tuberculata) into a hatchery having quarantine facilities; the effluent is chlorinated and then released on land.

6.2 Stock relaid in small quantities under controlled experimental conditions

The European oyster (O. edulis) has been relaid in small quantities in a number of locations in the Maritimes region of Canada. Small experimental lots held in suspension in the Bideford River at Ellerslie, P.E.I., spawned in 1972 and 1976, producing small natural sets. None of the spat from these sets appear to have survived. Hatchery-reared O. edulis from the 1969 introduction continue to be produced and relaid to a number of sites along the eastern shore of Nova Scotia.

Pacific oyster (C. gigas) seed is being produced in the Federal Republic of Germany at a recently constructed (1978) hatchery on the Baltic coast. Small amounts of the seed produced have been relaid to containers for growth and observation. These experimental relayings will likely continue in 1980.

6.3 Stock supplied in larger quantities to the industry or some other organization

In the Maritimes region of Canada, federally operated fish hatcheries have in the last few years produced rainbow trout for private aquaculture enterprises in New Brunswick and Nova Scotia.

A hatchery in Normandy has made a number of introductions of molluscs for the establishment of brood stocks. Species imported include the bay quahog (Mercenaria mercenaria) from Britain, the Japanese oyster (C. gigas) and the Japanese clam (Ruditapes philippinarum = Tapes japonica). As well, approximately 15 x 10^6 juvenile R. philippinarum were imported. Almost all of these were supplied to the shellfish industry.

Table 1. FINFISH SPECIES INTRODUCED FOR HATCHERY REARING

Country	Species	Not planted outside hatchery	Small amounts relayed under controlled experimental conditions	Larger quantities supplied to industry or other organizations
Canada	*Salmo gairdneri*	x		x
Denmark	*Scophthalmus maximus*	x	x	
United Kingdom				
	Salmo gairdneri	x		
	Solea solea	x		
	Scophthalmus maximus	x		

Table 2. CRUSTACEAN SPECIES INTRODUCED FOR HATCHERY REARING

Country	Species	Not planted outside hatchery	Small amounts relayed under controlled experimental conditions	Larger quantities supplied to industry or other organizations
France	Homarus americanus	x	x (hybrids with H. gammarus)	
	Penaeus japonicus	x		
United Kingdom				
	Penaeus monodon	x	x	
	P. merguiensis	x		
	P. semisulcatus	x		
	P. indicus	x		
	P. japonicus	x		
	P. orientalis	x		
	P. aztecus	x		
	P. occidentalis	x		
	P. schmitti	x		
	P. setiferus	x		

Table 3. MOLLUSCAN SPECIES INTRODUCED FOR HATCHERY REARING

Country	Species	Not planted outside hatchery	Small amounts relayed under controlled experimental conditions	Larger quantities supplied to industry or other organizations
Canada	Argopecten irradians	x		
	Ostrea edulis	x	x	
France	Mercenaria mercenaria			x
	Crassostrea gigas			x
	Crassostrea rhizophorae	x		
	Ruditapes philippinarum			x
Federal Republic of Germany				
	Crassostrea gigas		x	
Ireland	Haliotis tuberculata	x		
United Kingdom				
	Crassostrea gigas			x
	Crassostrea cucullata	x		
	Haliotis tuberculata	x		
	Crassostrea rhizophorae	x		
	Venerupis semidecussata	x		
United States				
	Arc-shell (Arca noae)	x		
	Crassostrea rhizophorae	x		
	Crassostrea cortenzensis	x		

7.0 PLANNED INTRODUCTIONS

Among finfish, Pacific salmon species are being given the most serious consideration for future introductions.

At Lowestoft (UK) a desk study investigating the feasibility and possible impact of introducing pink salmon (Oncorhynchus gorbuscha) on an ocean ranching or free introduction basis is in hand. Areas of investigation include the suitability of freshwaters for natural spawning or hatchery rearing, suitability of UK waters regarding salinity, temperature, food supplies and other factors, possible ecological impact, and significance to the fishing industry. Also various species of sturgeon have been considered.

Besides pink salmon, (O. gorbuscha), Atlantic Canada has made a serious study of the potential for introduction of several other Pacific salmon species such as chum (O. keta), coho (O. kisutch), sockeye (O. nerka) and chinook (O. tshawytscha). It is felt that additional introductions of pink and chum could be especially valuable in Labrador where a short growing season, low water system productivity, and diverse species community all serve to reduce the freshwater carrying capacity for salmonids. Although such factors make exotics attractive, further introductions will not take place until completion of a thorough bio-economic assessment of Atlantic salmon potential.

Although no immediate introduction is foreseen, France has considered O. gorbuscha and O. keta as possible candidates for sea-ranching. The establishment of an experimental aquaculture based on "steelhead" (Salmo gairdneri) seems likely to take place before long in France.

In Sweden, further introductions of Pacific salmon (no species mentioned) may take place, while in Norway fish farmers have shown interest in importing coho (O. kisutch).

Batches of Crassostrea gigas from North America will be introduced to UK through the Conwy Laboratory at 3-4 year intervals in order to maintain viable hatchery brood stocks. Likewise there is some interest in Sweden in introduction of C. gigas, and Ireland (Shellfish Research Laboratory at Carna) is looking into the reintroduction of C. angulata, C. virginica, and Mercenaria mercenaria. Also the introduction of Ruditapes semidecussatus (=Tapes japonica) has been considered by Ireland and the UK. France envisages the introduction of the Chilean oyster, Ostrea chilensis, initially into an isolated basin for pathological and behavioral observations. If the results of these initial studies are favorable, the oyster will be hatchery reared.

In United States, the State of Maine has approved the importation of mussels, Mytilus edulis, from Canada (Bay of Fundy) to be introduced into waters of the central Maine coast. The rate of import is to be 700 bushels of 2 mm seed per year. The Canadian laboratory at St. Andrews (N.B.) has found no prior history of disease in the stocks, and no associated species that would not be found in Maine. The State of Maine is conducting gross and histological examinations of samples before import.

A further introduction of the bay scallop (Argopecten irradians) into hatchery quarantine at Ellerslie, P.E.I., Canada, is anticipated in mid-1980. These brood stocks will be taken from Connecticut, USA.

For the other nations reporting (The Netherlands, Denmark, the Federal Republic of Germany, and Spain) there were no further introductions known to be under consideration.

8.0 LIVE EXPORTS FOR CONSUMPTION

8.1 Molluscs (Table 4)

The main export species of reporting countries are oysters (the Pacific or Japanese oyster Crassostrea gigas and the flat or edible oyster (Ostrea edulis). Five other species of bivalves (Veneridae: Protothaca staminea, Venerupis japonica (=Tapes japonica), Venerupis decussata, Mercenaria mercenaria; Pectinidae: Pecten maximus and one periwinkle species (Littorina littorea) are also reported as live exports.

Canadian exports from British Columbia to Pacific coast areas of the United States are sometimes held on arrival in open waters until sold, but no estimates are available of the quantities held in this manner. French exports of Crassostrea gigas to Canada are reported (1980) as experimental in nature. Ireland exports of Crassostrea gigas and Venerupis decussata are in "small quantities" only; however, "large quantities" of Littorina littorea are exported.

Norway reports that oyster and mussel farming is a growing industry, and it is possible that export of live shellfish will take place in the future.

No records are available from the United States, which keeps no specific records of live exports.

8.2 Crustaceans and sea urchins (Tables 5 and 5a)

North Atlantic lobsters, Homarus americanus and Homarus gammarus, continue to make up the bulk of the live trade in crustaceans. Canadian exports (Table 2a) for 1978 and 1979, 2,181 and 3,369 metric tons respectively, were sent to at least 15 countries. The figures shown

include some "frozen in shell" lobsters, but are primarily for live exports. Gaffkemia is present in lobsters in both North America and Europe. Sampling of lobsters in England and Wales in 1979/80 did not disclose the disease in native stocks, whereas it was present in Canadian imports. (Some of these imports are of US origin, but are held in Canadian lobster pounds prior to export).

Table 4. Mollusc species exported alive for consumption

Exporting Country	Species	Exported to											
		Canada	USA	Austria	Belgium	Fed.Rep. Germany	France	Ireland	Nether-lands	Spain	Switz	UK	Other
CANADA	Crassostrea gigas		+										
	Pratothaca staminea		+										
	Venerupis japonica		+										
DENMARK	Mytilus edulis												+
FEDERAL REP. GERMANY	Mytilus edulis			+	+		+		+				
FRANCE	Ostrea edulis				+	+					+		
	Crassostrea gigas	+			+	+					+		
IRELAND	Ostrea edulis				+	+	+	+(North)	+	+		+	
	Crassostrea gigas					+						+	
	Mytilus edulis						+					+	
	Venerupis decussatus						+					+	
	Littorina littorea						+		+				
NETHERLANDS	Mytilus edulis				+		+						
	Ostrea edulis				+	+					+		
UNITED KINGDOM	Ostrea edulis									+			
	Crassostrea gigas										+		
	Mytilus edulis								+				
	Pecten maximus									+			
	Mercenaria mercenaria				+				+	+			
	Venerupis decussata						+	+		+			
	Littorina littorea									+			

Table 5. Crustaceans and sea urchins exported alive for consumption

		Exported to										
		Belgium-Luxemb.	Fed. Rep. of Germany	France	Japan	Nether-lands	Norway	Spain	Sweden	Switz.	UK	Other
CANADA*	Homarus americanus	+	+	+	+	+	+	+	+	+	+	+
IRELAND	Homarus gammarus			+				+			+	
	Panulirus elephas			+				+				
	Paracentrotus lividus (sea urchin)			+								
NORWAY	Homarus gammarus		+									+
UNITED KINGDOM	Maia squinado			+				+				
	Nephrops norvegicus			+								

Table 5a. Exports (MT) of Atlantic lobsters by Canada in 1978-79

Country	1978 (MT)	1979
United Kingdom	130	166
Belgium-Luxembourg	441	944
Denmark	25	101
France	583	1097
Fed. Rep. Germany	209	256
Netherlands	377	453
Norway	37	59
Spain	-	17
Sweden	169	190
Switzerland	10	29
Hong Kong	3	4
Japan	194	39
Caribbean Islands, incl.Bermuda	3	2
Others	1	12
Total	2181	3369

8.3 Fish (Table 6)

Eels (Anguilla anguilla) continue to constitute a major exported species. Sweden reports (1980) that Salmo gairdneri has been "exchanged with a few countries". Denmark exported 5,782 tons of Salmo trutta and Salmo gairdneri, combined, in 1978.

Table 6. Fish species exported alive for consumption

Exporting Country	Species	Exported to: Fed. Rep. Germany	Netherlands	Norway	Spain	Other Countries (Unspecified)
DENMARK	Anguilla anguilla	+				+
	Salmo trutta	+				+
	Salmo gairdneri					+
FRANCE	Anguilla anguilla				+	
IRELAND	Anguilla anguilla	+	+			
SWEDEN	Salmo gairdneri					+
UNITED KINGDOM	Anguilla anguilla		+			+

9.0 LIVE EXPORTS FOR PURPOSES OTHER THAN DIRECT CONSUMPTION

9.1 Molluscs (Table 7)

Oysters (Crassostrea virginica, Crassostrea gigas, Ostrea edulis), primarily shipped for breeding or growth and fattening, constiture the major exports. Clams (Venerupis spp.) are apparently at this time somewhat less important. Details for five countries are as follows:

Canada: Forty live adult Crassostrea virginica were sent in April, 1976 to the Institut für Küsten und Binnenfischerei (Hamburg), for studies on possible interspecific competition with Crassostrea gigas. These oysters were placed in the Flensburger Fjord, at Langballigau. Crassostrea gigas are sent from British Columbia to the Pacific coast of the USA for growth and eventual marketing.

France: Ostrea edulis and Crassostrea gigas from both hatcheries and "de captage naturel" are sent for culture and growth purposes to the localities shown in Table 7, and as follows: O. edulis, Tunisia (hatchery seed); C. gigas, Réunion, Martinique, Morocco, Tunisia (all, hatchery seed) and New Caledonia (from natural collectors). Young (seed) and 18-month-old O. edulis from collectors in Quiberon Bay (a non-contaminated area) are sent to Spain. Two-year-old oysters are sent to Holland.

Federal Republic of Germany: About 1,000 specimens of C. gigas were sent for experimental purposes to Yugoslavia (1977, 1978); Romania (1978), and Denmark (1979).

United Kingdom: Crassostrea gigas "brood stock" are sent to the Federal Republic of Germany. In addition to the localities shown in Table 1, small quantities of juvenile bivalves (principally C. gigas) have been supplied to Brazil, Cyprus, Gibraltar, Israel, Kenya, Malta, Seychelles and South Africa for experimental or commercial evaluation.

Table 7. Other live exports: Molluscs

Exporting Country	Species	Exported to: Belgium	Denmark	Fed.Rep. Germany	France	Holland	Ireland	Italy	Norway	Romania	"Scandinavia"	Spain	USA	Yugoslavia	Other
CANADA	Crassostrea gigas												+		
	Crassostrea virginica			+											
	Mytilus edulis												+		
FRANCE	Crassostrea gigas	+	+					+		+				+	+
	Ostrea edulis	+				+						+			+
	Venerupis japonica	+													+
FED. REP. GERMANY	Crassostrea gigas		+							+				+	
IRELAND	Crassostrea gigas*						+ (North)		+						
UNITED KINGDOM	Crassostrea gigas		+	+	+		+			+		+	+	+	
	Ostrea edulis		+	+	+		+			+		+	+	+	
	Venerupis decussata		+	+	+		+			+		+	+	+	
USA	Crassostrea gigas*				+	+					+	+			
	Ostrea edulis*				+	+					+	+			
	Venerupis japonica* (=Tapes japonica)				+	+					+	+			

*records from private hatcheries only

USA: The culture of Ostrea edulis in waters of the northeastern United States (particularly in Maine) has been developing rapidly in recent years. Brood stock is derived from an original introduction from Europe in 1949. Production has apparently reached the point where export of seed or adults is feasible. There is a report that seed oysters will soon be sent to Spain for growout.

At least one shellfish hatchery on the United States west coast has apparently been shipping bivalve mollusc seed to the United States (Maine) and European countries. Quoting from the January 1980 newsletter of that company:

"The hatchery produces high-quality single oyster and clam seed ... The species under regular production include Ostrea edulis, Crassostrea gigas, Tapes semidecussata (=Tapes japonica) ... The individual seeds are sold to growers throughout the world. In Europe, the French and Spanish growers prefer to purchase seed in the larger size categories ... Buyers in Holland and Scandinavia prefer even larger seed ...". The specific recipients of seed oysters from this company are not stated. It is important to note that seed oysters may be held for a time in coastal waters of California before shipment.

9.2 Fish and Crustacea (Table 8)

Few detailed data are available. Only two shrimp species (Penaeus and Macrobrachium) and six fish species are reported. Details are available for only five countries.

Canada: (1) Maritimes Region hatcheries of the Federal Department of Fisheries and Oceans have supplied eyed eggs of Atlantic salmon to Argentina for purposes of establishing self-sustaining recreational fisheries in certain rivers. Numbers supplied by year are as follows:

Table 8. Other live exports: Fish and Crustacea

Exporting Country	Species	Exported to													
		Argentina	Chile	"Europe"	France	Fed.Rep. Germany	Italy	Japan	Korea	Mauritius	Mexico	South Africa	Sweden	USA	USSR
CANADA	Salmo salar	+												+	
DENMARK	Salmo gairdneri					+							+		
FRANCE	Anguilla anguilla						+	+							
UNITED KINGDOM	Anguilla anguilla			+				+							
	Scophthalmus maximus (turbot)				+										
	Penaeus merguinsis											+			
UNITED STATES	Morone saxatilis											+			
	Salmo gairdneri														+
	Oncorhynchus kisutch		+						+						
	Macrobrachium rosenbergii									+	+				

100,000 eyed eggs - December 3, 1978

100,000 eyed eggs - December 12, 1977

100,000 eyed eggs - December 15, 1975

(2) Newfoundland Region hatcheries of Fisheries and Oceans Canada supplied fertilized Atlantic salmon eggs to Connecticut (USA) in 1968, 1969, 1971 and 1972.

Denmark: Salmo gairdneri is exported for recreational purposes.

France: Anguilla is exported to Italy, the Federal Republic of Germany, and Japan for growth purposes.

United Kingdom: Eggs and '0' age group turbot (Scophthalmus) are reported as exported to France. Anguilla is sent to Japan "and various European countries" for fattening.

United States: FAO Aquaculture Bulletins (1970-1977) have reported several fish and shrimp exports; no officlal records are generally kept by the United States. Of the fish shown in Table 8, Morone saxatilis (striped bass) were sent to South Africa between 1971 and 1975; Oncorhynchus kisutch (coho salmon) were sent to Korea in 1973 and to Chile in 1968-1969, and Salmo gairdneri to USSR in 1971. Of these, no results have been reported except for Korea, where returns are reported as low. Macrobrachium was sent to Mauritius in 1972, and to Mexico in 1973-1974; results are unreported.

SUMMARY AND CONCLUSIONS

Introduced species in the marine environment present a number of potential or real difficulties: (1) Once a species is introduced, it can rarely be eradicated; (2) National boundaries have no significance as barriers to spread of organisms (except in the case of some island countries); (3) It is difficult to observe the spread of introduced species (except in the littoral zone); (4) Much is still unknown about the pathogens of marine species, and many pathogens are undoubtedly still unrecognized; and (5) Ecosystem dislocations, resulting from competition or predation from introduced species, may result in negative effects on native species.

Despite such difficulties, there are a number of positive factors to consider: (1) there are several examples of successful introductions which have led to development of new industries with minimal environmental damage or dislocation; (2) increasing sophistication of hatchery technology for fish and shellfish makes available a range of economic species, with reduced danger of introducing pests or pathogens; and (3) introduced species may provide crops in areas which have been commercially unproductive.

Taking into account these and other pros and cons concerning introductions, examination of the new information contained in this report leads to a number of conclusions and summarizing statements:

(1) There has been relatively little activity during the past decade (1970-1980) regarding legislation on introductions and transfers and the review mechanisms through which national control may be exercised. Notable exceptions include Canada, the UK, and Ireland. Since international control,

there is a continuing need for development of adequate regulations and review processes in all member nations. It is also important that review, sampling, diagnostic, and quarantine procedures be standardized to some reasonable degree.

(2) The ICES Code of Practice for introductions, approved by the Council in 1973, has received little attention from member nations when plans for introductions (and actual introductions) are made. Part of the problem may be the absence of detailed guidelines, or unwillingness to subject national initiatives to international scrutiny at an early stage in their development.

(3) Major introductions of non-indigenous species to the ICES area in the past decade include the Pacific oyster, Crassostrea gigas, and Pacific salmon (particularly the coho, Oncorhynchus kisutch, and the pink, O. gorbuscha). Oyster introductions, largely Crassostrea gigas by France, have been successful in terms of maintaining an industry, but have created problems of introduced pests and parasites, some of which have affected native species. Several species of algae (Undaria pinnatifida, Porphyra sp., Laminaria sp.) have apparently been introduced with the oysters, and some are spreading rapidly and internationally in certain coastal sectors. Salmon introductions are only now reaching a scale where an evaluation may be made of effects on the receiving areas.

(4) There are encouraging signs that several member countries are utilizing hatcheries and quarantine facilities to reduce risks associated with introductions. The MAFF laboratory at Conwy is mentioned repeatedly as a source of shellfish seed, and other countries are developing facilities to maintain brood stocks and to produce seed stocks of fish and shellfish. Many possible candidates for introduction are being brought first into hatcheries and quarantine facilities, rather than being placed directly into open waters.

RELEVANT LITERATURE

Anonymous (FAO). 1970. Fish and shellfish introductions. Recent introductions. FAO Aquacult. Bull. 2(2): 17.

1972. Fish and shellfish introductions. Recent introductions. FAO Aquacult. Bull. 4(2): 16.

1972. Fish and shellfish introductions. Recent introductions. FAO Aquacult. Bull. 4(3): 13.

1973. Fish and shellfish introductions. Coho salmon in the Republic of Korea. FAO Aquacult. Bull. 6(1): 19.

1976. Fish and shellfish introductions. American striped bass in South Africa. FAO Aquacult. Bull. 8(1): 16.

1977. Fish and Shellfish introductions. Macrobrachium rosenbergii in Mexico. FAO Aquacult. Bull. 8(2): 27.

1977. Fish health protection regulations, manual of compliance. Fish. Env. Canada, Fish. Mar. Serv., Misc. Spec. Publ. No. 31, Ottawa. 32 p. (in English and French).

1977. Policy on introductions and transplants of fish and aquatic invertebrates. Unpubl. report prepared by the Interagency Committee on Transplants and Introductions of Fish and Aquatic Inverte-breates in British Columbia. 4 p.

1979. Considerations and feasibility studies relevant to the introduction of Pacific salmon to Atlantic waters. Unpubl. report prepared for the Anadromous, Catadromous, and Freshwater Fisheries Subcommittee, CAFSAC. 39 p.

1979. Proposed rainbow trout introductions policy for the Maritime Region. Unpubl. report prepared for the Maritimes Region Advisory Committee on the Introduction of Non-Indigenous Species. 4 p.

Anwand, K. 1978. Der Signalkrebs (Pacifastacus leniusculus DANA). Untersuchungen über seine Einbürgerungswürdigkeit. Z. Binnenfisch. DDR 25(42): 373-380.

Aro, K. V. 1979. Transfers of eggs and young of Pacific salmon within British Columbia. Fish. Mar. Serv. Tech. Rep. 861: 145 p.

Bell, G. R. 1977. Experience with Canada's new fish health protection regulations. 1st Sympos. of the Latin American Aquaculture Assoc.: 4 p.

Bogdanov, A. S. et al. 1971. Results of research conducted by VNIRO on transoceanic acclimatization of fish. VNIRO, Proceedings Vol. LXXIX.

Bourne, N. 1979. Pacific oysters, Crassostrea gigas Thunberg, in British Columbia and the South Pacific. In Species in Mariculture, R. Mann (ed.), MIT Press, Cambridge, Mass.

Bulnheim, H.-P. 1976. Gammarus tigrinus, ein neues Faunenelement der Ostseeförde Schlei. Schr. Naturw. Ver. Schlesw.-Holst. 46: 79-84.

Canadian Committee on Fish Diseases. 1972. Consideration and recommendations for the control of fish diseases in Canada. (Co-chairman G. R. Bell and L. Margolis), Fish. Res. Bd. Canada, Misc. Spec. Publ. No. 16, 52 p.

Courtenay, W. R., and C. R. Robins. 1973. Exotic aquatic organisms in Florida, with emphasis on fishes: A review and recommendation. Trans. Am. Fish. Soc. 102(1): 1-12.

Dare, P. J. 1974. A survey of the distribution limits of Mytilicola intestinalis Steuer in England and Wales 1972-1974. ICES CM 1974/K:12.

1977. Enzyme extraction of the parasitic copepod Mytilicola intestinalis Steuer from mussels Mytilus edulis L. J. Cons. Int. Explor. Mer 37(2): 170-172.

Davey, J. T., and J. M. Gee. 1976. The occurrence of Mytilicola intestinalis Steuer, an intestinal copepod parasite of Mytilus, in the south-west of England. J. Mar. Biol. Ass. UK, 1976, 56: 85-94.

Drinkwater, J., and T. R. W. Howell. 1977. A method of detecting Mytilicola intestinalis Steuer in mussels Mytilus edulis L. using pepsin digestion and its use in a survey of Scottish waters. ICES CM 1977/K: 28.

Dyagilev, S. E., and N. B. Markevich. 1979. Maturation of pink salmon Oncorhynchus gorbuscha (Walb.) occurring at different times in odd and even years as the important factor in the variation of results of its acclimatization in the European North of the USSR. J. Voprosy ikhtiologii, Vol. 19, Iss. 2(115), Moscow.

Fralick, R. A., and A. C. Mathieson. 1973. Ecological studies of Codium fragile in New England, USA. Mar. Biol. 19: 127-132.

Franklin, A. 1974. The destruction of the oyster pest Crepidula fornicata by brine-dipping. Fish. Res. Tech. Rep., MAFF Direct. Fish. Res. Lowestoft (8): 5 pp.

1976. The disinfection by brine-dipping of seed oysters produced from hatcheries in Crepidula-infested areas. Fish. Res. Tech. Rep., MAFF Direct. Fish. Res. Lowestoft (25): 4 pp.

1979. The immigrant Japanese seaweed Sargassum muticum in UK waters. ICES CM 1979/E: 18.

Franklin, A., and G. D. Pickett. 1974. Recent research on introduced oyster pests in England and Wales. ICES CM 1974/K: 15.

Gruet, Y., M. Héral, and J.-M. Robert. 1976. Premières observations sur l'introduction de la faune associée au naissain d'huîtres Japonaises Crassostrea gigas (Thunberg), importé sur la côte Atlantique Française, Cah. Biol. Mar. 17: 173-184.

Herhaus, K. F. 1978. Die ersten Nachweise von Gammarus tigrinus Sexton, 1939, und Chaetogammarus ischnus (Stebbing, 1906) (Crustacea, Amphipoda, Gammaridae) im Einzugsgebiet der Ems und ihre Verbreitungsgeschichtliche Einordnung. Natur Heimat 38(3): 71-77.

Hillson, C. J. 1976. Codium invades Virginia waters. Bull. Torrey Bot. Club 103: 266-267.

Hoagland, K. E., and R. D. Turner. 1980. Range extensions of teredinids (shipworms) and polychaetes in the vicinity of a temperate-zone nuclear generating station. Mar. Biol. 58: 55-64.

Hynes, H. B. N. 1955. Distribution of some British freshwater amphipods in Britain. Verh. int. Verein theor. angew. Limnol. 12: 620-628.

ICES. 1972. Coop. Res. Rep., Cons. Perm. Int. Explor. Mer (32): 59 pp.

Jaždžewski, K. 1980. Range extensions of some gammaridean species in European inland waters caused by human activity. Crustaceana, Suppl. 6, 84-107.

Karpevich, A. F. 1975. Acclimatization of water organisms: theoretical and practical aspects. Pischevaya promyshlennost, Moscow.

Karpevich, A. F., and A. K. Kukonina. 1968. Transplantation of fishes and shellfish in 1965. J. Voprosy ikhtiologii, Vol. 8, Iss. 6(53).

Key, D. 1977. Deposit of molluscan shellfish. Lab. Leafl. MAFF Direct. Fish. Res., Lowestoft (34): 9 pp.

Knight-Jones, P., E. W. Knight-Jones, C. H. Throp, and P. W. G. Gray. 1975. Immigrant spirorbids (Polychaeta, Sedentaria) on the Japanese Sargassum at Portsmouth, England. Zool. Scripta 4: 145-149.

Kornicker, L. S. 1975. Spread of ostracodes to exotic environs on transplanted oysters. Bull. Amer. Paleont. 65, no. 282, pp. 129-139.

Lachner, E. A., C. R. Robins, and W. R. Courtenay, Jr. 1970. Exotic fishes and other aquatic organisms introduced into North America. Smithsonian Contr. Zool. 59: 1-29.

Mann, R. (ed.). 1979. Exotic species in Mariculture. MIT Press, Cambridge, Mass.

McCoske, J. E., C. E. Dawson. 1975. Biotic passage through the Panama Canal, with particular reference to fishes. Mar. Biol. 39(40): 343-351.

Meijering, M. P. D. 1971. Die Gammarus-Fauna der Schlitzerländer Fliessgewässer. Arch. Hydrobiol. 68(4): 575-608.

Miller, R. L. 1969. Ascophyllum nodosum: A source of exotic invertebrates introduced into West Coast nearshore marine waters. The Veliger 12: 230-231.

Munro, A. L. S. 1979. Introduction of Pacific salmon to Europe. ICES CM 1979/F: 28.

Munro, A. L. S., K. G. R. Elson, E. A. Needham, R. J. Morris, and E. J. McGrath. 1980. ICES Code of Practice for the Introduction of Non-Indigenous Species - The quarantine of coho salmon for a whole life cycle. ICES, Manuscript, 9 pp.

Orlov, Yu. I., and B. G. Ivanov. 1978. On the introduction of the Kamchatka King Crab Paralithodes camtschatica (Decapoda: Anomura: Lithodidae) into the Barents Sea. Marine Biology 48: 373-375.

Ramus, J. 1971. Codium: the invader. Discovery 6(2): 59-68.

Robert, G. 1978. Biological assessment of the bay scallop (Argopecten irradians) for Maritime waters. Fish. Mar. Serv. Tech. Rep. 778: 13 p.

Rosenthal, H. 1980. Implications of Transplantations to aquaculture and ecosystems. Mar. Fish. Rev. Vol. 42, No. 5: 1-14.

Rosenthal, H. 1978. Bibliography on transplantation of aquatic organisms and its consequences on aquaculture and ecosystems. Spec. Publ. European Maricult. Soc. 3, 1-146.

Schmitz, W. 1960. Die Einbürgerung von Gammarus tigrinus Sexton auf dem europäischen Kontinent. Arch. Hydrobiol. 57: 223-225.

Shatunovsky, M. I., M. A. Argba, N. I. Kotova. 1970. Transplantation and acclimatization of steelhead (Salmo gairdneri) in the USSR. VNIRO, Proceedings Vol. LXXXI.

Spencer, B. E., M. M. Helm, and P. J. Dare. 1977. Recommended quarantine measures for marine molluscs. Fish. Res. Tech. Rep., MAFF Direct. Fish Res. Lowestoft (32): 7 pp.

Walford, L., and R. Wicklund. 1973. Contribution to a worldwide inventory of exotic marine and anadromous organisms. FAO Fish. Tech. Pap. 121, 49 pp.

Walne, P. R., and M. M. Helm. 1979. Introduction of Crassostrea gigas into the United Kingdom. In Exotic species in mariculture, R. Mann (ed.). MIT Press, Cambridge, Mass.: 83-105.

Wassman, R., and J. Ramus. 1973. Seaweed invasion. Natural History 82(10): 24-36.

Wickins, J. F., and T. W. Beard. 1978. MAFF prawn culture research. Lab. Leafl. MAFF Direct. Fish. Res. Lowestoft (42): 41 pp.

APPENDIX I

QUESTIONNAIRE

Statement of the present situation in relation to the transfer and introduction of marine organisms

For completeness each record should if possible include the source and site of introductions, dates or periods, quantities and full references to published descriptions. For species introduced as a regular practice over many years, only a general statement is required.

I. Statement of relevant laws in member country.

II. Statement of other procedures governing decisions on introductions, e.g., committee recommendations.

III. List of deliberately introduced animal or plant species, including a statement of the result, introduced for the following purposes:

(a) Establishment of new reproducing populations
(b) Growth and fattening
(c) Live storage prior to sale, including eels
(d) Improvement of food supplies for other species
(e) Research purposes, excluding hatcheries (see VI below)
(f) Intended for the control of other pests
(g) Intended to alter the environment
(h) For recreational purposes
(i) For other reasons, and only where relevant, e.g., zoos, aquaria adjacent to the sea, with particular reference to animals known to harbor parasites, e.g., dolphins, seals.

IV. List of species introduced accidentally with III(a) to (i) above, with a statement of the effects, specifying particularly

(a) Any beneficial effects, e.g., if subsequently utilized;

(b) Harmful effects

(i) establishment of predators
(ii) establishment of parasites
(iii) introduction of disease agents
) indicating whether the deliberately introduced species and/or other species are affected

(iv) establishment of competitors
(v) other modifications of the ecosystem or environment.

V. List of species introduced by mechanisms other than in III (above), with a statement of the effects.

(a) Completely accidentally, and including specifically instances where survival has been facilitated by special environmental conditions, e.g., in heated effluents from power stations.

(i) attached to the hulls of ships
(ii) in ballast tanks of ships
(iii) attached to floating wood or other drifting objects
(iv) escaped from aquaria, zoos, etc.
(v) by some other means including natural invasion.

(b) Through man-made or natural changes in environmental conditions in areas linking water masses (as for example in the Suez Canal).

VI. List any species introduced for the purpose of hatchery rearing, the progeny of which

(a) Have not subsequently been planted outside the hatchery
(b) Have been relaid in small quantities under controlled experimental conditions
(c) Have been supplied in larger quantities to the industry or some other organization.

Give the site of the hatchery, areas to which transplanted and, where possible, dates and an approximate indication of quantities. State what treatment is given to the effluent from any hatchery housing exotic species, and give particulars of any "escapes"

VII. Is your country contemplating any further introductions of new species?

VIII. List any shellfish, fish or algae exported live for consumption to named countries and give an approximate indication of quantities. (If exported as a regular practice, species and countries but not dates and quantities are required).

IX. Record any live species, with dates, supplied by your country for introduction into any other named country in the world, for any of the purposes listed under headings III(a)-(i) and VI above. (For species supplied as a regular practice, species and countries but not dates and quantities are required).

APPENDIX II

REVISED CODE OF PRACTICE TO REDUCE THE RISKS OF ADVERSE EFFECTS ARISING FROM INTRODUCTION OF MARINE SPECIES*

I. Recommended procedure for all species prior to reaching a decision regarding new introductions (this does not apply to introductions or transfers which are part of current commercial practice).

(a) Member countries contemplating any new introduction should be requested to present to the Council at an early stage information on the species, stage in the life cycle, area of origin, proposed place of introduction and objectives, with such information on its habitat, epifauna, associated organisms, etc., as is available. The Council should then consider the possible outcome of the introduction, and offer advice on the acceptability of the choice.

(b) Appropriate authorities of the importing country should examine each "candidate for admission" in its natural environment, to assess the justification for the introduction, its relationship with other members of the ecosystem and the role played by parasites and diseases.

(c) The probable effects of introduction into the new area should be assessed carefully, including examination of the effects of any previous introductions of this or similar species in other areas.

(d) Results of (b) and (c) should be communicated to the Council for evaluation and comment.

II. If the decision is taken to proceed with the introduction, the following action is recommended:

(a) A brood stock should be established in an approved quarantine situation. The first generation progeny of the introduced species can be transplanted to the natural environment if no diseases or parasites become evident, but not the original import. The quarantine period will be used to provide opportunity for observation for disease and parasites. In the case of fish, brood stock should be developed from stocks imported as eggs or juveniles, to allow sufficient time for observation in quarantine.

*Note: A marine species is defined as any aquatic species that does not spend its entire life cycle in fresh water.

(b) All effluents from hatcheries or establishments used for quarantine purposes should be sterilized in an approved manner.

(c) A continuing study should be made of the introduced species in its new environment, and progress reports submitted to the International Council for the Exploration of the Sea.

III. Regulatory agencies of all member countries are encouraged to use the strongest possible measures to prevent unauthorized or unapproved introductions.

IV. Recommended procedure for introductions or transfers which are part of current commercial practice.

(a) Periodic inspection (including microscopic examination) by the receiving country of material for prior mass transplantation to confirm freedom from introducible pests and diseases. If inspection reveals any undesirable development, importation must be immediately discontinued. Findings and remedial actions should be reported to the International Council for the Exploration of the Sea.

(b) Inspection and control of each consignment on arrival.

(c) Quarantining or disinfection where appropriate.

(c) Establishment of brood stocks certified free of specified pathogens.

It is appreciated that countries will have different attitudes to the selection of the place of inspection and control of the consignment, either in the country of origin or in the country of receipt.

APPENDIX III

INTRODUCTIONS AND TRANSFERS OF FISH AND SHELLFISH IN THE USSR

Because of the extent of the program of transfers and introductions of marine species carried out under the acclimatization program of the USSR, it seems useful to append to this report a recent detailed summary, as received from Dr P.A. Moiseev, Acting Director of VNIRO.

Table 1 presents a list of fishes deliberately introduced in the Azov, Black, Baltic, Barents, and White Seas. Several species - striped bass, steelhead (Black Sea), pink salmon (Barents and White Seas) were introduced both for the establishment of new reproducing populations and for hatchery rearing.

Table 2 covers all introductions of fishes in the Azov and Black Seas. Not all introductions listed in this table were successful. Introductions of sea and common bass were experimental. Growth rates of these fishes relaid in an experimental mullet hatchery (Belgorod-Dnestrovsky, Odessa region) proved to be low. Work with Pacific mullet was experimental as well.

Table 1. List of deliberately introduced fishes and shellfish.

Species	Sea of Introduction	Objective
Morone saxatilis (Mitch.)	Black and Azov Seas	Establishment of new reproducing populations; research purposes; the progeny have not been subsequently planted outside the hatchery.
Salmo gairdneri gairdneri (Rich.)	"	"
Rutilus frisi kutum (Kamensky)	"	Establishment of new reproducing population.
Barbus brachicephalus Kessl.	"	"
Stenodus leucichthys	"	"
Mugil so-iuy Basilewsky	"	Establishment of new reproducing populations; growth and fattening; research purposes; the progeny have been relaid in small quantities under controlled experimental conditions.
Huso huso (L.)x*Acipenser ruthenus* (L.)	"	Growth and fattening.
Oncorhynchus gorbuscha (Walb.)	"	Establishment of new reproducing populations.
O. keta (Walb.)	"	"
O. gorbusha	Baltic Sea	Growth and fattening.
O. keta	"	"
Acipenser baeri Brandt	"	"
Acipenser baeri Brandt (Siberian)	"	"
Paralithodes camchatica	Barents Sea	Establishment of new reproducing populations.
Callinectes sapidus	"	?
O. gorbuscha	Barents and White Seas	Establishment of new reproducing populations.
O. keta	"	"
Pleurogrammus monopterygius (Pallas)	"	Establishment of new reproducing populations; research purposes.
Fish species delivered to the USSR in small quantities for experiments relaid in hatcheries near Odessa.		
Lateolabrax japonicus (Cuv. at Val.)		*Dicentrarchus labrax* L.

Table 2. Introduction of fish species into the Black and Azov Seas.

Species	Years of Introduction	Age at Introduction	Numbers (thousands)	Waterbody of Introduction
Rutilus frisi kutum	1932-33	Juvenile	15.0	River Don
	1957-78	"	45.5	Rivers Don and Kuban
Barbus brachicephalus	1963-67	Juvenile of different age	66.8	River Kuban
Stenodus leucichthys	1927-28	Eggs	420.0	River Don
			500.0	River Kuban
	1925-33	Larvae	3 565.0	River Don
Huso huso x Acipenser ruthenus	1972	Fingerlings	593.2	River Don
Mugil so-iuy	1975-79	Juvenile	27.5	North-western Black Sea (Shabolatsky estuary - for natural feeding and to hatcheries with brackish water)
			7.6	Azov Sea (Molochny estuary - experimental rearing)
O. gorbuscha	1961-63	Larvae	8 000.0	Rivers of the Black Sea; coast of Caucasus
O. keta	1958-62	Larvae	30 000.0	"
Lateolabrax japonicus	1973	Juvenile of different age	0.07	Experimental rearing Experimental mullet hatchery
Dicentrarchus labrax	1976	Fingerlings	1.7	"

Table 3. Introduction of Salmo gairdneri (Rich.) into the Black Sea.

Year of Release	Place of Release	No. of Fish Released (thousands)	Weight of Fish Released (g)	Age
1965	River Chernaya	44.0	0.6	Fingerlings
1968	"	2.5	0.5	"
1968	River Bzyb	9.5	0.6	"
1968	River Belaya	3.5	0.6	"
1972	River Aapsta	10.0	0.5	"
Total number of fingerlings		69.5		
1966	River Chernaya	10.0	10.2	Yearlings
1969	"	10.0	12.2	"
1970	"	20.0	10.0	"
1971	"	10.0	10.0	"
Total number of yearlings		50.0		
1970	River Chernaya	2.0	150.0	Two year olds
1971	"	0.3	210.0	"
Total number of two year olds		2.3		
Total number of fish of all age groups		121.8		

Table 4. Introduction of Morone saxatilis into the Azov and Black Seas for the establishment of natural populations (fingerlings).

Year of Introduction	Waterbody and Areas of Release					
	Black Sea			Azov Sea		
	Numbers	Weight of Juvenile (g)	Area of Release	Numbers	Weight of Juvenile (g)	Area of Release
1965	200					
1968				1 280	1.2	Taganrog Bay
1970	660	10.0	Dnestrovsky estuary	1 030	10.0	"
				80	60.0	"
1971	1 373	30-40	The Dniepr, Kherson	220	3-15	Mouth of the River Don
				273	30-40	"
	730	"	Sukhumi	1 475	30-40	Taganrog Bay
1972	600	"	North-western Black Sea	-	-	-
1973	540	"	Dnestrovsky estuary	320	"	"
				340	"	River Kuban
1974	1 100	"	"			
Total	5 203 (including 4 343 weighing 30-40 g)			5 018 (including 2 488 weighing 30-40 g)		

Table 5. Introduction of Oncorhynchus gorbuscha (Walbaum) in the Barents Sea and White Seas and results of acclimatization.

Year of Delivery of Eggs	Amount of Eggs Delivered ($x10^{-6}$)	Year of Release	Amount of Eggs Released ($x10^{-6}$)	Year of Return	No. of Fish Captured and Recorded (thousands)
Oncorhynchus gorbuscha in even years of reproduction					
1956	3.8	1957	2.0	1958	No returns
1958	17.1	1959	15.1	1960	72.6
1960	12.0	1961	10.4	1962	0.1
1962	24.7	1963	23.8	1964	1.4
1964	No delivery	-	-	1966	Single returns
1966	No delivery	-	-	1968	Single returns
1968	10.1	1969	6.2	1970	0.4
1970	5.2	1971	4.0	1972	1.2
1972	4.9	1973	3.5	1974	9.9
1974	5.0	1975	3.4	1976	3.6
1976	5.0	1977	4.7	1978	1.9
Total	85.0		74.5		91.1
Oncorhynchus gorbuscha in odd years of reproduction					
1957	8.5	1958	5.5	1959	No returns
1959	15.5	1960	14.4	1961	1.8
1961	37.9	1962	34.3	1963	Single returns
1963	41.7	1964	36.0	1965	44.2
1965	No delivery	-	-	1967	2.4
1967	6.3	1968	6.2	1969	0.1
1969	10.6	1970	7.4	1971	27.8
1971	5.3	1972	4.3	1973	143.7
1973	No delivery			1975	105.1
1975	5.0	1976	4.9	1977	133.0
1977	6.0	1978	4.5	1979	25.0
Total	138.4		117.3		483.1

Table 6. Transplantation of Crustacea into the seas of the USSR.

Species	Years	Age Groups	Numbers (thousands)	Sea of Transplantation
Pandalus kessleri	1959	Different	0.3	Black Sea
	1960	"	3.2	"
	1961	"	3.2	"
	1962	"	8.6	"
	1963	"	12.5	"
	Total		27.8	
Paralithodes camshatica	1960-70	Adult	4.3	Barents Sea
		Eggs	6 020.0	"
		Larvae	1 500.0	"
		Juvenile	10.1	"
Callinectes sapidus		?	1 - 2	"
Experimental rearing in aquarium				
Macrobrachium rosenbergii	1978-79	Juvenile	0.3	
Penaeus japonicus	"	Juvenile	0.5	

Table 7. Accidental acclimatization of organisms in the Azov and Black Seas.

Species	Waterbody of Introduction	Year of Appearance	Way of Penetration and Causes
Balanus improvisus	Black Sea	1893	Evidently with ships
Rhithropanopeus harrisi (sin. *Heteropanope tridentata*)	Azov and Black Sea Basin	1938 1960s	"
Mya arenaria[*]	Black Sea	1934	"
Rapana thomasiana[*]	"	"	"
Mersierella enigmatica (Polychaeta)	Azov Sea	1960s	Black Sea species introduced into the Azov Sea in connection with the increase of salinity
Diatomea: *Biddulphia mobiliensis* *Dytylum brigthwellii*			
Others: *Cerastoderma exiguum* *Borneo candida* *Plyllodoce tuberculata*			

[*]These two species also penetrated into the Azov Sea in the 1960s in connection with the decrease of river outflow and the increase of the salinity of the sea.

APPENDIX 4

Amendments and Additions to Cooperative Research Report, No.22.

APPENDIX 4

International Council for the
Exploration of the Sea

C.M. 1974/E:23
Fisheries Improvement Committee

ICES Working Group on the Introduction of Non-indigenous Marine Organisms - Amendments and Additions to Cooperative Research Report No. 22

A. Franklin
(Secretary of the Working Group)

I. AMENDMENTS

Page 4, line 18 should read: "licence specifying quantities and, for eggs, conditions for disinfection; a health certificate is also required".

Page 5, line 10 should read: "In Sweden, under the Fisheries Act 1954, paragraph 24, 'fish' may ....".
line 12 should read: "...of the National Veterinary Institute. The regulation regarding the importation of fish was passed in 1968 (Svensk Författningssamling No. 551, 1968). Live fish and fish eggs for hatchery purposes may be imported only by permission of the State Veterinary Board. A certificate is required signed by a fish pathologist in the country where the fish were caught. An exception to this rule is the import of Nephrops".

Page 7, line 2, delete "brown".
Line 11 should read: "caught in coastal waters. Due to the risk of introducing viral diseases, this import to Sweden has decreased considerably during the last year. Eggs of ...".
Line 33, delete "brown", substitute "sea".

Page 10, line 8: "O. edulis are occasionally imported into Sweden from Norway and Denmark".
line 10: "of the Bohuslän from Norway".
line 18: "at Ellerslie, Prince Edward Island. Work is now being undertaken with the third generation and it has been demonstrated that growth is twice as fast as in the native species. Reproduction has occurred in one locality and survival has been good except under winter or spring conditions of low salinity. In the United States ...".

Page 11, line 16: Delete the passage from "Now, controlled..." to "America" on line 19.
Line 32 should read "1914. After this introduction, the Gulf of St. Lawrence stock...". Delete "following...stock".

Page 13, line 28 should read: "Denmark, Finland, Norway and the USA of rainbow trout...".

Page 14, line 8: delete "fario", substitute "trutta".
line 9: "waters of the Baltic. Similar practices with rainbow trout and salmon have been developed in other countries".

Page 17, line 13 should read: "they were sometimes imported into Sweden, but now are deep-frozen: imports of H. gammarus...".

Table 1: Under "Importing country - Sweden"

Delete	Homarus americanus from Canada, Homarus gammarus from the Netherlands.
Bracket	O. edulis from France, C. angulata from France, O. edulis from Denmark, O. edulis from the Netherlands.

since these imports are now not important.

II. ADDITIONAL INFORMATION ON INTRODUCTIONS (till January 1974)

Section 1 - Relevant laws

In France, the 1964 regulations were replaced in 1969 by new legislation which retains the ban on the immersion of molluscan shellfish (except littorinids) of foreign origin in French waters, though listing the conditions under which exceptions can be made. The public health certificates which must accompany consignments of molluscs meant for human consumption are also described. Legislation also makes it obligatory to supply certificates of origin with import consignments and, by reciprocal agreement, certificates are also supplied with exports when required.

The relaying of Crassostrea angulata in French waters has been forbidden since September 1971, except during the period from October to December in 1971 and 1972 when consumption oysters could be held before sale.

In the UK controls exercised under the Diseases of Fish Act 1937 have been strengthened: all imported freshwater fish require an import licence, and for some coldwater species certificates are required indicating freedom from named diseases. The Control of Deposit Order in England and Wales is in the process of being amended to divide the coastline into approximately 25 regions, licences being required to deposit molluscs in the tidal waters of each of these areas. A special licence will be required for the deposition of molluscan shellfish from any foreign source.

Although there are no specific regulations covering introductions into Spain, a licence is required by custom authorities before entry is allowed. In Portugal, a special licence is required from the Ministry of Trade.

Section 2 - Other procedures

No new information.

Section 3 - Deliberate introductions

3.1 For the establishment of new reproducing populations

3.1.1 Fish eggs

The Canadian transfers of pink salmon (Oncorhynchus gorbuscha) eggs are petering out, with fewer and fewer adults being found.

Kokanee (Oncorhynchus nerka kennerlyi) eggs were -mported into Sweden in 1960 from British Columbia and the State of Washington. Experiments with these have been undertaken in various Swedish lakes and ponds during the 1960's, but resultant survival and reproduction has been poor.

In the last two years, Norway has imported Atlantic salmon (Salmo salar) eggs from Canada, Iceland and Sweden, rainbow trout (Salmo gairdneri) eggs from Iceland, Sweden and Denmark, and brook trout (Salvelinus fontinalis) eggs from Denmark.

Salmo gairdneri have been imported into Sweden from Seattle in the USA, and results of releases into the Baltic and Kattegat have been excellent. However, considerable drifting away from the original release sites has taken place: from west coast of Sweden to Stavanger in Norway.

Salvelinus namaycush eggs from Canada and the USA have been reared in Sweden since 1959. Releases have been made into Bothnian Bay and into many rivers and lakes, and this species may have some potential for management in the northernmost part of the Baltic.

Germany has recently imported rainbow trout eggs from Seattle and from Australia. In addition, S. salar eggs have been imported from Iceland.

Rainbow trout eggs have been imported by Portugal from Denmark.

3.1.2 Juveniles and adult fish

In June 1972, some 1 500 1-year-old O. nerka kennerlyi were released in the River Delåven in Sweden. These fish might be expected in the Baltic in the near future. Trout (Salmo trutta) have been imported into Sweden from the River Vistula in Poland since 1959. Smolts released into the Baltic have displayed excellent growth, though there have been few recoveries.

Salvelinus alpinus char have been imported to Sweden from Arctic Norway and released along the Bothnian Bay. Recaptures have been extremely rare and growth very poor. Two thousand S. salar smolts were imported into Germany from Sweden in 1973. Germany has also recently imported elvers from Italy.

3.1.3 Oysters

Large-scale development of Crassostrea gigas culture has continued in Europe.

France has imported large quantities of seed from Japan, some fr-m Canada and a small quantity from hatcheries in the UK. Adult C. gigas have also been imported from British Columbia for the establishment of a breeding population, with good results in 1971, poor in 1972.

Germany has imported seed C. gigas from UK hatcheries and these are growing well. Spain has imported Crassostrea angulata from Portugal; no disease has been reported amongst these, though mortality has been widespread in other European countries. Spain has also imported Ostrea edulis hatchery seed from the UK.

3.2 Growth and fattening

O. edulis have been exported from France to the Netherlands and to the UK, but in 1973 the presence of disease on the north Brittany coast led to a restriction on exports to the Netherlands and a complete ban to the UK.

France has imported O. edulis from UK beds in the Solent area, from the Netherlands and from Italy.

Ireland and Holland have imported seed O. edulis from Norway.

Imports of C. angulata have continued to many European countries, but mortality has been widespread and the French authorities have banned imports from Portugal except from October to December, when consumption oysters only may be imported.

Mercenaria mercenaria and Venerupis decussata hatchery seed have been imported by France from hatcheries in the UK and the USA.

3.3 Live storage

Spain: O. edulis and Maia squinado from France;
Palinurus elephas and Homarus gammarus from the Republic of Ireland;
Venerupis decussata from Portugal.

Portugal: Maia squinado from France;
Palinurus mauritanicus and Palunaris rissoni from the Cape Verde Islands.

3.5 Research purposes

Penaeus japonicus, P. aztecus and P. kerathurus have been imported into France for experimental rearing; Crassostrea rhizophorea have been imported from Senegal and French Guyana for research on parasitism. Experimental hybridization studies have been made with Homarus americanus. French scientists have also imported spores of the giant seaweed Macrocystis pyrifera from Chile. Growth studies were carried out in the sea near Roscoff, though the plants were removed before the reproductive phase was reached. ICES Council Resolution 1973/2:18 stated that a special meeting of the Introductions Working Group should be convened to consider this proposed introduction.

3.7 Intended to alter the environment

The rice grass Spartina townsendii, which has been transplanted for shore-protection to many areas in the UK, has spread very rapidly in the Burry Inlet, South Wales. It is now threatening important cockle (Cardium edule) beds in the area, and control measures are being considered. Chemical spraying of this plant has already taken place in other areas, to protect beach amenities.

Section 4 - Species accidentally accopanying organisms deliberately introduced

4.2.1 Establishment of predators

The flatworm Pseudostylochus ostreophagus has continued to appear amongst seed C. gigas imported to France from Japan and Canada, and control measures have been required to be implemented before the oysters can be relaid in French waters.

4.2.3 Introduction of disease

Heavy losses amongst introduced C. angulata have been reported in France, the Netherlands and the UK.

The flat-oyster disease present in France, which originally appeared in Aber Wrach and Aber Benoît, has also caused large-scale mortality in oysters in other areas in Brittany. The origin of the disease is unknown: quarantine restrictions have been applied to prevent any further spread.

4.2.4 Establishment of competitors

Undaria pinnatifida, a brown seaweed, has been found in France in the Etang de Thau region, an area which has received seed C. gigas from Japan.

A salt-dip treatment has been developed in the UK to allow the relaying of oysters from the Solent area, which are infested with Crepidula fornicata, to south-west England and to France.

Section 5 - Completely accidental introductions

Two specimens of the Chinese mitten crab (Eriocheir sinensis) were recorded in Lake Erie by Canadian biologists in 1973.

The Japanese brown seaweed Sargassum muticum was recorded in 1973 around the Isle of Wight on the south coast of England. The plant was well established at one site on the Isle of Wight and in Portsmouth Harbour. Attempts are being made to eradicate it by hand-gathering. The origin of the weed is unknown at present. Council Resolution 1973/4:5 urges eradication, by whatever means considered appropriate, in any country where it is found.

Section 6 - Species introduced for hatchery rearing

Imports to the UK:

Crustacea	Penaeus indicus from South Africa
	Penaeus orientalis from South Korea
	Penaeus japonicus from Japan
	Penaeus setiferus from the USA
	Penaeus schmitti from the USA
	Penaeus occidentalis from the USA
	Penaeus semisulcatus from Kuwait

Oysters	*Crassostrea gigas* from British Columbia *Crassostrea cucullata* from the Gulf of Eilat
Import to Sweden	20 000 larval *Anguilla anguilla* were imported from Italy in 1973 and reared in a closed-circuit system.

Indication of spine colours

Reports of the Advisory Committee on Fishery Management	Red
Reports of the Advisory Committee on Marine Pollution	Yellow
Fish Assessment Reports	Grey
Pollution Studies	Green
Others	Black

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