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REPORT OF THE

WORKING GROUP ON INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

The Hague, Netherlands
25–27 March 1998

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK-1261 Copenhagen K Denmark

TABLE OF CONTENTS

Section **Page**

1 OPENING OF THE MEETING AND INTRODUCTION

The 1998 meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was held at the National Institute for Coastal and Marine Management (RIKZ), The Hague, The Netherlands from 25 March to 27 March 1998. The objectives of the 1998 meeting were reviewed and the agenda for the meeting was considered. The approved Agenda is attached as Annex 1.

At this meeting, there were 36 participants representing nine ICES Member Countries and invited guests from Australia, Georgia, Italy, Israel, and New Zealand. A complete list of participants is attached as Annex 2. This was the largest meeting in the 19-year history of WGITMO. The meeting was chaired by Dr J. Carlton.

2 TERMS OF REFERENCE

The terms of reference for the 1998 meeting of the WGITMO (ICES C.Res.1997/2:12:8) were to:

a) make detailed plans for the Theme Session on 'Marine Bioinvasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' for the 1999 or 2000 ICES Annual Science Conference (TOR 2:12:8:a);

b) pursue progress on the harmonisation of the joint EIFAC/ICES Codes of Practice, through an invitation to the Chairman of the EIFAC Working Party on Introductions to meet with WGITMO (TOR 2:12:8:b);

c) continue the assessment of the potential marine biocontrol activities through review of current proposed programs in the ICES area, and through the invitation to the Marine Biocontrol Risk Assessment Specialist of the Australian CSIRO/CRIMP to meet with WGITMO (TOR 2:12:8:c);

d) review the findings of the *Caulerpa* Aquarium Review conducted in 1997–1998 by WGITMO members, relative to the status of the importation, holding, and disposal of *Caulerpa* in waters of Member Countries (TOR 2:12:8:d);

e) continue to prepare historical risk assessment studies for selected case histories of introduced marine plants, invertebrates, and fish in Member Countries, in order to understand the ecological and other environmental effects of commercially used exotic species introductions into Member Countries, so that the types of risk can be identified retrospectively and thus be used as a basis for aiding future management decisions (TOR 2:12:8:e)

f) continue work on a 'Directory of Vectors Involved in the Introduction and Transfer of Marine and Estuarine Organisms', which work reviews the diversity, nature, and specific roles of vectors that are important in the transportation of exotic marine and brackish water organisms, in order to provide decision-makers with ready access to data sources that may aid in risk assessments, when specific vectors are proposed or come into play that have previously not existed or have not yet been recognised in individual Member Countries (TOR 2:12:8:f);

g) report on the current status of fish, shellfish, algal, and other introductions in and between Member Countries, through (TOR 2:12:8:g):

   i. submission of the National Reports,

   ii. updates on the issues of transport of exotic organisms through ships' ballast water and sediments, and other ship-associated vectors, through information provided by the joint ICES/IOC/IMO SGBWS,

   iii. review of the status of the current and projected distribution, ecological impacts and commercial use in Member Countries of introduced marine and brackish water organisms, such as the marine seaweeds *Porphyra yezoensis*, *Undaria pinnatifida*, *Sargassum muticum*, and *Caulerpa taxifolia*, and the marine invertebrates *Marenzelleria viridis*, *Hemigrapsus penicillatus*, and *Dreissena polymorpha*;

   iv. review of the status of research on genetically modified organisms (GMOs) in Member Countries, with particular attention to the current status of transgenic salmon in aquaculture,

   v. continued coordination of cooperative databases on introductions and transfers of marine and brackish water organisms,

vi. continued communication and cooperation with the Baltic Marine Biologists' NEMO,

vii. development of a questionnaire and expanded terms of reference for a more general review of the non-native temperate marine and brackish-water organisms being held in public and research aquaria in Member Countries, under what temperature conditions, and the nature of effluent treatment, and also the extent to which non-native temperate animals and plants are available for purchase within the private aquarium hobby within Member Countries.

3 REPORTING TO ACME AND ICES COMMITTEES

WGITMO will report to ACME before its June 1998 meeting, and to the Marine Habitat and Mariculture Committees at the 1998 Annual Science Conference. Reporting to the latter Committees will be via ACME.

Dr Carlton brought to the attention of WGITMO a letter received from Dr S.R. Carlberg, the Chairman of ACME, in which appreciation of the quality of the work carried out by WGITMO was noted.

4 REVIEW OF RECOMMENDATIONS FROM 1997 MEETING IN LA TREMBLADE

4.1 ICES/GESAMP Working Group on the Control of Marine Pests Relative to WGITMO Recommendation 1997–1 (La Tremblade) which became TOR 1997/3:1 that:

An ICES/GESAMP Working Group on the Control of Marine Pests (WGPEST) will be established under the co-chairmanship of Dr J. Carlton (USA) and a GESAMP representative, subject to the agreement to co-sponsorship by GESAMP and its sponsoring agencies, to:

- draft advice and recommend strategies on the prevention and post-introduction surveillance and control of introduced species.

WGPEST was to work by correspondence during 1998 and to report progress on development to ACME before its June 1998 meeting and to the Marine Habitat and Mariculture Committees at the 1998 Annual science Conference.

Manfred Nauke informed WGITMO that while GESAMP had noted the proposal, no action was taken during 1998. WGITMO asked Manfred Nauke to alert GESAMP at its meeting in Geneva, 20–24 April 1998, that GESAMP should notify ICES of the administrative needs for the establishment of an ICES/GESAMP Working Group on the Control of Marine Pests (WGPEST) so that further progress could be made. WGITMO continues to support this initiative.

4.2 OTHER RECOMMENDATIONS

Recommendation 1997–2: WGITMO supported the recommendation of the joint ICES/IOC/IMO Study Group on Ballast Water and Sediments (SGBWS) that SGBWS convene for a second year to discuss research and management programmes on ballast water and sediments and other ship mediated vectors with a view toward increased international cooperation and coordination. A meeting of the SGBWS was convened in The Hague, March 23–24 1998.

Recommendations 1997–3, 1997–4, and 1997–5 were adopted under TOR 2:12:8:d, TOR 2:12:8:b and TOR 2:12:8:a, respectively (see Section 2, above).

5 ICES CODE OF PRACTICE

5.1 Status of Translations

At present, the 1994 ICES Code of Practice is available in English, French, Swedish, German, and Japanese. Dr Carlton encouraged members of WGITMO to promote the translation of the Code into their languages if they had not already done so. Copies of the translated versions of the Code will be collated on disk so that a complete record is available.

WGITMO also recognised the potential for wider dissemination of the Code of Practice through the ICES website. As an additional method of disseminating the Code, Dr Carlton encouraged all WGITMO members to put the Code on their Institutes' websites wherever appropriate.

5.2 EIFAC-ICES Code Harmonisation (EIFAC WPI) (TOR 2:12:8:b)

There has been no direct contact between ICES and EIFAC in the past year. WGITMO has recommended that harmonisation of the Codes should proceed but further action should be taken by the ICES General Secretary to follow up this issue.

6 STATUS OF NEW ICES COOPERATIVE RESEARCH REPORTS

Two reports, namely 'Summary of Introductions in ICES Member Countries as of 1990' and 'Aalborg Ballast Water Symposium' are in press. The 'ICES Code of Practice: Guidebook and Case Examples' will be submitted in summer 1998.

7 MULTINATIONAL INITIATIVES AND PROGRAMMES

7.1 EU Concerted Action Plan: Testing Monitoring Systems for Risk Assessment of Harmful Introductions by Ships to European Waters

Participants: Harald Rosenthal, Stephan Gollasch, Ian Laing, Erkki Leppäkoski, Elspeth Macdonald, Manfred Nauke, Dan Minchin, Sergej Olenin, Sue Utting, Matthias Voigt, Inger Wallentinus

Six European countries (Finland, Germany, Ireland, Sweden, United Kingdom (England and Scotland) and Lithuania) and several experts from elsewhere (North America, some Mediterranean countries, Australia, and Asia) are involved in a Concerted Action Plan on ballast water recently funded by the EC. The IMO (International Maritime Organization) is also a partner of this study. The EU project is linked with ICES WGITMO and ICES/IOC/IMO SGBWS for the duration of the project. The study is being coordinated by Germany.

Various methods will be examined as to how representative qualitative and quantitative sampling of species in ballast water can be obtained. Treatment measures for the control of exotic species will be evaluated. There will be an examination of potential risks from harmful introductions and their management by means of interdisciplinary approaches. The subject areas of the EU Concerted Action include:

a) determination of the state-of-the-art of ballast water studies;

b) evaluation of sampling method;

c) validation of sampling method (through intercalibration workshops), and assessment of in-transit survival;

d) development of a set of intercalibrated monitoring systems for use by EU countries and by intergovernmental agencies such as ICES, BMB (Baltic Marine Biologists), IOC, and IMO.

In addition, case histories of selected harmful species associated with ballast water movements to aid in management are being prepared. Information about ballast water as a vector for exotic species movements using multimedia will be used to provide informed advice on the current status of activities.

The Concerted Action invites open discussion and opportunities for joint studies by means of land-based or sea-going workshops. The EU Concerted Action members welcome those who would like to become involved and who have interests in this area and are prepared to contribute. For further information, contact: sgollasch@aol.com

7.2 Update on BMB NEMO Activities (TOR 2:12:8:g:vi)

Stephan Gollasch presented the following report of the activities of the Baltic countries.

7.2.1 Baltic Marine Biologists' Working Group on Nonindigenous Estuarine and Marine Species (BMB NEMOs)

The first meeting of the BMB NEMOs was held at the University of Klaipeda (Lithuania) in 1995, followed by a joint meeting with the ICES WGITMO in Gdynia (Poland) in 1996. Since then, and in the future, the BMB NEMOs will be working by correspondence. The main outcome of the BMB activities is the increasing interest in (a) the field of nonindigenous species in the Baltic area and (b) the unintentional introduction of species by ballast water. The

homepage of BMB NEMOs (which includes information and first entries of the Klaipeda database on nonindigenous species of the Baltic Sea) is: http://www.ku.lt/nemo/mainemo.htm

The activities of the ICES WGITMO, the IOC/ICS/IMO Study Group on Ballast Water and Sediments, and the BMB NEMOs are complementary but are not identical. BMB NEMOs focuses on developing and maintaining the Baltic Sea alien species database. This action was initiated by BMB on a voluntary basis but in order to complete this work (e.g., to ensure geographical coverage) support will be needed. Increasing awareness based on the work of the BMB NEMOs has directly and indirectly led to several activities, noted below.

7.2.2 Baltic Marine Biologists' Symposium

The 16th Baltic Marine Biologists' Symposium (21–26 June 1999) will be held at the University of Klaipeda, Lithuania. The Symposium programme will comprise both oral presentations and posters on the following topics:

- functional diversity and ecosystem dynamics of the Baltic Sea;
- development of marine biology in the Baltic Sea area: history and frontiers for the future;
- alien species in the brackish water ecosystems.

During the 30 years of BMB existence, its biannual symposia were mostly oriented towards Baltic Sea biological and ecological studies. Although this tradition will be maintained, scientists from other European as well as overseas regions are also welcome to contribute papers that are in tune with the above themes. Each of the Symposium topics will be introduced by invited speakers. The names of speakers and the titles of the lectures will appear on the Symposium internet homepage http://www.ku.lt/ku6.htm and will be included in a second announcement. The Symposium proceedings will be published in a peer-reviewed journal during late 1999 to early 2000.

7.2.3 Database on alien species in the Baltic Sea

A database on alien species in the Baltic Sea, initiated during the first meeting of the BMB NEMOs, is under development. The aims of the database are to:

- develop an up-to-date and standardised inventory of nonindigenous species in the Baltic Sea area;
- document effects and impacts (ecological, economic, and social) posed by unwanted nonindigenous species;
- elaborate schemes for fast dissemination of information on new invasions and introductions within and outside the Baltic Sea region.

Specialists from countries bordering the Baltic Sea will be involved. At present, about 50 scientists deal with the subject from various parts of the Baltic Sea. The Environment Committee (EC) of the Helsinki Commission requested the HELCOM Contracting Parties to take action in reducing risks associated with intentional introductions and to consider possibilities of monitoring the distribution of already established species within the Baltic Monitoring Programme and Coastal Monitoring Programme.

7.2.4 Monitoring programmes

In the Baltic Sea region, all the riparian countries (Denmark, Germany, Finland, Poland, Lithuania, Latvia, Estonia, Russia, and Sweden) have established routine monitoring programmes on marine environmental quality by the end of the 1970s. Within these ongoing HELCOM programmes, biological observations are performed on phytoplankton, zooplankton, and macrozoobenthos. The spread of information on nonindigenous species in the Baltic Sea by the BMB NEMOs has helped to consider non-native species during these sampling programmes. In this way it was possible to document newly introduced species and their spread (e.g., the dinoflagellate *Prorocentrum minimum*, the polychaete worm *Marenzelleria viridis*, and the crustacean (cladoceran) *Cercopagis pengoi).* The monitoring programmes will be continued.

7.2.5 Ecology of marine invasions and introductions

A cooperational Nordic educational programme brought together experts and Ph.D. students from several countries at the Abo Akademi, Finland in August 1997. This post-graduate course was sponsored by the Nordic Academy for Advanced Study (NorFA). Subjects included: nonindigenous species in the Baltic Sea and other marine or brackish

environments, characteristics of invaders (their biology, ecology, invasion history), vectors, relationships to native species, habitat modification ability, interspecific and ecosystem impacts, linkages with biodiversity issues, world-wide case studies on ecological and economic impacts of marine introductions, marine biocontrol of introduced species, global issues relative to ballast water (history, science and policy, treatment techniques to reduce the risks arising from ballast water releases), international treaties and instruments to control introductions of Nonindigenous species and regional conventions and agreements. The course leader was Prof. E. Leppäkoski. Invited lecturers came from Sweden (I. Wallentinus, K. Jansson), Lithuania (S. Olenin), Russia (V. Panov), Germany (S. Gollasch), and the USA (J.T. Carlton).

7.2.6 Risk assessment for marine alien species in the Nordic Area 1997–1998

Participants: Project Leader: Prof. Erkki Leppäkoski, Åbo Akademi University, Finland.

Partners: S. Olenin, Klaipeda University (Lithuania), V. Panov (Zoological Institute RAS, Russia)I. Wallentinus, Univ. of Göteborg (Sweden), H. Botnen, Univ. of Bergen (Norway), K. Jansson, Swedish EPA and S. Gollasch (Germany) as a consultant.

A Nordic Risk Assessment Study (funded by the Nordic Council of Ministers) was launched in 1997 to evaluate whether:

- resources were at risk and vulnerable to invasions of Nonindigenous species;
- Nordic marine areas were particularly sensitive to the introduction of nonindigenous organisms;
- organisms or categories of them were particularly potent to cause large-scale environmental problems (impact on biodiversity in particular);
- economic effects, ecosystems and indigenous species were particularly sensitive to the impact of nonindigenous species.

A calculation of economic losses due to the impact of nonindigenous species and prerequisites (e.g., salinity and temperature conditions, availability of habitats, turbidity, eutrophication, pollution) will be carried out and probabilities of harbour areas to act as receivers and/or donors will be quantified in relation to survival probabilities of non-native species. Studies of existing vectors in selected, international harbours, including harbour profiles with regard to import/export of ballast water (i.e., a origin/destination profile for imported/exported ballast water) are being undertaken together with suggestions of measures and strategies to be employed with a view to tackling the problem and the need for further research, and suggestions concerning monitoring activities.

The final report will indicate shipping traffic patterns and ballast water dumping in some harbours in the Nordic countries. The harbours selected are St. Petersburg (Russia), Klaipeda (Lithuania), Turku (Finland), Stenungsund (Göteborg, Sweden) and the oil terminal Sture in western Norway. In addition, the physical environment in these harbours was documented (water depth, sediment types, temperature and salinity, and nutrients). These 'harbour profiles' indicate risks of introducing unwanted species by ballast water imports.

The results of the project may be used to fulfill commitments within several international conventions/organizations such as HELCOM, OSPAR, and ICES. A report from the project, scheduled to be published in late 1998, could be of use for national authorities and international bodies, in contributing to the assessment of the scope of the problem in Nordic marine areas.

Other objectives are to:

a) review some existing risk assessment (RA) methods applicable to introductions of nonindigenous species, including ecological RA models and models applied to ballast water introductions;

b) apply such a model to one or more key/target species. A semi-quantitative model (low-medium-high risk) will be identified and applied to a vector of introduction and a target organism. Relevant parameters should be described, and data needs and availability identified. A tentative list of parameters for ballast water introductions could include, but not be limited to: vessel ballasting characteristics, ballast water treatment applied (if any), characteristics of donor and receiving ports or geographical areas, voyage route and duration, relevant biological information for the key/target species. Information on the key/target species could include, but not be limited to, environmental requirements such as temperature, salinity, and light/energy requirements during different stages of the life cycle (including resting stages), habitat requirements, known biotic interactions.

8 NEW PUBLICATIONS AND COMMUNICATION CHANNELS

8.1 A New Journal: Biological Invasions

Dr Carlton alerted the group to a new journal 'Biological Invasions' published by Kluwer, of which he will be editor-in-chief. This journal will bring together information from the terrestrial, freshwater, and marine fields of research. At present, scientific papers on biological introductions and invasions are published in a large number of diverse journals. Papers are encouraged that examine the broader principles of the patterns and processes of invasions, whether based on single species or on community-ecosystem level approaches.

8.2 Inventory of Data Sources

Kristina Jansson presented the document 'Inventory of Data Sources' which details 'Sources of information on biodiversity in general and alien species in particular on the internet'. The document is in three parts: 1) planned databases and policy developments on introduced species, 2) list servers/electronic mailing lists (e-mail), and 3) internet sites (world-wide web). The advantage of having databases on the internet is that information can be continually updated and therefore information is always current.

8.3 Standardized Species Data Forms

Clare Eno introduced a standardised data collection proforma as a topic for WGITMO to discuss. WGITMO has kept a running record of newly established introduced marine species since its inception. Over time, species may be added to (and occasionally removed from the list). Increasingly, researchers in a number of countries and/or states are collating more detailed information. As with any data gathering exercise, it would be helpful if a standard, basic proforma were adopted for the collection of information detailing events surrounding the introduction and subsequent establishment of species. This would ease comparison of records from different countries. It may also help neighbouring countries/states to be able to predict future developments relating to particular introduced species. Where more detailed information is required (e.g., specific to a restricted locality or on the life history of a species (especially if it has invasive tendencies), a further tier of information may be collated. Access to the internet is now readily available in most parts of the world and is a very useful mechanism for data sharing, especially where regular updating is desired.

In Britain, information has been collated on non-native marine species (introductions established in the wild) in a standard format. This information is contained in a report as a series of 'species sheets' and is also available on the internet on the UK Joint Nature Conservation Committee's website [http://www.jncc.gov.uk]. It refers to introductions to Great Britain in the context of Europe.The major subject areas on which information has been collected are listed. This format may be useful for adoption by other countries and/or states carrying out similar studies, especially if provision is also made for electronic dissemination on the internet.

WGITMO agreed that standardisation of data collection is important, particularly for countries that are beginning to collate data for the first time. Therefore, it was proposed that WGITMO develop a standard form to assist those wishing to embark on data collection, by identifying the most crucial information to gather. On this form WGITMO should also include information on the range of databases being developed, including their purpose and access points.

9 NATIONAL REPORTS

National reports were received from the following ICES Member Countries: Canada, France, Germany, Ireland, The Netherlands, Norway, Sweden, the UK (England and Wales), and the USA and from visiting delegates representing countries outside the ICES area, namely Australia, Italy, and Israel.

9.1 Highlights from the National Reports

National Reports (Annex 3) contain details of new laws and regulations, deliberate releases, accidental introductions and transfers, live imports, live exports, planned introductions, and meetings. References cited in the National Reports, and elsewhere in the report, are listed in the Bibliography (Annex 5).

9.1.1 Australia

Ballast water management programmes are becoming well established in Australia compared with many ICES Member Countries. These programmes are based on a knowledge of the diversity and identity of known invasive species. There are 228 recognised introduced species and more than 150 cryptogenic species in Australian waters. A targeted species list for port surveys has been established which includes species that have been introduced into Australian waters. There is also a target list for species known to be pests in other regions of the world but which are not currently known in Australian waters.

9.1.2 Canada

The seaweed*Codium fragile* is causing significant problems at oyster cultivation sites in Malpeque Bay, Prince Edward Island. This alga forms a thick mat covering much of the seabed; the mat smothers oysters and makes harvesting very difficult.

A national 'Introductions and Transfers Policy' document is in the developmental stage with a target date for completion by the end of 1998.

Two hundred bay scallops (*Argopecten irradians*) were introduced to a provincial hatchery on Prince Edward Island and 125 hard-shell clams (*Mercenaria mercenaria notata*) were introduced into a government facility at Halifax, Nova Scotia. Both importations were made from Rhode Island, USA and both are held in quarantine.

Two hundred 2-year old European oysters (*Ostrea edulis*) were sent from Nova Scotia to the quarantine facility at La Tremblade, France as part of a joint project on bonamiasis pathogenicity and susceptibility.

9.1.3 France

The Japanese shore crab *Hemigrapsus penicillatus* was found in Le Havre, a port on the English Channel. It is believed to have been spread by shipping. There is likely to be potential for further spread to the UK and along the northern coast of Europe.

Local populations of the tubeworm *Ficopomatus enigmatica* in southern Brittany have shown rapid build-up during 1997 causing problems in harbour areas.

Concerns on the spread of the seaweed *Caulerpa taxifolia* continue. *Caulerpa racemosa,* another exotic species, has been reported in Marseille.

9.1.4 Germany

The shipworm *Teredo navalis* continues to spread in the Baltic Sea and there is evidence that recruiting populations have become established.

Juvenile sturgeon were imported from Russia for commercial purposes. A few specimens of exotic species (mainly *Acipenser baeri*) were caught in the wild and hybrids have been reported.

9.1.5 Ireland

The parasitic copepod *Mytilicola orientalis*, an exotic species introduced with imports of oysters from France and first reported in Dungarvon Bay in 1993, has become established.

The zebra mussel *Dreissena polymorpha* has become established in the Shannon River from Lough Derg in the north to Limerick Docks in the south. It was introduced on boats and is causing many practical problems (see Section 12.3).

The transport of zebra mussels on boats to Ireland also highlights the risks of Lighter Aboard Ship (LASH) vessels trading between North America and Europe, with the possibility that such vessels will carry aquatic organisms.

9.1.6 Israel

Since the opening of the Suez Canal, around 300 new species have invaded the Mediterranean Sea. Although most are viewed as pests, some, such as the shrimp *Penaeus japonicus*, are an integral part of local fisheries and have commercial value.

The seaweed *Porphyra yezoensis* has been introduced from Japan for aquaculture purposes in land-based tanks.

9.1.7 Italy

The Lessepsian seaweed *Caulerpa racemosa* was recently found in the harbour of Marseille. *Caulerpa taxifolia* is now present in the Ligurian Sea (hectares of the western Riviera are colonized), in Tuscany, in Sicily, and in the Croatian side of the Adriatic Sea. Changes in fauna, from a qualitative and quantitative point of view, are known.

9.1.8 Netherlands

The North American worm *Marenzelleria* was first reported in the western Scheldt in 1995.

An increase in the distribution of the amphipod *Corophium curvispinum* and the clam *Corbula gibba* has been noticed in the Rhine River in recent years.

9.1.9 Norway

The range of the introduced red crab *Paralithodes camtschatika* in the Barents Sea and along northern Norway has increased in a westerly direction through active migration of individuals. Successful reproduction occurs and many large specimens have been found, many occurring as by-catch in the long-line and net fisheries.

Large, live, mature specimens of Manila clams *Ruditapes philippinarum* were found at three sites where cultivation trials were carried out in 1987–1991. There was no evidence of successful recruitment.

9.1.10 Sweden

New records of the cladoceran water flea *Cercopagis pengoi* and the polychaetes *Marenzelleria viridis* and *Polydora redeki* were reported.

The dinoflagellates *Alexandrium tamarense*, *A. ostenfeldi*, and *A. minutum* were abundant on the Swedish west coast during May and June 1997 causing paralytic shellfish poisoning (PSP) problems in mussel fisheries.

9.1.11 United Kingdom (England and Wales)

A non-native hydroid species, *Clavopsella navis*, has been recently listed as a species that is protected under national legislation. The justification for adding this hydroid to the list of protected species is that it is under threat globally. If other populations are found in the future, then protection can be revoked and it can be removed from the list.

The concept of protecting an introduced species was discussed by WGITMO since it appears that the UK example was a unique case of national protection for an introduced species. Although it is a rare example, it is apparent that it may not be a unique case since there are introduced algae (*Chara connivens*) in Sweden that have some degree of protection, although it is not legal protection. A proposal has also been made to protect an introduced talitrid amphipod (beach hopper), *Transorchestia enigmatica*, in San Francisco Bay, in California.

WGITMO concluded that it would be of value to learn if other introduced species are under protection in other ICES Member Countries, and agreed to discuss this issue further at its next meeting.

9.1.12 United States of America

Numerous research and management projects and efforts are under way as a result of the National Invasive Species Act (NISA) of 1996.

In 1997, the first extensive report was produced on an unidentified South African sabellid worm that has been infecting the Californian abalone aquaculture industry since the late 1980s. Infestation on the abalone shell causes extensive deformation and malformation and heavily-infected abalone cannot be marketed. The worm does not cause a human health problem nor does it affect the quality of the meat. Control of the worm is carried out using a range of management activities.

Grateloupia doryphora, a red algae native to the Pacific Ocean, has become well established south of Cape Cod after it was first reported by Rhode Island in 1996. Further spread from current sites is likely. The introduction was probably via shipping although the source of the introduction is unknown.

9.2 General Discussion

WGITMO noted with particular interest the arrival of a damaging South African parasitic polychaete worm in the American abalone industry, and discussed the movements of abalone, and shellfish and finfish in general, around the world. WGITMO recalled its earlier deliberations in relation to commerce-related invasions, noting that such introductions could become more frequent with relaxed trade barriers. A particular incident with the transfer of the Japanese oyster parasitic copepod *Mytilicola orientalis* to Ireland from mainland Europe with commercial oysters was noted. WGITMO recommends that ICES establish a dialogue with international agencies, such as the European Commission, with respect to the increasing movements of commercial goods, aquaculture products, and other merchandise, often due to increasing trade agreements that foster freer enterprise, which concomitantly may inadvertently foster the spread of aquatic organisms and their disease agents.

WGITMO also noted with great interest an increasing pattern of the novel expansion or population blooms of long-established alien species in the North Atlantic Ocean and in the Mediterranean Sea (for example, the tubeworm *Ficopomatus* in France and Ireland, the Lessepsian alga *Caulerpa racemosa* (as well as the native *Caulerpa prolifera*) in the northern Mediterranean, possibly the shipworm *Teredo navalis* in the Baltic Sea, the expansion of the alga *Codium fragile tomentosoides* in the Gulf of St. Lawrence, the population increases in the Chinese mitten crab *Eriocheir sinensis* in Germany and England, the continued expansion of the alga *Sargassum muticum* in Scandinavia) and urges ICES Member Countries to alert ICES of any additional records of unexplained changes in the abundance or distribution of non-native species (as well as any unusual changes of ranges or population sizes of native species, that may elucidate the patterns and possible causes of range expansions or population changes now being seen with Nonindigenous taxa).

Finally, WGITMO discussed the utility of assembling a comprehensive list of the major invasive marine and estuarine animals and plants of Europe and Atlantic North America, as a basis for interannual tracking through the National Reports. It was agreed to further discuss this proposal at the next meeting.

10 UPDATE ON GENETICALLY MODIFIED ORGANISMS (GMOS) (TOR 2:12:8:g:iv)

Members of WGITMO presented information on the status of work and legislation/regulations concerning GMOs in their countries.

10.1 Canada

Work is continuing on both the east and west coasts of Canada to develop transgenic salmonids for the aquaculture industry. On the west coast, the federal Department of Fisheries and Oceans (DFO) has been working on growth hormone-enhanced native salmonids. It is the stated commitment of the commercial company concerned with the work that fish that are capable of reproducing will only be reared in enclosed land-based facilities and that all fish destined for open water (net-pen) culture will be sterile. DFO continues to develop a policy which is aimed at providing guidelines for the development and use of transgenic and other genetically modified fish and shellfish species.

10.2 Ireland

Dan Minchin brought to the attention of WGITMO a publication of the Marine Institute in Ireland on the nature and current status of transgenic salmon (see bibliography).

10.3 Germany

During a 2-day meeting in March 1998 at the German Environmental Protection Agency (EPA) (Umweltbundesamt, Berlin), scientists, lawyers, and members of administrative boards discussed the occurrences, transport vectors, and

(potential) impacts derived from Nonindigenous species. In addition, national and international laws (regulations and guidelines), regarding Nonindigenous species and genetically modified organisms were discussed. Both the ICES WGITMO 'Code of Practice' and the IMO Assembly Resolution 'Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens' were presented and discussed.

The German Federal Nature Conservation Act (Bundesnaturschutzgesetz) intends to protect species in the wild. The Act sets out the framework provisions for the release of non-native animals and plants into the environment: 'Alien wild and non-wild species of animals and plants may only be released or introduced into the wild (excluding parks, forestry and agriculture areas or other anthropogenically modified areas) if permission is granted by the responsible authority under state law.' Permission will be refused if negative influences to the native species community are to be expected. The Federal Nature Conservation Act includes import regulations and rules regarding control measures. In addition, the Act includes definitions. It is noted that the definition 'indigenous' includes all species that reproduce (without human support) over 'several generations', regardless of their origin. The definition therefore includes established Nonindigenous species. In its present form, the Act protects not only the native biodiversity but also a Nonindigenous species established in the wild.

The outcome of the meeting will be published in German and English by the end of 1998.

10.4 Sweden

The Swedish Environmental Protection Agency has finalized its Policy on the Introduction and Spread of Non-Native and Genetically Modified Organisms (Naturvårdsverket, 1997). The document presents four overall objectives and identifies a number of measures and instruments that need to be developed and implemented in order to achieve these objectives. Cooperation and consultation with central and local authorities and other parties will be essential.

Objectives for non-native species and genes:

1) The unintentional introduction and spread of non-native species and genes should be prevented, in order to avoid damage to biological diversity and other adverse impacts to human health or the environment.
2) The deliberate introduction of non-native species and genes must not be allowed to damage biological diversity or have any other adverse impact on human health or the environment. Non-native species and populations should only be permitted to be imported into Sweden, moved within the country and/or introduced into the environment following examination of an application for a permit in accordance with regulations. The examination of applications and regulations must be based on risk assessments which comprehensively elucidate the risks of damage to biological diversity or other aspects of the external environment, within or outside the intended area of introduction, or to human health.

In parts (1) and (2), 'damage to biological diversity' means any adverse ecological or genetic impact either on ecosystems or species, or on genetic variation or distinctiveness.

Objectives for genetically modified organisms (GMOs):

1) Any use of GMOs which conflicts with the objectives of conserving biological diversity, protecting human health or ensuring the sustainable use of natural resources must not be allowed.
2) Introductions of GMOs must not be allowed to damage biological diversity or have any other adverse impact on human health or the environment. GMOs should only be permitted to be introduced into the environment when it is clear that they can neither multiply nor spread outside the area of introduction, nor spread genes that are likely to multiply outside the area of introduction.

In terms of measures and instruments, specific reference is made to international guidelines such as the ICES Code of Practice and the IMO Guidelines. Areas that need to be developed are risk assessment models, environmental monitoring, legislation, information, and identification and control of vectors of introduction. A precautionary approach should be applied for deliberate introductions.

10.5 United Kingdom

It was reported in the trade press (Fish Farming International, February 1998, 25(2)) that a commercial company in Scotland has just completed a two-year trial on transgenic salmon. Salmon eggs (10,000), manipulated with a gene

construct produced by Canadian fishery scientists, had been imported and 0.7 % of the population showed increased growth rates (x5–x10 of the control). Food conversion rates were low and salmon showed good flesh quality. This programme will not be continued because of current concerns from environmentalists and consumers in the UK on the use of transgenics. At the end of the trials the fish will be destroyed.

There are EU Directives, implemented in the UK through national legislation, for the contained use of GMOs and for the release of GMOs. Any proposed release to the wild would have to include a very thorough risk assessment analysis under EU Directive 90/220.

10.6 General Discussion

After the national reports were presented, there was a general discussion on the role that GMOs are likely to play as future introductions. Although the interest in transgenics at present is currently relatively static because of consumer and environmental concerns, the inevitability of GMOs in aquaculture was recognised. There is national legislation in most developed countries although it was recognised that the use of marine GMOs in, for example, Asian countries is proceeding with less control. It is likely that in the future ICES, through WGITMO, will be asked for advice on the release of GMOs and should maintain awareness of developments.

It was also decided to add a category on genetically modified organisms to the Guidelines for Preparation of National Reports.

11 STATUS OF JAPANESE RED ALGA (NORI) *PORPHYRA YEZOENSIS* IN THE GULF OF MAINE

Dr Ike Levine presented an update on the commercial culture of *Porphyra yezoensis* in the Gulf of Maine (Annex 4). He has been requested by ICES to provide information on a regular basis on any effects that may have arisen from the introduction of this macroalga. The following summarises the information given.

During the year-long monitoring programme carried out in 1996, *P. yezoensis* plants, in the form of asexual monospores, were found in the surrounding intertidal area on rocks but none survived the cold winter temperatures. In 1997, a more extensive monitoring programme was carried out that confirmed the results of 1996. Overwintering and freezing tolerance studies are currently being carried out to answer conclusively whether or not *P. yezoensis* can survive during the winter.

Dr Levine alerted WGITMO to inquire about the opportunity to develop nori culture in Nova Scotia and Newfoundland. This request has received Canadian Federal and Provincial New Brunswick approval. Dr Levine requested clarification on the northern boundary for *P. yezoensis* culture. Dr Carlton noted that a request for culture of *Porphyra yezoensis* in Canada would have to come from Canada to ICES and be passed on to WGITMO for discussion through the usual means.

It was recommended that the Canadian WGITMO members should contact and advise the National Government as to whether ICES needs to be consulted.

Dr Levine also notified WGITMO of planned cultivation trials for nori at sites outside the Gulf of Maine, namely sites off the coast of Massachusetts, Connecticut, and New York. However, only native New England *Porphyra* species would be domesticated for culture. *P. yezoensis* will not be used at those sites.

Although a genetically modified *Porphyra* has been produced by the technique of protoplast fusion, it is not intended for culture in US waters. It may be used in China or Japan, commercial enterprises from those countries having given their support to establishing the nori culture in Maine.

Dr Levine was thanked by WGITMO for his presentation and for his continued cooperation. In the discussion that followed it was noted that Dr Levine had been approached by a business enterprise from Israel for a net of live *P. yezoensis* to trial in polyculture systems in land-based tanks in Israel. Dr Levine's company did not fulfill this request, but it is believed that nets were obtained from Japan (see Israel's National Report).

12 CASE HISTORIES IN AQUATIC AND MARINE INVASIONS (TOR 2:12:8:e)

12.1 Examples from Marine Tubeworms (Annelida: Polychaeta: Serpulidae)

Dr Harry ten Hove gave a very comprehensive review on this subject. Tubeworms, as a main constituent of fouling communities, are of economic importance.

Tubeworms are represented in a wide variety of aquatic habitats, individual species generally being restricted to a single biogeographical region. Most taxa are marine, broadcasting spawn. The trochophore larva is planktotrophic, remaining planktonic for 6 days to two months, but once settled it cannot leave its tube. Serpulids are suspension feeders. Some serpulid species may form veritable reefs of up to a few metres in height, and some kilometres in length. Mass settlement can result in competition with oysters. Species with a very wide distribution are thought to have been distributed by human activities. Important vectors such as ship fouling, epifauna of oysters, the aquarium trade, and rafting on artificial substrates were mentioned. Direct and circumstantial evidence for introductions were discussed and examples of both successful and unsuccessful invasions were given. Possible source areas for the species *Hydroides dianthus, Hydroides elegans*, and *Ficopomatus enigmaticus* were debated.

12.2 Dispersal of Two North American Immigrant Species: the Spionid Worm *Marenzelleria* spp. (Annelida: Polychaeta) and the Razor Clam *Ensis americanus* (Mollusca: Bivalvia) in Northwest Europe

Dr Karel Essink presented this report to WGITMO. The American razor clam *Ensis americanus* was first found in the German Bight in 1979 where it is considered to have been introduced in the larval stage via tanker ballast water. At present, on the European mainland the species ranges from the Kattegat/Skagerrak (in the north) to northern France. It is also found in the UK, in East Anglia. In the Dutch Wadden Sea, *E. americanus* seems to have occupied a niche in the lower intertidal area.

Investigations at the University of Rostok (Germany) have demonstrated that two species of *Marenzelleria* are present in Europe, namely *M.* cf. *wireni* in the North Sea (from Denmark to Belgium and Great Britain) and *M.* cf. *viridis* in the Baltic Sea (from Germany to the Bothnian Bay). For each of these species, parent populations (genetically similar) were identified in coastal waters of Atlantic North America. The records from North Sea estuaries, however, may also be due to range extensions of Arctic populations of *M.* cf. *wireni.* Some local populations developed successfully (Ems estuary in The Netherlands; Darss-Zingst Bodden in Denmark) with 2000–3000 individuals m^{-2} and 8–16 g ash-free dry weight m^{-2}. In the Ems estuary, there is indication of interspecific competition between *M.* cf. *wireni* and the worm *Nereis* spp. On the other hand, total benthic biomass increased significantly, with polychaetes now being dominant over bivalves.

12.3 The Zebra Mussel *Dreissena polymorpha* (Mollusca: Bivalvia) Arrives in Ireland

Dr D. Minchin reviewed the current status of *Dreissena* in Ireland. The zebra mussel was reported for the first time in Ireland during 1997. It may have been introduced before or during 1994. Information, based on eye-witness accounts from 1995 and the age structure of zebra mussels sampled during October and November 1997, suggests that they first became established in the region between southern Lough Derg and Limerick Docks on the Shannon River, Ireland's largest river. Based on the age structure of samples, the species expanded its range during 1996 to include most of Lough Derg and by 1997 had settled in the remaining northeastern region of the lake.

It is likely that the mussels were carried on the hulls of boats imported either from Britain or the European continent. A barge imported from Britain was found with thousands of living mussels.

In the Shannon River, the mussels have formed dense concentrations on the dock gates in Limerick, and on the sluice gates and pillars of the Parteen and Ardnacrusha dams. Piped water to a hatchery was blocked with a subsequent loss of fish. Densities on the hulls of vessels were up to 53,000 m^{-2}. They were most frequently found attached to the hulls of barges and private craft not slipped annually. Few hire cruisers were fouled. Some moorings have sunk under the weight of attached mussels. Freshwater mussels *Anodonta anatina*, rocks, stones, and some aquatic plants were found with attached zebra mussels. It is likely that there will be changes to the ecosystem. The overall effects cannot be predicted and will require careful study.

It is inevitable that mussels will spread throughout the navigable waterways of the Shannon and Erne Rivers and to the Barrow via the Grand Canal. The spread to other water bodies can be curtailed if boats are cleaned before being transported. Because mussels can survive up to three weeks under damp conditions, special care is necessary to ensure

that transfers are avoided. Leaflets have been distributed to boat owners and anglers to advise on precautionary measures.

This example from Ireland was used to highlight the risks of Lighter Aboard Ship (LASH) vessels trading between North America and Europe. These vessels are carried onboard ships from one freshwater body to another, for example, from the Mississippi River in the US to the Rhine River in Europe. Such movements may provide a possible vector for sessile organisms between the North American and European continents, and this could, potentially, be a route for the introduction of the Asian clam to Europe.

13 DISPERSAL VECTORS

13.1 Living Organisms Transported in Dried Seaweed and with Unprocessed Fish

The transport of species for human consumption, both live and unprocessed, is increasing in the world market. As a result, there is increasing potential for the accidental and unintentional transport of associated, and especially microscopic, species.

The following examples were discussed:

Australia. In Dunedin there is a processing plant for South Pacific species, mainly tuna, which is right on the water's edge. Mariculture facilities in the area are expected to increase substantially in the near future without a concomitant awareness of potential risks from the processing plant. In addition, fish and aquaculture feeds are imported from all over the world and may be a vector for unwanted introductions. Tuna ranching in Australia, for example, is dependent on frozen or processed anchovy which are imported. The cause of a recent substantial fish (pilchard) kill was not identified but may have been associated with a disease agent introduced in such a manner.

Canada. A very large number of species are imported from many countries, either unprocessed or minimally processed. Many processing facilities discharge their liquid effluents untreated into sea water. As documented in the literature for fish viruses, such practice can readily serve as a vector for the dissemination of pathogens and parasites, as well as for other marine organisms.

New Zealand. In New Zealand mussel spat is shipped from northern New Zealand to Nelson/Marlborough. The spat is on seaweed fragments washed up on surf beaches in the far north. This seaweed is routinely tested for dinoflagellates (including cysts) by The Cawthron Institute in New Zealand; several potentially harmful species have been found (information supplied by Dr C. Hay).

United States. One of the largest producers of carrageenan, agar, and other seaweed derivatives, which is located on the shore of Penobscot Bay, Maine, USA, imports dried seaweeds in bales from Chile and the Philippines. During offloading, many fragments of the dried weed are said to break off and go down storm water drains and into the Bay.

In e-mail correspondence prior to the meeting, WGITMO members and other correspondents identified a number of concerns and challenges relative to this potential vector. It was noted, for example, that:

- *Vibrio cholerae* is known to attach to algae that can settle to the bottoms of ponds, desiccate, and that the cholera bacteria are still viable.
- If the algae are dried on beaches, insects could be transferred in this manner.
- Many protists can form very resistant encysted stages, including stages resistant to desiccation.
- Certain toxic dinoflagellates, including *Prorocentrum lima* and *Gambierdiscus* causing ciguatera are known to be epiphytes on seaweeds—however, they are not known to form cysts, but their tolerance to heat and dryness is unclear.
- Small invertebrates that can form cysts or have calcified eggs may be transported in this manner.

Given these and other concerns, it was concluded that members of WGITMO should be encouraged to collect information on the importation of seaweeds and unprocessed or only partially processed fish, and the industrial plants in which the products are processed, and report it to the Working Group. Analyses of potential impacts of such introductions would also be of great value.

13.2 The Dispersal of the European Green Crab *Carcinus Maenas* as a Model System for Interpreting Multivector Transport

Dr J. Carlton presented a brief overview of the multiple transport mechanisms now available to disperse the European green (shore) crab *Carcinus maenas* around the world. It was noted that in the 1990s there are more transport vectors than ever before that may be involved in the dispersal of this crab, which has only appeared in South Africa, Japan, Tasmania, and California since the 1980s.

Modern-day vectors include ships' ballast water, fouled sea-water systems, fouled sea chests, and ship full fouling; being transported as juvenile crabs in seaweed (algae) used as packing for commercial seafood products (such as lobsters) or for the commercial baitworm industry, wide availability as an experimental organism (it can be ordered directly from biological supply houses year round), and indeed being intentionally released as a potential human food or harvestable fish bait resource.

Management issues with respect to the prevention of future invasions of this ecologically important omnivore, which occurs over a wide variety of habitats, are thus complicated by these multiple vectors, suggesting that it is critical to learn which of these and other vectors are operating in one's geographical area.

WGITMO discussed Dr Carlton's presentation and concluded that it would be of great value to continue its efforts to produce a Directory of Dispersal Vectors.

13.3 Update on the Issues of Transport of Exotic Organisms Through Ships' Ballast Water and Sediments, and other Ship-Associated Vectors

(Term of Reference 2:12:8:g/ii)

The report of the SGBWS, which convened prior to the WGITMO meeting in The Hague, was referenced.

One issue that was highlighted by WGITMO during discussion was that of the responsibility of a nation as a *donor* port for the uptake of ballast water. Information should be available to ships' captains, harbour authorities, etc., as to the risk of including potentially invasive species in ballast water taken up in a donor port. As a result, ICES should encourage Member Countries to carry out national surveys of their ports to determine temporal and spatial distributions of target (risk) species.

13.4 Public and Research Aquaria

13.4.1 *Caulerpa* aquarium review

The tropical green alga *Caulerpa taxifolia* was accidentally introduced into the Mediterranean Sea in the 1980s. Negative impacts on the biodiversity and a tremendous growth rate brought this alga into focus. As a consequence, a term of reference from the ICES WGITMO meeting 1997 (TOR 2:12:8:d) recommended a general survey on the use of this alga in aquaria of ICES Member Countries. At a recent meeting on *Caulerpa* held in Crete in March 1998, it was recommended that the exploitation of *Caulerpa* spp. (except *C. prolifera*) for the aquarium trade be prohibited in the future.

Reports from Member Countries are as follows:

Canada. A brief survey of the presence of *Caulerpa* in aquaria in the coastal areas of Canada indicated that *Caulerpa* was readily available. However, the species could not be determined. Much of the *Caulerpa* traded on the west coast of Canada is not imported but is grown by local aquarists and resold. Staff at the public aquarium in Vancouver, British Columbia felt that the *Caulerpa* species present in their tanks would not survive local conditions.

France. A French law enacted in 1993 forbids the trade and transfer of *C. taxifolia*. However, *Caulerpa* spp. are available in pet shops without an easy method of differentiating between the species *C. taxifolia* and *C. mexicana*.

Caulerpa is widely present in tropical aquaria. Although these aquaria use closed-water systems, theoretically without the risk of the release of effluents, there is some evidence that aquaria might be a vector of dispersal. Since *Caulerpa* is a fast-growing species, the management of tanks is critical, particularly when discarding materials.

Germany. *Caulerpa taxifolia* and public aquaria. In some aquaria, *Caulerpa* spp. are used as a bio-accumulator in order to extract nutrients from the water. Mostly the species is used for ornamental purposes as in the aquarium of the Institut für Meereskunde in Kiel. Treatment facilities for waste water are available.

Caulerpa taxifolia and private aquaria. *Caulerpa* spp. are robust, fast growing and easy to handle in seawater aquaria. But the interest in *Caulerpa* is moderate compared to other marine algae. The high availability is evidenced by the fact that all known pet shops in northern Germany dealing with seawater species are selling *Caulerpa* spp. to their customers. Several aquarium journals list *C. taxifolia* in their 'buy and sell' section. It is easy and cheap to order the algae by mail. One litre of *Caulerpa* wet weight from the Mediterranean Sea (an approx. 5 m long rhizoid) costs about 7 US$, including postage and handling. In Germany, about 5 tonnes of *Caulerpa* spp. are sold each year, originating mainly from the tropics and the Mediterranean Sea.

Caulerpa taxifolia and science. Stephan Gollasch reported carrying out one experiment with *C. taxifolia*. At the beginning of the experiment, a 1 cm^2 piece of *C. taxifolia* from the aquarium of the French IFREMER Institute in La Tremblade was placed in a 100 litre aquarium. After 3 months the algae covered a surface of approximately 10 cm^2, after 10 months, approximately 500 cm^2. The water temperature varied from 18 ° to 25 °C (room temperature). At 22 °C *Caulerpa* grows about 1 cm in length per day.

Ireland. *Caulerpa* species are known to have occurred in one public facility which is no longer operating. One aquarium on the southwest coast claimed not to have *C. taxifolia.* Few private sea water aquaria exist in Ireland at present but interest is increasing.

Norway. At present there are no regulations/controls of the aquarium trade. An expert group has discussed the situation and developed new recommendations (September 1997). These are now being evaluated in the Ministry of Agriculture.

Several species of *Caulerpa* are used in warm water aquaria. According to the information from a large public aquarium (Bergen, Alesund), 4–5 species are present. In one case, *Caulerpa* was grown in a separate aquarium for use as food for tropical fish (Alesund). According to an expert in tropical aquarium systems (S. Fossia), *C. taxifolia* was more common in Norway some years ago but has been replaced by other *Caulerpa* species. In all cases, conclusive identification to species was uncertain, although the traders claim that different species were available.

Sweden. Many public aquaria (and probably many dealers as well) import 'living rock', i.e., chunks from coral reefs, with much of their associated biota intact. These rocks serve as a source of various species of *Caulerpa.* This means that even though various species or 'types' of *Caulerpa* are indeed present in public aquaria, there is not necessarily much official trade, since they are delivered, free of charge, with the 'rocks'. There are a couple of major importers of tropical species in Sweden, and they acquire material via the UK, Germany, and the Netherlands, but also direct from local agents, for example, in Bali (Indonesia). Serious dealers and aquaria are careful to use only certified local agents (to avoid the risk of trading in CITES-listed species), but there may well be a fair amount of import from unlicensed sources. In addition to tropical fish and 'living rock', many species of tropical red algae are imported.

Aquaria–Regulations. Importers must sign a declaration that fish imported for use in aquaria are not to be released into the wild and that they do not belong to species that could reproduce in Swedish waters. For certain species of carp (*Ctenopharyngodon idella, Cyprinus carpio* (including koi-carp), *Leucisus idus*) all import is prohibited, as well as for some species occurring naturally in Swedish waters. Also regulated are CITES-listed species. (For lists of CITES-species, see http://www.wcmc.org.uk:80/CITES/english/database.htm).

Existing regulations only cover fish, crustaceans, and molluscs—other invertebrates are unregulated. Special regulations, however, apply to CITES-listed species, for example, certain species of coral and shrimp.

United Kingdom. *Caulerpa* in private aquaria trade. Five aquarium suppliers were contacted, most of whom were not holding and did not deal with *C. taxifolia.* One supplier was able to offer *C. mexicana* on order but supplies were intermittent and limited, plants usually being available attached to rocks sent in imports of tropical marine invertebrates. However, from the responses received, it is not impossible to obtain *C. taxifolia* in the UK. The Ornamental Fish Industry (OFI) report that *C. taxifolia* is readily available and trade is quite common. OFI contacted the Tropical Marine Centre where it was said that a 'grape' variety of *Caulerpa*, one variety with a central stem and fronds, and another variety with thongs were available. This highlights the general lack of knowledge on species that are held and traded.

Caulerpa in public aquaria. Of six large public aquaria that were contacted, only two appeared to have *C. taxifolia.* The National Marine Aquarium, Plymouth uses this species in a quarantined facility during its sea horse culture as an attachment source.

United States. Two of the largest public aquaria in the United States (the New England Aquarium in Boston and the Steinhart Aquarium in San Francisco) report that they do not have or exhibit *Caulerpa taxifolia.* Suppliers contacted through the New England Aquarium reported that they can supply *C. mexicana* and *C. prolifera*, but not *C. taxifolia.*

13.4.2 Review of the Non-Native Temperate Organisms held in Aquaria (TOR 2:12:8:g:vii)

WGITMO went on to discuss at some length the potential threat from the introduction of *C. taxifolia* and other potentially invasive plants and animals through the aquarium trade which, in most ICES Member Countries and elsewhere, is an unregulated industry. The review showed that globally there is a lack of information and public awareness of the potential risks associated with the dispersal of *C. taxifolia* and many other species of aquatic plants and animals.

During the discussions, it was suggested by Dr C. Hewitt (Australia) that given the fluid nature of the movement of *Caulerpa* through ICES Member Countries, there would be considerable value in establishing a reference collection of specimens now being moved through the aquarium trade, both for taxonomic-systematic baselines, and also for future genetic studies. WGITMO concluded it would be of value to further discuss this concept at its next meeting.

However, there is one avenue where the trade into EU ICES Member Countries might be controlled, namely through CITES (The Convention on Trade in Endangered Species).

CITES is covered by EC Regulation No. 338/97 (the protection of species of wild fauna and flora by regulating trade therein). This Regulation contains specific reference to the control of alien species. Article 3(2)(d) states that Annex B of the Regulation shall 'contain species in relation to which it has been established that the introduction of live specimens into the natural habitat of the Community would constitute a threat to wild species of fauna and flora indigenous to the Community'. Such species will therefore require import and export permits [Article 4(2)(a)] and impose restrictions on countries of origin [Article 4(6)(d)]. WGITMO recognises that this may be a method of restricting the trade of invasive species as well as endangered species. CITES representatives in ICES Member Countries may wish to consider the addition of *C. taxifolia* and *C. racemosa* to Annex B of Article 3(2)(d).

14 THEME SESSION FOR 2000 ICES ANNUAL SCIENCE CONFERENCE (TOR 2:12:8:a)

WGITMO again considered that a theme session on 'Marine Biological Invasions: Retrospectives for the 20th Century: Prospectives for the 21st Century', could be held as part of the ICES Annual Science Conference in Belgium in 2000.

The timing of such a conference in 2000 appears to be ideal. WGITMO will have completed 22 years of work by September 2000 and concerns for ecological and environmental impacts, and economic impacts (pro and con) of exotic species invasions in freshwater, brackish water (estuarine), and marine ecosystems has never been higher. As a reflection of the scale of this interest, a new journal (Biological Invasions) is being established, and will have its first volume in 1999. Research endeavors are escalating throughout all ICES Member Countries on introduced species, acclimatization principles, dispersal vectors such as ballast water, the use of non-native species in aquaculture/mariculture systems, the mechanical and biological control of invasive species, and so forth. A National Conference on Marine Bioinvasions to be held in January 1999 in Cambridge, Massachusetts, expects to attract over 200 workers, again suggesting the depth and breadth of interest in this topic. A Theme Session in Belgium in 2000 would bring together many workers from the ICES arena.

15 RECOMMENDATIONS TO ICES COUNCIL

The following recommendations to the Advisory Committee on the Marine Environment (ACME) were formulated by WGITMO (and are also listed in Annex 6):

1) WGITMO recommends that a Theme Session entitled 'Marine Biological Invasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' be convened for the 2000 ICES Annual Science Conference in Belgium. The Theme Session would focus on the ecological, environmental, and economic impacts (pro and con) of exotic species invasions in marine ecosystems, including dispersal vectors such as ballast water, the use of non-native species in aquaculture/mariculture systems, the mechanical and biological control of invasive species.

2) WGITMO recommends that ICES increase dissemination of the 1994 Code of Practice on a worldwide basis by placing the Code in its full bilingual format on the ICES website.

3) On the basis of newly reported invasions (e.g., a South African parasitic worm in abalone aquaculture in California and the Eurasian zebra mussel transported to Ireland), and noting earlier commerce-mediated invasions (e.g., the oyster parasitic copepod *Mytilicola orientalis* transported to Ireland with commercial oysters), WGITMO recommends that ICES establish a dialogue with international agencies, such as the European Commission, with respect to the increasing movements of commercial goods, aquaculture products, and other merchandise, often due to increasing trade agreements that foster freer enterprise, which concomitantly may inadvertently foster the spread of aquatic organisms and their disease agents.

4) WGITMO notes an increasing pattern of the novel expansion or population blooms of long-established alien species in the North Atlantic Ocean and in the Mediterranean Sea (for example, the tubeworm *Ficopomatus* in France and Ireland, the Lessepsian alga *Caulerpa racemosa* (as well as the native *Caulerpa prolifera*) in the northern Mediterranean Sea, possibly the shipworm *Teredo navalis* in the Baltic Sea, the expansion of the alga *Codium fragile tomentosoides* in the Gulf of St. Lawrence, the population increases in the Chinese mitten crab *Eriocheir sinensis* in Germany and England, the continued expansion of the alga *Sargassum muticum* in Scandinavia) and urges ICES Member Countries to alert ICES of any additional records of unexplained changes in the abundance or distribution of non-native species (as well as any unusual changes of ranges or population sizes of native species, that may elucidate the patterns and possible causes of range expansions or population changes now being seen with Nonindigenous taxa).

5) WGITMO noted that many current records of new populations of invasive species are believed to have spread from the primary site of first establishment and therefore recommends that ICES Member Countries, as potential donor regions, undertake proactive management to alert potential receiving countries (such as those that may take up ballast water in their ports and harbours) of the presence of new and previously established species invasions based, for example, on information obtained from port and marina surveys and associated monitoring programmes.

WGITMO will meet at the Center for Environment, Fisheries and Aquaculture Science (CEFAS) in Conwy, Wales, from 14–16 April 1999 to:

a) review the value in promoting the establishment of reference collections of the alga *Caulerpa* based on specimens now being moved through the aquarium trade;

b) finalize plans for a Theme Session on 'Marine Biological Invasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' to be convened at the ICES Annual Science Conference in Belgium in 2000;

c) continue work on a 'Directory of Dispersal Vectors' as an ICES Cooperative Research Report, including a continued review of aquarium-related transportation of exotic species;

d) discuss the rationale for listing non-native species in ICES Member Countries as endangered or protected species, or under other actual or proposed conservation measures ,

e) report on the current status of fish, shellfish, algal, and other introductions in and between Member Countries, through:

   i. submission of the National Reports, to further newly include information on genetically modified organisms,

   ii. standardization of a data base questionnaire,

   iii. review of the status of selected current invasions, as well as any biocontrol programmes that are under consideration,

   iv. continued coordination with the Baltic Marine Biologists' Working Group on Nonindigenous Estuarine and Marine Organisms (NEMO) and the EU Concerted Action Plan on ballast water,

   v. review information on unprocessed and partially processed materials (e.g., fish, algae) as a dispersal vector for invasive species (such as pests, parasites, and disease agents) and to describe any potential impacts,

   vi. assemble a comprehensive list of the major invasive marine and estuarine animal and plant taxa of Europe and Atlantic North America as a basis for interannual tracking through the National Reports.

16 CLOSING OF THE MEETING

A final review of the 1998 terms of reference was made and the proposed agenda and action points for 1999 were considered. The offer from Dr Sue Utting to hold the meeting at the Centre of Environment, Fisheries and Aquaculture Science in Conwy, North Wales, UK was accepted. Final draft recommendations were discussed, revised and approved by WGITMO participants. The Chairman thanked all of the WGITMO members and guests for their dedicated work and thanked RIKZ for hosting the 1998 meeting in The Hague. The Chairman adjourned the meeting at 12.00 h on Friday, 27 March.

ANNEX 1

AGENDA

25 March 1998 Wednesday

9:00 OPENING SESSION

- Welcome and Introductory Remarks by Chairman
- Welcome by RIKZ Officials
- Appointment of Rapporteur
- Introduction of Participants and Guests
- Logistical Announcements (meals, telephone, FAX, photocopying, transportation, etc.) [Bas de Groot]
- Review of Agenda and changes, corrections, additions
- WGITMO Report Deadline
  WGITMO reports to ACME before its June 1998 meeting, and to the Marine Habitat and Mariculture Committees at the 1998 Annual Science Conference

9:30 REVIEW OF THE PREVIOUS MEETING: 1997, La Tremblade, France

- Review of 1997 La Tremblade Report and Addenda/Errata (if any)
- Review of Recommendations from 1997 La Tremblade meeting:
  - c 1997-1: WGITMO supports the recommendation of the ICES Study Group on Marine Biocontrol of Invasive Species (SGMBIS) that a permanent international 'Working Group on The Control of Marine Pests' be formed, as initially proposed by GESAMP, which would advise and recommend strategies on the prevention and post-introduction research and control of introduced species. This Group could be formed by a possible consortium of GESAMP, ICES, and other international agencies.
    [see TOR 3:1 and Agenda item on this matter, below]
  - c 1997-2: WGITMO supports the recommendation of the joint ICES/IOC/IMO Study Group on Ballast Water and Sediments (SGBWS) that SGBWS convene for a second year to discuss research and management programs on ballast water and sediments and other ship-mediated vectors with a view toward increased international cooperation and coordination.
    [SGBWS convened in The Hague, 23–24 March]
  - c 1997-3: WGITMO should conduct a general survey to determine the extent to which the green alga *Caulerpa taxifolia* is being held in public and research aquaria in ICES member states, under what temperature conditions, and the nature of effluent treatment, and also the extent to which this alga is available for purchase within the private aquarium hobby within ICES member states.
    [see TOR below]
  - c 1997-4: FAO/EIFAC should be contacted by ICES with the view of establishing a coordinated effort between EIFAC and ICES to harmonize the ICES 1994 Code of Practice on the Introduction and Transfer of Marine (and Freshwater) Organisms with the earlier EIFAC Code of Practice.
    [see TOR below]
  - c 1997-5: WGITMO recommends that a theme session, 'Marine Bioinvasions: Retrospectives for the 20th Century, Prospectives for the 21st Century', be convened for the 1999 or 2000 ICES Annual Science Meeting, to gain an overview of the issues that have engaged ICES member countries on the introductions and transfers of marine organisms for the past 20 years, since the first reconvened meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (1979), and to gain insights into the challenges that face ICES member countries in the opening decades of the 21st century.
    [see TOR below]

9:40 ICES/GESAMP WORKING GROUP ON THE CONTROL OF MARINE PESTS

Relative to WGITMO Recommendation 1997-1 (La Tremblade) which became TOR 1997/3:1 (ICES Annual Report, January 1998, page 110), as follows:

- C.Res. 1997/3:1 An GESAMP/ICES Working Group on the Control of Marine Pests (WGPEST) will be established under the co-chairmanship of Dr J. Carlton (USA) and a GESAMP representative, subject to the agreement to co-sponsorship by GESAMP and its sponsoring agencies, to:
  draft advice and recommend strategies on the prevention and post-introduction surveillance and control of introduced species.
  - WGPEST will work by correspondence during 1998. Progress in development will be reported to ACME before its June 1998 meeting and to the Marine Habitat and Mariculture Committees at the 1998 Annual Science Conference.

  Also note:
  - TOR 2:12:8:c: 'continue the assessment of the potential marine biocontrol activities through review of current proposed programmes in the ICES area, and through the invitation to the Marine Biocontrol Risk Assessment Specialist of the Australian CSIRO/CRIMP to meet with WGITMO'

10:00 TERMS OF REFERENCE (TORS) FOR THE 1998 HAGUE MEETING

Brief review, followed by discussion, clarification, or comments about the TOR (*which are individually considered during the course of the meeting*). The wording that follows is that of WGITMO has submitted in 1997, with minor editorial modifications made by the ICES home office:

The Working Group on Introductions and Transfers of Marine Organisms will meet in The Hague, Netherlands to:

a) make detailed plans for the Theme Session on 'Marine Bioinvasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' for the 1999 or 2000 ICES Annual Science Conference,
TOR 2:12:8: a

b) pursue progress on the harmonization of the joint EIFAC-ICES Codes of Practice, through an invitation to the Chair of the EIFAC Working Party on Introductions to meet with WGITMO;
TOR 2:12:8: b

c) continue the assessment of the potential marine biocontrol activities through review of current proposed programmes in the ICES area, and through the invitation to the Marine Biocontrol Risk Assessment Specialist of the Australian CSIRO/CRIMP to meet with WGITMO;
TOR 2:12:8:c

d) review the findings of the *Caulerpa* Aquarium Review conducted in 1997-98 by WGITMO members, relative to the status of the importation, holding, and disposal of Caulerpa in waters of Member Countries;
TOR 2:12:8: d

e) continue to prepare historical risk assessment studies for selected case histories of introduced marine plants, invertebrates, and fish in Member Countries, in order to understand the ecological and other environmental effects of commercially used exotic species introductions into Member Countries, so that the types of risk can be identified retrospectively and thus be used as a basis for aiding future management decisions;
TOR 2:12:8: e

f) continue work on a 'Directory of Vectors Involved in the Introduction and Transfer of Marine and Estuarine Organisms', which work reviews the diversity, nature, and specific roles of vectors that are important in the transportation of exotic marine and brackish water organisms, in order to provide decision-makers with ready access to data sources that may aid in risk assessments, when specific vectors are proposed or come into play that have previously not existed or have not yet been recognized in individual ICES member countries.
TOR 2:12:8: f

g) report on the current status of fish, shellfish, algal, and other introductions in and between Member Countries, through:
TOR 2:12:8: g

   i. submission of the National Reports,
   ii. updates on the issues of transport of exotic organisms through ships' ballast water and sediments, and other ship-associated vectors, through information provided by the joint ICES/IOC/IMO SGBWS,
   iii. review of the status of the current and projected distribution, ecological impacts and commercial use in Member Countries of introduced marine and brackish water organisms, such as the marine seaweeds *Porphyra yezoensis*, *Undaria pinnatifida*, *Sargassum muticum*, and *Caulerpa taxifolia*, and the marine invertebrates *Marenzelleria viridis*, *Hemigrapsus penicillatus,* and *Dreissena polymorpha*,
   iv. review of the status of research on genetically modified organisms (GMOs) in Member Countries, with particular attention to the current status of transgenic salmon in aquaculture,
   v. continued coordination of cooperative databases on introductions and transfers of marine and brackish water organisms,
   vi. continued communication with and cooperation with the Baltic Marine Biologists' WGNEMO,
   vii. development of a questionnaire and expanded Terms of Reference for a more general review of the non-native temperate marine and brackish-water organisms being held in public and research aquaria in ICES member states, under what temperature conditions, and the nature of effluent treatment, and also the extent to which non-native temperate animals and plants are available for purchase within the private aquarium hobby within Member Countries.

10:10 THE ICES CODE OF PRACTICE
- Brief Summary
- Status of Translations
- EIFAC-ICES Code Harmonization (EIFAC WPI)
  TOR: 2:12:8:b
- Any Other Matters

STATUS OF NEW COOPERATIVE RESEARCH REPORTS
- Summary of Introductions in ICES Countries as of 1990
  in press
- Aalborg Ballast Water Symposium
  in press
- The ICES Code of Practice: Guidebook and Case Examples
  to be submitted April 1998

10:20 MULTINATIONAL INVASION/INTRODUCTION/TRANSFER INITIATIVES AND PROGRAMMES
- Concerted Action Plan (S. Gollasch)
- Update on Baltic NEMO Activities (S. Gollasch)
  16th Baltic Marine Biologists Symposium: 21–26 June, 1999, Klaipëda, Lithuania: Special session: Session: * Alien species in the brackish water ecosystems
  TOR: 2:12:8/g/vi [continued cooperation with BMB NEMO]

10:30 COFFEE BREAK

11:00 NEW GENERAL PUBLICATIONS, JOURNALS, WEBSITES, INTERNATIONAL DATA BASES, 'PROFORMA' SPECIES DATA SHEETS, *et cetera*
TOR 2:12:8: g/v
- 'Biological Invasions': a new journal from Kluwer Academic Publishers (J. T. Carlton)
- Update on databases/listservers (K. Jansson)
- England: http://www.jncc.gov.uk (C. Eno)
- Standardized Species Data Sheets (C. Eno)

12:00–1:30 LUNCH

1:30 RECONVENE FOR THE AFTERNOON SESSION
NATIONAL REPORTS [TOR 2:12:8: g; g/i; g/iii]
- Australia
- Canada
- France
- Germany
- Ireland
- Israel
- Italy
- Netherlands

3:30 COFFEE BREAK

4:00 NATIONAL REPORTS (continued)

4:30 GENETICALLY MODIFIED ORGANISMS (GMOs): Update
[TOR 2:12:8: g/iv]

5:00 ADJOURN

26 March 1998 Thursday

9:00 REVIEW OF PREVIOUS DAY, AND TODAY'S AGENDA
NATIONAL REPORTS [continued]
- Norway
- Sweden
- UK: England and Wales
- USA

9:45 STATUS OF JAPANESE RED ALGAE (Nori), *Porphyra yezoensis*, IN THE GULF OF MAINE (Canada and USA) (I. Levine)
Questions and Discussion

10:30 COFFEE BREAK

11:15 CASE HISTORIES IN AQUATIC AND MARINE INVASIONS:
Examples from Marine Tubeworms (Annelida: Polychaeta: Serpulidae) (H. ten Hove)
Questions and Discussion

12:00–1:30 LUNCH

1:30 CASE HISTORIES IN AQUATIC AND MARINE INVASIONS:
Dispersal of two North American immigrant species: the spionid worm *Marenzelleria* spp. (Annelida: Polychaeta) and the razor clam *Ensis americanus* (Mollusca: Bivalvia) in Northwest Europe, and development of local populations (K. Essink)
Dr Essink is Chair of the ICES Benthos Ecology Working Group (BEWG), which meets this year in Heraklion, Crete, Greece from 23-25 April 1998. One of their TOR is to 'review the ecological aspects of the introduction of *Marenzelleria* sp. in northwestern European waters'

2:15 CASE HISTORIES IN AQUATIC AND MARINE INVASIONS: The zebra mussel *Dreissena polymorpha* (Mollusca: Bivalvia) arrives in Ireland (D. Minchin)

2:30 DISPERSAL VECTORS: Living Organisms Transported in Dried Seaweed and with Unprocessed Fish (see handout)

2:45 DISPERSAL VECTORS: Directory of Vectors [TOR 2:12:8: f]
'The Dispersal of the European Green Crab *Carcinus maenas* as a Model System for Interpreting Multivector Transport' (J. Carlton)
Discussion

3:15 SUMMARY OF INFORMATION PROVIDED BY ICES/IOC/IMO SGBWS, relative to updates on the issues of transport of exotic organisms through ships' ballast water and sediments, and other ship-associated vectors, through information provided by the joint ICES/IOC/IMO SGBWS [TOR 2:12:8: g/ii]

3:30 COFFEE BREAK

4:00 DISPERSAL VECTORS: Public and Research Aquaria
Caulerpa Aquarium Review [TOR 2:12:8: d]
A general review of the non-native temperate organisms held in aquaria (Development of a questionnaire and expanded TOR) [TOR 2:12:8: g/vii]

4: 30 DRAFT RECOMMENDATIONS

5:00 ADJOURN

27 March 1998 Friday

9:00 REVIEW OF PREVIOUS DAY, AND TODAY'S AGENDA

9:15 THEME SESSION FOR 2000 ICES ANNUAL SCIENCE CONFERENCE: 'Marine Bioinvasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' [TOR 2:12:8: a]
88th Statutory Meeting, Annual Science Conference, Belgium (Ostende or Bruges), 2000

9:45 SUBJECTS (IF ANY) REQUIRING COMPLETION (Rotated Forward from Previous Days)

10:00 REVIEW OF RECOMMENDATIONS: DISCUSSION AND FINAL EDITING
- Principal Agenda Items for 1999 WG Meeting
- Place & Time for 1999 Meeting

10:15 REPORT WRITING SESSION

10:30 COFFEE BREAK

11:00 REPORT WRITING SESSION

12:00 ADJOURNMENT OF MEETING

ANNEX 2

LIST OF PARTICIPANTS

Name	Address	Telephone	Telefax	E-mail
Avigdor Abelson	Institute for Nature Conservation Research Tel Aviv University Tel Aviv 69978 Israel	+972-3-6407690 +972-3-6409813	+972-3-6407304	avigdor@post.tau.ac.il
Helge Botnen	UNIFOB, Section of Applied Environmental Research c/o Department of Fisheries and Marine Biology University of Bergen High Technology Centre N-5020 Bergen Norway	+47 55 58 44 65	+47 55 58 45 25	helge.botnen@ifm.uib.no
Malcolm I. Campbell	Fish Health Unit Maritimes Region Department of Fisheries and Oceans P.O. Box 5030 Moncton, New Brunswick E1C 9B6 Canada	+1 506-851-6247	+1 506-851-2079	campbellm@dfo-mpo.gc.ca
Allegra Cangelosi	Northeast-Midwest Institute 218 D Street SE Washington, D.C. 20003 USA	+1 202-544-5200	+1 202-544-0043	acangelo@nemw.org
James T. Carlton (Chairman)	Maritime Studies Program Williams College -- Mystic Seaport P.O. Box 6000, 75 Greenmanville Avenue Mystic, Connecticut 06355 USA	+1 860 572 5359	+1 860 572 5329	jcarlton@williams.edu
S.J. (Bas) de Groot	National Institute for Fisheries Research (RIVO-DLO) Haringkade 1 P.O. Box 68 NL-1970 AB IJmuiden The Netherlands	+31 255 564 646 / 731	+31 255 564 644	els@rivo.dlo.nl
N. Clare Eno	Joint Nature Conservation Committee Monkstone House, City Road Peterborough, Cambs PE1 1JY England United Kingdom	+44- 17-33-866-833	+44- 17-33-555-948	eno_c@jncc.gov.uk
Bella Galil	National Institute of Oceanography P.O. Box 8030 Haifa 31080 Israel	+972-4-8515202	+972-4-8511911	galil@math.tau.ac.il

Name	Address	Telephone	Telefax	E-mail
Michel Gilbert	Department of Fisheries and Oceans Maurice Lamontagne Institute P.O. Box 1000 850, Route de la Mer Mont-Joli, Québec G5H 3Z4 Canada	+1 418 775 0604	+1 418 775 0542	gilbertm@dfo-mpo.gc.ca
Stephan Gollasch	Institut fur Meereskunde Universitat Kiel Dusternbrooker Weg 20 24105 Kiel 1 Germany	+49 431 597 3916	+49 431 565 876	sgollasch@aol.com
Julie Hall	National Institute of Water & Atmospheric Research (NIWA) Box 11-115 Hamilton New Zealand	+64 7 856 1709	+64 7 876 0151	j.hall@niwa.cri.nz
Cameron Hay	Cawthron Institute 98 Halifax Street East Private Bag 2 Nelson New Zealand	+64 3 548 2319	+64 3 546 9464	cameron@environment.cawthron.org.nz
Chad L. Hewitt	CSIRO - Centre for Research on Introduced Marine Pests (CRIMP) Castray Esplanade GPO Box 1538 Hobart, Tasmania 7001 Australia	+64 (03) 6232 5102	+64 (03) 6232 5485	chad.hewitt@marine.csiro.au
Bridget Holohan	Williams College -- Mystic Seaport P.O. Box 6000, 75 Greenmanville Avenue Mystic, Connecticut 06355 USA	+1 860 572 5359	+1 860 572 5329	bridget@mysticseaport.org
Norbert Huelsmann	Zoology - Free University Berlin Koenigin-Luise-Strasse 1-3 14195 Berlin Germany	+49 30-838 3921	+49 30 838 3916	hulsmann@zedat.fu-berlin.de
Kristina Jansson	Swedish Environmental Protection Agency Research & Development Department SE-106 48 Stockholm Sweden	+46 (0) 8698 1451	+46 (0) 8698 1584	kristina.jansson@environ.se
Anders Jelmert	Institute of Marine Research Austevoll Aquaculture Research Station N-5392 Storebø Norway	+47 56 18 03 42	+47 56 18 03 98	anders.jelmert@imr.no

Name	Address	Telephone	Telefax	E-mail
Knut E. Jørstad	Department of Aquaculture Institute of Marine Research P.O. Box 1870 N-5011 Nordnes, Bergen Norway	+47 55 23 4347	+47 55 23 8333	knut.joerstad@imr.no
Dorothee Kieser	Pacific Biological Station 3190 Hammond Bay Road Nanaimo, B.C. Canada	+1 250 756 7069	+1 250 756 7053	kieserd@dfo-mpo.gc.ca
Anthony Knap	Bermuda Biological Station for Research Bermuda GE 01	+441 297 1880 ext. 244	+441 297 0860	knap@sargasso.bbsr.edu
Joel Kopp	Nonindigenous Species Project Manager Prince William Sound Regional Citizens' Advisory Council Valdez, Alaska USA	+1 907 835 1940	+1 907 835 5926	kopp@pobox.alaska.net
Penny Lockwood	Ballast Water and Introduced Marine Pests Section Australian Quarantine and Inspection Service (AQIS) GPO Box 858 Canberra Australia	+1 612 62725363	+1 612 62723036	penny.lockwood@dpie.gov.au
Ian Lucas	University of Wales Bangor, Anglesey LL59 5EY North Wales United Kingdom	+44 1248 38 2871	+44 1248 38 2906	oss066@bangor.ac.uk
Elspeth Macdonald	Fisheries Research Services FRS Marine Laboratory P.O. Box 101 Victoria Road Aberdeen AB11 9DB Scotland United Kingdom	+44 1224 876 544	+44 1224 295 511	macdonaldem@marlab.ac.uk
Tracy McCollin	School of Ocean Sciences University of Wales Bangor, Anglesey LL59 5EY North Wales United Kingdom	+44 1248 38 2871	+44 1248 38 2906	oss138@bangor.ac.uk
Whitman Miller	Smithsonian Environmental Research Center P.O. Box 28 Edgewater, Maryland 21037 USA	+1 410 798 4424 ext. 139	+1 410 867 7842	miller@serc.si.edu
Dan Minchin	The Marine Institute Fisheries Research Centre Abbotstown, Dublin 15 Ireland	+353-1-8210-111	+353-1-8205-078	dminchin@frc.ie
Manfred Nauke	International Maritime Organization Albert Embankment London, England United Kingdom	+44-171-587-3124	+44-171-587-3210	jhallett@imo.org (or) mnauke@imo.org

Name	Address	Telephone	Telefax	E-mail
Darren Oemcke	Dept. of Civil & Environmental Engineering & CRC Reef Research James Cook University Townsville, Queensland 4811 Australia	+61 7 47 81 5081	+61 7 47 75 1184	eng-djo@jcu.edu.au
Sergej Olenin	Centre for System Analysis Klaipeda University Manto 84 LT-5808 Klaipeda Lithuania	+370 6 212 936	+370 6 212 940	s.olenin@samc.ku.lt
Judith Pederson	Massachusetts Institute of Technology Sea Grant College Program 292 Main St. E38 - 300 Cambridge, Massachusetts 02129 USA	+1 617-252-1741	+1 617-252-1615	jpederso@mit.edu
Giulio Relini	Società Italiana di Biologia Marina (S.I.B.M.) c/o Istituto di Zoologia - Università Via Balbi, 5 I-16126 Genova Italy			sibmzool@unige.it
Geoff Rigby	Reninna Pty. Limited 36 Creswell Avenue Charlestown NSW 2290 Australia	+61 24 943 04 50	+61 24 947 89 38	rigby@mail.com
Anya Shotadze	Georgian Ministry of Environment Convention Inspection Office for Protection of the Black Sea 9 April Street no. 6 Batumi Georgia	+995 (222) 7 28 50	+995 (222) 76153 or 54	mechat@pop.kheta.ge <Mary Ellen Chatwin>
Susan D. Utting	CEFAS, Conwy Laboratory Benarth Road Conwy LL32 8UB North Wales UK	+44 1492-593-883	+44 1492-592-123	s.d.utting@cefas.co.uk
Inger Wallentinus	Avd. Marin botanik (Department of Marine botany) Göteborg University Botaniska Institutionen P.O.Box 461 S-405 30 GÖTEBORG Sweden	+46-(0)31 773 27 02	+46-(0)31 773 27 27	inger.wallentinus@marbot.gu.se

ANNEX 3

NATIONAL REPORTS

AUSTRALIA

Research and Management

The Australian approach to the management of ballast water and other introduction vectors relies on the knowledge of the diversity and identity of existing marine invasions. Current activity at the Commonwealth level is leading to a Marine Policy as outlined by Penny Lockwood of AQIS. A National Incursion Detection and Response programme with a distinctively community level focus is being pursued and a one-year demonstration project has been jointly funded by Environment Australia (EA), Australian Quarantine and Inspection Service (AQIS), and the Centre for Research on Introduced Marine Pests (CRIMP) at CSIRO Division of Marine Research. It has been agreed in consultation with stakeholders that there should be established:

1) a single contact at the state level;
2) the development of an incursion notification network;
3) the establishment of a single, coordinated target list for reporting;
4) the development of multi-target (i.e., community, industry, academia, science) species information and identification sheets;
5) the development of coordinated legislation for the mandatory reporting of targeted species;
6) the development of a national database which records new incursions and documents the verification process;
7) the need for research into the appropriate incursion response plans and activities was highlighted.

Port Surveys

While the community activities outlined above will lead to a broad-based input to new incursions, the lack of baseline studies in areas most likely to receive new invasions has led to the development of a National Ports Survey Program. The Program was a joint initiative between the Australian Association of Ports and Marine Authorities (AAPMA) and CRIMP. Initially the port surveys will be conducted by CRIMP at a 50:50 cost share arrangement with the individual port authorities in order to obtain a circum-Australia perspective. To facilitate this, CRIMP has published a set of Port Survey Protocols (Hewitt and Martin, 1996; CRIMP Tech Report No. 4) which are intended to be available to a broad-based research community without an onerous equipment requirement. These protocols are available on request from CRIMP. The intent of these protocols is to provide the background philosophy of introduced species survey design and suggest a template for a quantitative and qualitative assessment of introductions in Australian ports. These protocols have been successfully implemented in tropical and temperate ports by CRIMP and other researchers from various state agencies. The initial surveys are conducted for all species (targets and non-targets) in order to evaluate patterns of introductions at fine scale within ports, however, the protocols have an explicit target species/target site approach.

As of January 1998, 13 ports have been surveyed covering all states. Additional tropical surveys are planned in Western Australia, Northern Territory, and Queensland and temperate surveys in New South Wales, Victoria, Tasmania, and South Australia. Results to date can be generalised as follows:

1) a total of 228 introduced species have been recognised in Australian waters with an additional 150+ cryptogenic species;
2) introductions have been identified from all ports surveyed to date, these introductions may either be historic or recent;
3) patterns of invasion within ports can be discerned in which localised distributions are associated with specific shipping traffic, however, many species are broadly distributed potentially indicating older incursions.

Australia's targeted species list includes the European fan worm *Sabella spallanzanii*, the European shore crab *Carcinus maenas*, the Northern Pacific seastar *Asterias amurensis*, the Japanese seaweed *Undaria pinnatifida*, and four species of toxic dinoflagellates in the genera *Gymnodinium* and *Alexandrium*, the Asian date mussel *Musculista senhousia*, and the small bivalve *Corbula gibba*. Additionally a target list for species known to be pests in other regions of the world not yet currently known in Australian waters includes: the Chinese clam *Potamocorbula amurensis*, the Atlantic ctenophore *Mnemiopsis leidyi*, the New Zealand seaslug *Philine auriformis*, and the green algae *Codium fragile tomentosoides*.

Recent Incursions in Australia

Fan worm *Sabella spallanzanii*—recent incursions to Devonport, Tasmania, Eden, New South Wales, Esperance, Western Australia, Kangaroo Island, South Australia. These incursions appear to have been associated with small recreational or fishing vessel traffic rather than commercial shipping activities.

The crab *Carcinus maenas*—populations of *Carcinus* established in South Australia appear to have gone locally extinct; surveys are planned to document this.

The seastar *Asterias amurensis*—incursions to Port Phillip Bay appear to have occurred in low densities over the last several years. This does not appear to be an established, reproductive population yet.

The kelp (brown alga) *Undaria pinnatifida*—January 1997, Tinderbox Marine Protected Area, Tasmania; currently an eradication project is under way at this location as a demonstration project for physical removal; an incursion was identified within Port Phillip Bay and surveys indicate an areal coverage of 3–5 km^2.

The green algae *Codium fragile tomentosoides*—*Codium* has been identified in the same region of Port Phillip Bay as the *Undaria* invasion.

CANADA

1 LAWS AND REGULATIONS

The Department of Fisheries and Oceans (DFO) continues to work on amendments to the Fish Health Protection Regulations (FHPR) and hopes to have the major revision completed during 1998. The 'interim amendment', referred to in the Canadian Report for 1996, was finalised and came into force in August 1997. The purpose of this amendment is to allow Local Fish Health Officers (LFHO) to approve transfers of eggs and fish between sites, even when disease agents of concern are detected at the source; and to allow LFHO's to approve the transfer of disinfected eggs from source facilities or wild broodstocks that have only been tested for viruses.

Canada's specific Shellfish Health Protection Regulations are at a stage where a draft is ready to be distributed for technical review. A 'Technical Committee' has been assembled which will include representation from DFO, representation from various provincial fisheries and/or aquaculture agencies, and representation from the aquaculture industry. The disease lists and pertinent information synopses have been put on a world-wide web site [http://www.pac.dfo.ca/pac/sealane/aquac/pages] to permit non-regulatory updating as conditions and information evolve.

As indicated in the 1996 report, Canada presently has no federal regulations (Fisheries or Agriculture) which can prohibit or control the movements of marine plants. Efforts are continuing to have aquatic plants added to the 'Fishery (General) Regulations' made under the Fisheries Act, or to some other appropriate legislation. It is hoped that before the end of 1998 there will be a federal legislative authority to manage introductions and transfers of marine algae and higher plants.

The Department of Fisheries and Oceans is continuing to develop a national 'Introductions and Transfers Policy'. In 1997 there was a major national review of a draft document and it is anticipated that a final version should be ready for approval by the Minister for Fisheries and Oceans before the end of 1998.

2 DELIBERATE RELEASES

2.1 Fish

In general all planned fish movements receive rigorous scrutiny by regional/provincial introductions and transfers committees which consider disease, genetic, and ecological risks. In addition, all transboundary movements of salmonids must satisfy the Canadian FHPR.

Significant numbers of eggs and fish of the established cultured species (rainbow trout *Oncorhynchus mykiss;* chinook salmon *O. tshawytscha;* sockeye salmon *O. nerka;* coho salmon *O. kisutch;* Atlantic salmon *Salmo salar;* brown trout *S. trutta;* cutthroat trout *S. clarki;* Arctic charr *Salvelinus alpinus;* brook trout *S. fontinalis;* lake trout *S. namaycush;*

splake *S. fontinalis*; northern pike *Esox lucius;* walleye *Stizostedion vitreum;* smallmouth bass *Micropterus dolomieui;* striped bass *Morone saxatilis*; brown bullhead *Ameiurus nebulosus*; yellow perch *Perca flavescens*) continue to be transferred into the country, between provinces and intra-provincially, in support of aquaculture (not intended to be released into the natural environment) and enhancement programmes (released into the natural environment).

Increased interest in 'new' species (e.g., Atlantic cod *Gadus morhua*; Greenland cod *Gadus ogac*; wolffish *Anarhichas lupus*; lumpfish *Cyclopterus lumpus*; winter flounder *Pleuronectes americanus*; yellowtail flounder *Limanda ferruginea*; Atlantic halibut *Hippoglossus hippoglossus*; American plaice *Hippoglossoides platessoides*; and shortnose sturgeon *Acipenser brevirostrum*) has resulted in small-scale introductions and transfers into the country, between provinces, and intra-provincially for research and developmental purposes.

2.2 Invertebrates

Planned movements of invertebrates, with the current exclusion of lobsters (*Homarus americanus*) in Atlantic Canada, destined for open-water live-holding or release, are also reviewed by regional/provincial introductions and transfers committees (ITC). Factors taken into account when assessing the risk of adverse effects on receiving waters include possible disease, genetic, and ecological impacts.

In Atlantic Canada, American oysters (*Crassostrea virginica*), European oysters (*Ostrea edulis*), blue mussels (*Mytilus edulis*), soft-shell clams (*Mya arenaria*), hard-shell clams (*Mercenaria mercenaria* and the selected variety *M. m. notata*), bar clams (*Spisula solidissima*), giant sea scallops (*Placopecten magellanicus*) and bay scallops (*Argopecten irradians*) were transferred as seedstock, for broodstock or for relay purposes throughout the region in 1997. As in previous years, all official movements of shellfish destined for hatchery use or for remote setting, are screened for parasites, pests, and diseases, prior to transfer (1996 = 55 case submissions; 1997 = 78 case submissions). Research into the development of non-traditional shellfish species for aquaculture is principally responsible for the increase in ITC requests over the last two years.

As noted under Section 3.2, an official introduction of 125 hard-shell clams of the selected variety *Mercenaria mercenaria notata* was made from Rhode Island into quarantine at a Provincial hatchery on Prince Edward Island. Twenty-five adults were sampled on arrival and the remaining 100 are being spawned for seed production in early 1998. Results from the initial screening revealed no disease agents of concern. Additional health checks are scheduled for 100 % of the broodstock post-spawning, when the seed have attained a size considered to have a high survival probability.

Two hundred bay scallops *Argopecten irradians* were introduced into the DFO quarantine facility at Halifax, Nova Scotia, from Rhode Island in June 1997. Samples of mortalities were preserved and examined and no disease agents of concern to the import waters were detected. The late arrival of the bay scallops precipitated spontaneous spawning and subsequent attempts to produce an F1 generation failed. The remaining bay scallops were destroyed in February 1998 and tissue samples taken for a terminal health examination (see Section 6.2).

In addition to screening for parasites, pests, and diseases prior to transfer, American oyster *C. virginica* seed and juveniles which were transferred from New Brunswick into the Gaspé Peninsula area of Quebec were held in quarantine for 48 hours prior to placement in open waters to ensure complete digestion of any algal food (specific concern cited was the diatom *Pseudonitzchia multiseries).* In addition, a request to transfer giant sea scallop *P. magellanicus* seed from the Magdalen Islands (Province of Quebec) in the Gulf of Saint Lawrence to Jacques Cartier Bay, on the north shore of the Gulf of Saint Lawrence in Quebec was denied based on concerns about possible disruption of genetic equilibrium of the local feral population and the possibility of 'fellow travellers' in or on the seed collection bags (specific concern cited was the green crab *Carcinus maenas*).

In British Columbia, Manila clam *Tapes philippinarum* and Pacific oyster *Crassostrea gigas* seed continue to be imported from certified sources in the Pacific northwest USA for beach seeding purposes.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Fish

The current distribution of five species of fishes recently introduced (accidentally) into the Great Lakes, are summarised on the attached maps. The five species include ruffe (*Gymnocephalus cernuus*), round goby (*Neogobius melanostomus*), tubenose goby (*Proterorhinus marmoratus*), rudd (*Scardinius erythrophthalmus*), and fourspine stickleback (*Apeltes quadracus*). The maps were prepared by the Ontario Ministry of Natural Resources, and were updated in February, 1998.

There was a large escapement of rainbow trout into eastern Lake Ontario during spring 1997 from an aquaculture operation in the Bay of Quinte.

3.2 Invertebrates

All hard-shell clams of the selected variety (*Mercenaria mercenaria notata*) from the original 'unofficial' introduction to Atlantic Canada from the eastern United States in the early 1990s have been screened for disease agents of concern. The F1 generation from these are now being used for growth trial comparisons with local stocks (*Mercenaria mercenaria*), including one site on Prince Edward Island. A second stock of the *notata* variety was introduced into quarantine on Prince Edward Island from Rhode Island in order to have a better-documented seed-source.

The European amphipod *Echinogammarus ischnus*, present in the Detroit River and Lake Erie in 1996, has been confirmed in the upper St. Lawrence River at Prescott in October 1997. The species was still absent in eastern Lake Ontario and the outlet into the St Lawrence River suggesting shipping activity was the mode of transport into the St. Lawrence River.

3.3 Algae and Higher Plants

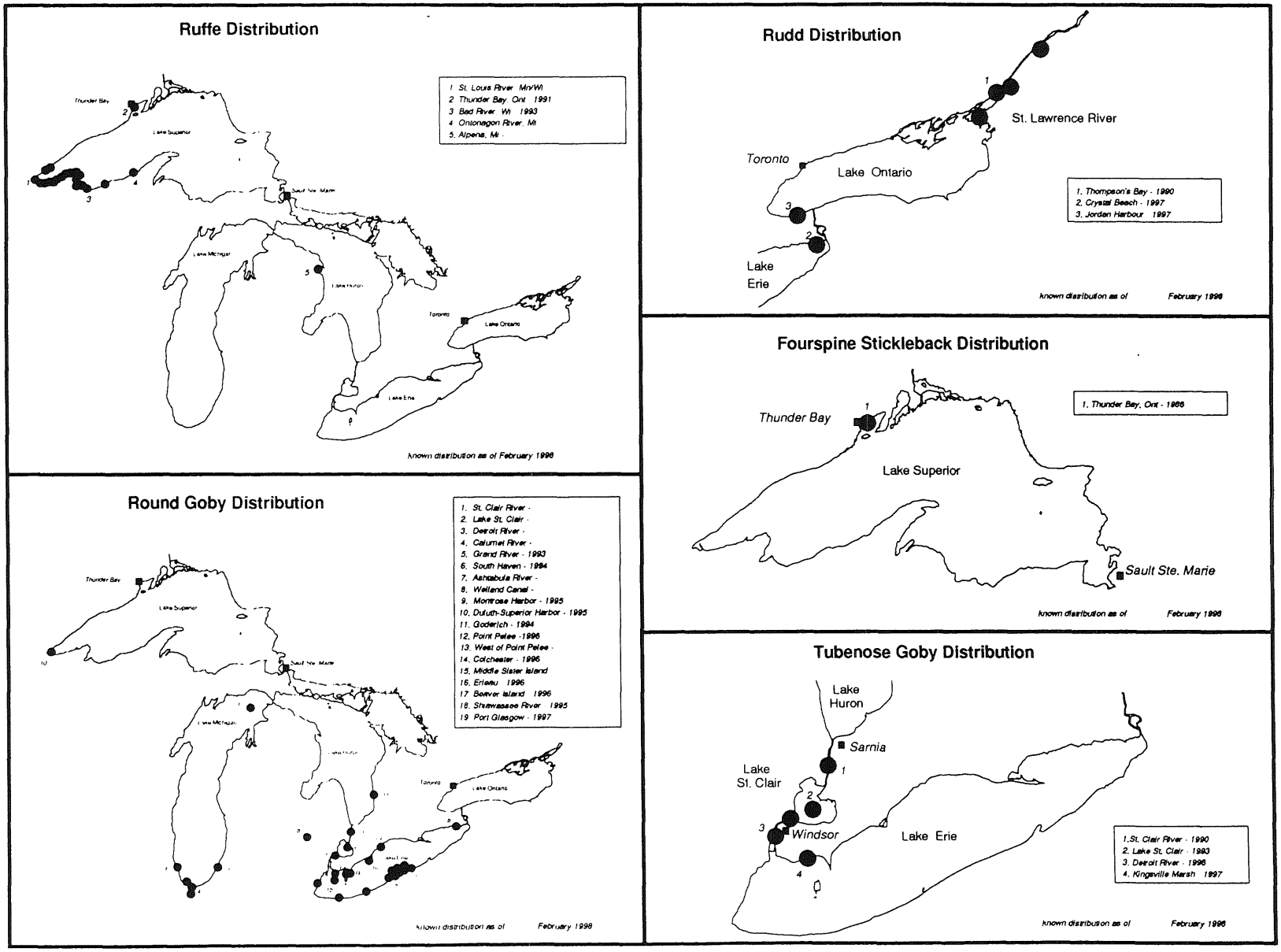
At the 1996 and 1997 meetings, the apparent spread of a seaweed identified as *Codium fragile tomentosoides* in Atlantic Canadian waters was reported. In 1996 there were numerous reports of *C. fragile* being found in Gulf of St. Lawrence waters with a confirmation of its existence during the fall of that year when samples were collected from an American oyster (*Crassostrea virginica*) aquaculture lease in the Lennox Island Channel on the western side of Malpeque Bay, Prince Edward Island. In 1997 the PEI Department of Fisheries and Environment distributed an information poster to all processing plants with a request to report any findings of *C. fragile.* Results gathered indicate that Malpeque Bay is now colonized throughout and that the plant is severely affecting oyster growing areas and is even growing on suspended cultured mussel gear. As well, a large colony of the seaweed has also been identified in the Enmore/Percival area on the Northumberland Strait side of the Island.

The oyster lease in the Lennox Island Channel, where the seaweed was first discovered in 1996, has become heavily colonized with a mat 1 to 2 feet thick covering much of the lease bottom. The presence of this large and heavy plant has made oyster collecting by hand-tonging very difficult. During the summer and fall of 1997, the owner had his employees remove and land-fill an excess of 100,000 pounds of the plant without making a noticeable reduction in plant volume.

During 1997, the PEI Department of Fisheries and Environment conducted preliminary trials on immersion treatments to kill *Codium* on individual oysters in an effort to provide the industry with a means of moving oysters without transferring the plant into *Codium*-free areas. From their results it appears that 4 % hydrated lime will effectively kill *Codium fragile* when used as a 5-minute immersion treatment and that saturated brine is effective if used for 15 minutes. (Air drying does not kill the seaweed, in fact it caused 'fragmentation' resulting in budding which spreads the plant even more quickly.) In an effort to determine the recolonization rate of *C. fragile*, the Provincial Government also used divers to physically remove all plants from a transect 45 metres long by 6 metres wide from the previously mentioned oyster lease in Lennox Channel. Because *Codium fragile* is one of the major concerns of oyster and mussel growers on PEI, the Provincial Government will be doing more work in 1998 directed at means of controlling the plant.

4 LIVE IMPORTS

A wide variety of marine and freshwater organisms continue to be imported into Canada and/or transferred between provinces for research, display or for human consumption purposes. The organisms are usually held in quarantine or other containment facilities and are generally either destroyed after research is completed or used as food. Although we believe that the stringent conditions of quarantines and many containment facilities effectively illuminates the risks that


Ruffe Distribution
1. St. Louis River MnWi
2. Thunder Bay, Ont 1991
3. Bad River Wi 1993
4. Ontonagon River, Mi
5. Alpena, Mi -
Thunder Bay
Lake Superior
Lake Michigan
Lake Huron
Toronto
Lake Ontario
Lake Erie
known distribution as of February 1998
Rudd Distribution
St. Lawrence River
Toronto
Lake Ontario
1. Thompson's Bay - 1990
2. Crystal Beach - 1997
3. Jordan Harbour 1997
Lake
Erie
known distribution as of February 1998
Fourspine Stickleback Distribution
1. Thunder Bay, Ont - 1986
Thunder Bay
Lake Superior
Sault Ste. Marie
known distribution as of February 1998
Round Goby Distribution
1. St. Clair River -
2. Lake St. Clair -
3. Detroit River -
4. Calumet River -
5. Grand River - 1993
6. South Haven - 1994
7. Ashtabula River -
8. Welland Canal -
9. Montrose Harbor - 1995
10. Duluth-Superior Harbor - 1995
11. Goderich - 1994
12. Point Pelee -1996
13. West of Point Pelee -
14. Colchester - 1996
15. Middle Sister Island
16. Erieau 1996
17. Beaver Island 1996
18. Shawassee River 1995
19 Port Glasgow - 1997
Thunder Bay
Lake Superior
Lake Michigan
Lake Ontario
known distribution as of February 1998
Tubenose Goby Distribution
Lake
Huron
Sarnia
Lake
St. Clair
Windsor
Lake Erie
1.St. Clair River - 1990
2. Lake St. Clair - 1993
3. Detroit River - 1996
4. Kingsville Marsh 1997
known distribution as of February 1998

such importations may pose to Canadian fisheries resources, we are unable to assess the true risks in other cases such as the large-scale importation of live fish for human consumption. Some jurisdictions are trying to develop ways of assessing that risk; e.g., the Ontario Ministry of Natural Resources is looking into the risks associated with large-scale importations of fishes for the live-fish food industry.

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES

Canadian aquaculturists continue to ship Atlantic salmon (*Salmo salar*), Arctic charr (*Salvelinus alpinus*), brook trout (*Salvelinus fontinalis*) and rainbow trout (*Oncorhynchus mykiss)* eggs and fish to the USA, subject to US Title 50 fish health conditions. In 1997, 15,000 striped bass (*Morone saxatilis*) fry were exported from New Brunswick to the southern USA (Louisiana?). An aquaculturist in Quebec sent shipments of Arctic charr and brook trout eggs to France and Arctic charr × brook trout hybrid eggs to Germany. An aquaculturist in the Yukon also exported Arctic charr eggs to Germany and Ireland (and to Japan as well).

In December 1997, two hundred 2-year-old European oysters (*Ostrea edulis*) were shipped from southeast Nova Scotia to the quarantine facilities at La Tremblade, France as part of a collaborative study between DFO and IFREMER on bonamiasis pathogenicity and oyster susceptibility (c.f. ICES CM 1997/F:6 Tor (i).

In 1996 France and Canada established a protocol under which display species for public aquaria could be brought into France. Since that time, British Columbia has exported small numbers of kelp greenling (*Hexagrammos decagrammus*), red Irish lord (*Hemilepodotis hemilepidotus*), and spotted ratfish (*Hydrolagus colliei*) to France.

6 PLANNED INTRODUCTIONS AND TRANSFERS

6.1 Finfish

Continued importations and transfers of salmonids for aquaculture, enhancement, and research purposes from other provinces in Canada and from sources in the USA are likely. Of note:

A research facility in New Brunswick has requested permission to import Danube sturgeon (*Acipenser gueldenstadti*) milt from Florida; fertilized eggs of a cross between Beluga sturgeon and Sterlet sturgeon (*Huso huso* × A. ruthenus) from Russia via Florida; and milt and eggs of lake sturgeon (*A. fluvescens*) from Ontario. These imports are intended for crossbreeding trials with shortnose sturgeon (*A. brevirostrum*) from the Saint John River in New Brunswick.

6.2 Invertebrates

Continued importations and transfers of invertebrates for aquaculture, enhancement, and research purposes from other provinces in Canada and from sources in the USA are likely. Of note:

Bay scallop (*Argopecten irradians*) may be re-introduced from the eastern United States, once an approved quarantine facility is finished for holding them in Halifax, Nova Scotia (see note under Section 2.2)

Hatchery-produced European oyster (*Ostrea edulis*) seed are proposed for transfer from Nova Scotia to the Pacific coast of the United States in 1998 for grow-out.

7 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS

Last year we reported on the activities of the Working Group on Nonindigenous Species formed under the Marine Science Panel of the British Columbia/Washington State Environmental Co-operation Council. Both the British Columbia Working Group and its counterpart in Washington State are in the process of completing strategies to minimize the introduction of Nonindigenous species. These strategies focus on the pathways by which Nonindigenous species may be transferred (live seafood, research, display, teaching institutions, ballast water, fouling organisms on ships, fishing vessels, and recreational boats, pet trade, and aquaculture). The British Columbia strategy seeks to achieve a number of outcomes including a rational legislative and regulatory framework, formal protocols, and voluntary guidelines to assess and minimize the risk of unplanned introductions via each identified pathway. Key components are education and training initiatives and the formation of public and private sector partnerships with defined obligations for all parties.

The Seventh International Zebra Mussel and Aquatic Nuisance Species Conference was held 28–31 Januray 1997 in New Orleans.

An International Symposium on Biology and Management of Ruffe was held 21–23 March 1997 in Ann Arbor, MI, USA,. The Symposium was organised by the US Sea Grant Great Lakes Network. Experts from several countries outside the United States participated in the Symposium, including Canada, Russia, Slovakia, Germany, England, Scotland, Finland, and France. The Symposium was designed to 'enhance the current understanding of the ruffe infestation and its implications to North America'. A selection of papers from the Symposium will be published in a future issue of the Journal of Great Lakes Research.

FRANCE

1 LAWS AND REGULATIONS

Additional State decrees were enacted in January and March 1997 to complement previous decrees with respect to sanitary conditions for shellfish production and marketing (EU Directive 91/492/CEE, Council 15 July 1991 - State Decree No. 94–300, April 1994). These State decrees specify shellfish transfer modalities with regard to sanitary zonation (A, B, C, D). They include required tag descriptions and maximal size for shellfish juveniles allowed in case of transfers among rearing zones and marketing. They should facilitate tracing the transfers of living shellfish products.

2 DELIBERATE RELEASES

2.3 Algae and Higher Plants

Undaria pinnatifida

In 1996, predation by a snail *Gibbula* sp. had a significant impact on natural subtidal *Undaria* populations located in Northern Brittany. Since then, no predation has been observed and the population has returned to its initial level. Cultivated populations are very limited, reaching 2–3 tonnes in yearly landings in St Guénolé (Southern Brittany) and 1 tonne in southwestern France (Oléron Island). No sightings in the nearby vicinity on the longlines have been reported.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Crab *Hemigrapsus penicillatus*

The first sighting of *Hemigrapsus penicillatus* was reported in 1994 around La Rochelle harbour (Atlantic coastline); it then spread quickly northward to the Loire estuary and southward to Laredo (Spain). In 1997, the species distribution did not show further extension along the Atlantic coastline. However, a new sighting was reported in wet-docks waters in Le Havre (Normandy, English Channel). This subtidal population, sampled by scuba diving, is likely to facilitate further extension in nearby waters (English Channel, North Sea). This disjunct distribution suggests spread by remote dispersal of mobile adults.

Crab *Callinectes* sp.

While establishing the national decapods' inventory, a first sighting of a juvenile *Callinectes* sp. was reported within the national marine sanctuary waters of Port Cros (Mediterranean Sea). Although it lacked the common blue color, this juvenile is thought to be a *C. sapidus*.

Polychaeta: Serpulidae: The Tubeworm *Ficopomatus (Mercierella) enigmatica*

This species was first noticed in France in 1921 (Fauvel, 1923). In 1997, local population outbreaks showing rapid build-up were reported in southern Brittany (Lorient) and in the Bays of Veys (Normandy) at the near vicinity of harbours in brackish waters. Although no significant environmental impacts were reported, these outbreaks had several impacts on harbour management and structures (e.g., pipe clogging, blocking tide-gates) as well as on ships. The latter case facilitates spread by dispersal of mobile adults on ships' hulls.

3.3 Algae and Higher Plants

Sargassum muticum

Natural populations showed no significant changes or further extensions. High turbidity levels in estuaries limit further population spread.

Caulerpa taxifolia

Since the first sighting of *Caulerpa taxifolia* on the French Mediterranean seaside, this species has extended its distribution considerably, colonizing areas in Croatia, Monaco, Italy and Spain. An additional exotic species *C. racemosa* is presently observed in oriental Mediterranean Sea and was recently reported in Genoa (Italy) and Marseille (France). Several on-going research programmes funded at the national level as well as by the UE (LIFE, DGXI), focus on the invasion by *C. taxifolia* and its resulting environmental impacts. There is no sign of regression for the species *C. taxifolia*. In contrast, new stations have been found showing small patches of *Caulerpa*. Attempts to eradicate these patches were carried out by hand and by using a covering leaching copper. *Caulerpa* density seems to increase in deeper areas (> 30m deep) shifting from 1–25 % coverage to > 25 % coverage in several areas. Optimal depth distribution for *Caulerpa* development remains between 1 and 30 m deep. Spatial competition between *Posidonia* and *Caulerpa* populations is still unsettled since their development cycle is reversed, therefore limiting the conclusions on that matter. The last working group on 'Invasive *Caulerpa*' in the Mediterranean Sea (21 countries are represented on this working group) unanimously adopted several recommendations including: sustaining coordination among countries to limit the species extension, sustaining national programmes at several levels (research, prevention, providing information to all possible users of the coastal areas). One recommendation emphasizes the need to ban marketing and the use of *C. taxifolia* and *C. racemosa,* and to avoid any use of the genus *Caulerpa* in aquarium activity except for the endemic species *C. prolifera.*

Spartina anglica (townsendii)

The common cord glass species, initially resulting from the crossing of the North American species *Spartina alterniflora* with the native *S. maritima* (occurrence in the UK prior to 1870), was first observed in France in 1906 (Bays of Veys - Normandy). The first sighting in the Bay of Arcachon (southwest of France) occurred in 1985 and has since then spread quickly on the mudflats. At present, hundreds of hectares have been colonized by this species. Moreover, a second North American species *Spartina juncea* has been occasionally reported in the Bay. Both species induce increased sedimentation rates which affect the entire ecosystem. A pilot study was conducted in 1997 to limit *S. anglica*'s colonization: quicklime was injected into the mud (15 cm deep) over one hectare to destroy the rhizome.

4 LIVE IMPORTS

4.1 Fish

Salmon *S. salar*, estimated at 400,000 smolts, were imported for aquaculture purposes from Ireland, Scotland, and Norway. Sanitary controls were carried out.

4.2 Invertebrates

Crustaceans

Juveniles (postlarval stages from hatcheries) of the shrimp *Penaeus japonicus* were imported from Spain for aquaculture purposes in earthen ponds on the Atlantic coastline.

Molluscs

Based on the farming industry, Pacific cupped oysters *C. gigas* were imported from Ireland, Portugal, The Netherlands, and the UK. Flat oysters *Ostrea edulis* were also imported from Denmark, The Netherlands, Ireland, and the UK. Juvenile clams of *Tapes philippinarum* were imported for aquaculture purposes from Italy. Total figures are not known.

A number of oyster species (*Crassostrea* sp. from Guyana, *C. rhizophorae*, *C. angulata* and *Tiostrea chilensis*) are currently held in quarantine and are unlikely to be released.

5 LIVE EXPORTS

5.1 Fish

The total production of the flatfish turbot *Psetta maxima* (*Scophthalmus*), sea bass *Dicentrarchus labrax*, and sea bream (Sparidae) reached 30 million juveniles in 1997. About two-thirds were exported to Mediterranean countries: Greece, Malta, Spain, Turkey, Tunisia, and Italy.

The large public fishery of elver resulted in live exports to Spain and Southeast Asia (Japan, South Korea, People's Republic of China) for aquaculture purposes as well as for consumption.

5.2 Invertebrates

Crustaceans

Juveniles (postlarval stages from hatcheries) of the shrimp *Penaeus japonicus* were exported to Spain for aquaculture purposes. Although not estimated, the total figures are likely limited in numbers.

Molluscs

Juvenile cupped oysters *C. gigas* were exported to several EU countries including Portugal. *Tapes decussatus* juveniles were also exported to Portugal.

6 PLANNED INTRODUCTIONS AND TRANSFERS

6.2 Invertebrates

Molluscs

The farming industry is currently evaluating the needs for juvenile flat oysters *O. edulis* from Croatia. Although not yet listed by the EU as an authorized country for exports, on-going monitorings have been developed to assess disease occurrences and sanitary conditions. If it is accepted, this might lead to future applications for juveniles' transfers from Croatia to the southern coastline (Thau lagoon).

7 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS

A Workshop in Crete on Invasive species: the case of *Caulerpa* in Mediterranean Sea was held 18–20 March 1998 at PAM/PNUE in Heraklion.

Several meetings in France among State Administrations and Research Institutes concerning the OSPAR Convention for the Region IV, Bay of Biscay have been held. This on-going programme aims to specify the current status by a comprehensive review of knowledge will incorporate data on pests and disease transfers.

GERMANY

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

In 1997 no new accidentally introduced non-indigenous species were reported from German marine or brackish waters. The following paragraphs consider various aspects of previously reported and established non-indigenous species.

3.2 Invertebrates

The shipworm *Teredo navalis*

As mentioned in the German National Report 1996/1997, the spread of the shipworm *Teredo navalis* in the Baltic Sea continues. Formerly, the species was found in maximum for a period of two years in the Baltic Sea. In 1998, the sixth year of re-occurrence will be further studied and documented. This phenomenon indicates that reproduction of the species in the Baltic does occur. Another indication of reproduction was the first observation of larvae in the mantle cavity of specimens of *T. navalis* in the Baltic region, but free swimming larvae were not found. Earlier, it was believed that *T. navalis* was re-introduced numerous times with water currents or ships' ballast water from the North Sea. Nowadays, there is an indication of a self-reproducing population of the shipworm in some areas of the German Baltic

Sea. Increasing damage to wooden installations occurs in ports and experimental trials are presently being undertaken to test alternative materials, mainly synthetics based on fibre glass components, instead of wood. A feasibility study for several materials is in progress.

The polychaete worms *Marenzelleria cf. viridis and M. cf. wireni*

The unintentionally introduced polychaete worm *M. viridis* is now believed to belong to two different species *M.* cf. *viridis* and *M.* cf. *wireni*. *M.* cf. *viridis* was found in the Baltic Sea since the early 1980s; the exact first record of *M.* cf. *wireni* in the North Sea is unknown. It is believed that this species was introduced earlier than *M.* cf. *viridis*. The population density of *M.* cf. *viridis* and *M.* cf. *wireni* in German waters seems to be balanced. No negative effects on native species or the environment have been documented thus far. However, in areas characterized by a high biomass of the introduced polychaete, the native polychaete *Nereis diversicolor* could be effected. On the other hand, it can be argued that high abundances of *Marenzelleria* spp. could have a beneficial effect as a food source for flatfish and crustaceans. It should be noted that the flatfish populations are increasing, however, there are other reasons known to support this trend.

The eel nematode *Anguillicola* sp.

In some lakes of northern Germany, the reported level of the swimbladder nematode infestation is slightly reduced compared to previous years. The spread of the nematode to other parts of central Europe continues, and this has been documented by scientists from Hungary (Lake Ballaton).

The zebra mussel *Dreissena polymorpha*

As in many other countries, the zebra mussel is spreading further. Increasing population densities are mentioned in some areas of southern Germany, but no mass occurrence was observed in recent times.

4 LIVE IMPORTS

4.1 Fish

Importation of juvenile sturgeon from Russia has continued for commercial purposes by several companies in various German states. A few records of wild caught exotic sturgeon species (mostly *Acipenser baeri*) and hybrids were reported to the authorities of northern Germany. In an attempt to save the common sturgeon *A. sturio* a few specimens have been transferred to Germany, following quarantine regulations.

Live eels and salmon were imported from Sweden for human consumption in an unknown quantity.

Live Imports for Public Aquaria

The opening of two public aquaria along the German Baltic coast in 1996 and 1997 has lead to the transfer and introduction of numerous species (mostly warm water (tropical) species). The aquarium systems operate with pre-treated brackish water, taken from the Baltic Sea. A study on associated fauna (including parasites and disease agents) has just been implemented by the Institut für Meereskunde, Kiel, and results will be reported next year.

4.2 INVERTEBRATES

The oyster farm located on the most northern German island (Sylt) of the Wadden Sea imports several 10,000 juvenile oysters annually. The exact number of the *Crassostrea gigas* imported (mostly from hatcheries in Ireland and France) is not known.

Live blue mussels (*Mytilus edulis*) were imported from Denmark for human consumption in an unknown quantity while German mussel production is, to a large extent, targeted for the Belgian and Dutch markets.

Live crustaceans (*Nephrops norvegicus*, *Homarus gammarus*, *H. americanus*, *Callinectes sapidus* and *Cancer pagurus*) have been imported for human consumption from various European countries in unknown numbers.

7 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS

An increasing number of activities in Germany indicate a growing awareness caused by the occurrence and effects of non-indigenous species.

EU Concerted Action 'Testing Monitoring Systems for Risk Assessment of Harmful Introductions by Ships to European Waters'

Six European countries: Finland, Germany, Ireland, Sweden, United Kingdom (England and Scotland), Lithuania and several experts from all over the world (e.g., North America, some Mediterranean Countries, Australia and Asia) are involved in the Concerted Action recently funded by the EU. The IMO (International Maritime Organization) is a direct partner of this EU Concerted Action, while cross-linkages to the ICES WGITMO are also established.

The coordinating country is Germany. Experts will be brought together through a series of workshops held at sites of relevance to the subject. Various methods on how qualitatively and quantitatively the fate of exotic species in ballast water may be examined will be studied with the aim of standardizing monitoring procedures. The sediment accumulating in ballast tanks and fouling biota on ships' hulls will also be examined, wherever possible. Treatment measures for the control of exotic species will be discussed and evaluated. Developing appropriate methodologies for the assessment of potential risks from hazardous introductions and their control is an internationally recognized subject that needs interdisciplinary approaches. Therefore, the main subject areas of the EU Concerted Action include:

- determination of the state-of-the-art of ballast water studies;
- evaluation of the various sampling methods presently used for ballast water studies in selected EU Member Countries;
- validation of the reliability of sampling methodologies (through intercalibration workshops, also on board ocean-going ships) while assessing in-transit survival capabilities;
- standardization of a protocol and procedure for sampling methods;
- development of a set of intercalibrated monitoring systems for use by EU countries and by intergovernmental agencies such as ICES, BMB (Baltic Marine Biologists), IOC, and IMO.

Additionally, the Concerted Action will consider case histories (i.e., inventories of various types of transmissions) and their major pathways in order to assist in understanding the requirements for the development of adequate mitigation (treatment) techniques while at the same time creating awareness about the dimension and the nature of the problem within the science community, the regulatory and intergovernmental agencies as well as within the shipping industry and the general public. The Concerted Action invites open discussion and opportunities for joint studies by means of land-based or sea-going workshops. We welcome those with interests in this area who would like to become involved and are prepared to contribute. For further information, contact: sgollasch@aol.com

Exotics of the North Sea Shore: Properties of Biotic Invaders

In February 1998 the First Sylt Seminar was held at the Biologische Anstalt Helgoland, Wadden Sea Research Station, List, Sylt. The meeting was chaired by Prof. Dr K. Reise. In total, 31 experts from Canada, Germany, Ireland, The Netherlands, the United Kingdom, and the USA were brought together. The meeting focused on the documentation of alien species in coastal waters, their impacts on the ecosystem, and on risk assessment for several vectors of introductions (e.g., shipping and aquaculture). The ranking according to the importance of these vectors lists ships (ballast water, hull fouling, and tank sediments), aquaculture (target and non-target species) followed by species transferred as common commercial practice (live fish for human consumption), and introductions for scientific purposes. The lectures and the discussion of the meeting (e.g., recommendations and an inventory of alien species in North Sea coastal waters) will be published in the 'Helgoländer Meeresforschung' in the fall of 1998.

Biodiversity Meeting

At the end of April 1998, the Protection Society of the German North Sea Coast (Schutzgemeinschaft Deutsche Nordseeküste e.V.) will host a meeting on changes of biodiversity in North Sea coastal waters. In addition to other subjects, one main topic will be the occurrence of non-indigenous species and their impacts. The meeting will link the scientific community and the public in order to create awareness and to disseminate information on potential impacts caused by non-indigenous species.

8 BIBLIOGRAPHY

The annotated bibliography on 'Transplantations of Aquatic Organisms' is now complete and includes over 11,000 entries. Problems regarding copyrights will further delay publishing. It is intended to provide the Working Group Chairman of the WGITMO and the ICES Headquarters as well as the EIFAC Working Party with an unpublished paper copy for internal use until further clarification has been achieved. With the existing search profile and various indices, the only reasonable means would be to publish the bibliography on CD-ROM.

Marenzelleria viridis

As announced during the 1997 WGITMO meeting, a list of relevant references was compiled and will be distributed as a separate handout during the meeting.

Papers in preparation

IMO Report(s)

In November 1997, the IMO contracted Dr S. Gollasch as a consultant in order to compile a worldwide inventory on results and methods of shipping studies as well as on guidelines and regulations dealing with ballast water. The complete version of this report consists of approximately 180 pages. The short version (about 35 pages) will be distributed as an informal paper during the next IMO/MEPC working group meeting. Both reports are intended to support an GEF/IMO/UNDP project, initiated by the IMO, entitled: 'Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries' with background information. Due to the limited time available to collect this information, the compiled lists cannot claim to be complete, but provide an overview relevant to the subject. The final draft of both reports will be tabled during the meeting.

Shipping Study (1992–1996)

With a delay of two years, the Shipping Study of the German EPA (Umweltbundesamt, Berlin) will be published in 1998. The study will include the results of a ballast water sampling programme of 189 vessels that also analyzed tank sediment or ship hull fouling in German ports. The study will be published in two sections. Section one includes the body of the report (about 300 pages) while section two will contain the complete databases of species found (about 200 pages). The Shipping Study is written in German, but will have an English summary and a translation of all the legends of tables and figures (the final draft of the study will be tabled during the meeting).

IRELAND

2 DELIBERATE RELEASES

2.2 Invertebrates

The abalones *Haliotis discus hannai* and *Haliotis tuberculata* continue to be cultivated on western, southwestern, and southern Irish coasts.

The clam *Venerupis philippinarum* is cultivated from seed on all Irish coasts. 12.2 million clam seed were imported in 1997.

The Pacific oyster *Crassostrea gigas* is cultivated on all coasts. There is no significant natural settlement and all cultivation is based on hatchery-produced seed. Imports of seed include 37.2 million from France, 39.8 million from Britain, and 12.5 million from Guernsey. Approximately 5 metric tonnes of half-grown material was imported from England.

2.3 Algae and Higher Plants

Alga *Asparagopsis armata* (Rhodophyceae)

This exotic species is currently under trial cultivation in a one hectare site on the west coast of Ireland. It is being cultured attached to ropes which are due for harvest during the early summer. The plant is easily managed and has good growth in culture and is to be processed for a non-food product. The species was originally thought to have been introduced to Ireland accidentally when it was first recorded in the 1940s.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

The copepod *Mytilicola orientalis* became established in Dungarvan Bay in 1993 and still remains there. The tubeworm *Ficopomatus enigmaticus* previously known in Cork harbour from 1972 has now been reported from one region in the Shannon estuary.

4 LIVE IMPORTS

4.1 Fish

Atlantic salmon eggs were imported from Scotland (9.9 million), Iceland (7.8 million, also 330 litres), and Australia (25 thousand). 250 thousand fry were imported from England.

Rainbow trout eggs were introduced from Denmark (2.5 million), Northern Ireland (1.02 million), the Isle of Man (0.33 million), and South Africa (0.3 million). Fry were imported from Northern Ireland (24 thousand) and England (200 thousand).

Turbot were imported from the Isle of Man (420 juveniles, 5,000 eggs) and France (1,700 juveniles).

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES

5.1 Fish

No significant changes were recorded since the previous year.

5.2 Invertebrates

No significant changes were reported since the previous year.

7 MEETINGS

Societas Internationalis Limnologiae XXVII Congress, Dublin, Ireland, 9–15 August 1998.

ISRAEL

The opening of the Suez Canal in 1869 has led to an influx of around 300 species that have established themselves in the Mediterranean Sea from Rhodes (Greece) to Tunisia. Israel is at the centre. Most invasions are viewed as pests although some are beneficial. For example, the shrimp *Penaeus japonicus* is now the single highest cash crop from Israeli shores. Eight other penaeid species are of commercial value. More than 60 species of fish are introduced and make up one-third of the commercial landings.

There has been some natural biological control of *Coropsis longicornis* through sterilisation of 83 % of the population which are infected with *Sacculina.*

Much of the information on invasive species has been collected from fishermen, coastguards, lifeguards, and naval personnel.

Israel is part of the Sea Atlas Project to collect and collate information on species in the Mediterranean Sea.

The World Bank will fund the deepening of the Suez Canal which could have implications for another influx of species. The role of ballast as a vector of introduction and the need to set up a monitoring programme was recognised at an early stage. In 1994 a note was circulated to mariners advising on mid-ocean exchange of ballast water. In 1996, report forms were implemented for the collection of information of ballasting operations.

The red seaweed *Porphyra yezoensis* was introduced from Japan for aquaculture purposes. It is grown in land-based ponds. In Israel, there is no legislation to control the importation of exotic species for aquaculture purposes or for the aquarium trade.

ITALY

In Italy there are two main problems dealing with introduced species: the first is the invasion of introduced molluscs in the Northern Adriatic Sea, and the second is the spread of two species of the seaweed *Caulerpa*, *Caulerpa racemosa* (Forsk) Agardh and *Caulerpa taxifolia* (Vahl) Agardh.

C. racemosa seems to be a Lessepsian species coming from the eastern part of the Mediterranean Sea. It was recorded in 1993 at Lampedusa Island, and at present occurs in the Ionian part of Sicily, southern part and Strait of Sicily, in the Gulf of Cagliari, in the Gulf of Salerno, in Tuscany, near Genova, and recently it was found in the harbour of Marseille. *C. taxifolia*, found for the first time near Monaco, is now present in the Ligurian Sea (hectares of Western Riviera are colonized), in Tuscany, in Sicily, and in the Croatian side of the Adriatic Sea. Changes of fauna, from qualitative and quantitative points of view, are known. The main concerns are in relation to possible competition of *C. taxifolia* with the endemic sea-grass *Posidonia oceanica* and with fishing activity, because of changes in the fish community and the interaction of sea weed with fishing gears.

There are two Lessepsian filamentous red algae (*Acrothamnion preissii* and *Womerslegella setacea*) that are epibionts also of *Caulerpa*, that are spreading in Italian waters; they arrived as far north as Montecarlo. The marine angiosperm *Halophila stipulacea* is another example of a species arrived from the levantine basin.

In the northern part of the Adriatic Sea and, particularly in some brackish lagoons of the Po River delta, some allochthonous molluscs were introduced for cultivation. The clam *Tapes philippinarum* (Adams and Reeve) has substituted the indigenous species *Tapes decussatus* (L.) in most areas of the central and northern Adriatic Sea; the same occurred with the oyster *Crassostrea gigas* (Thunberg) against *Ostrea edulis* L. G. Relini notes that, having the opportunity to study the fouling of platforms offshore Ravenna, twenty years after his first survey, *O. edulis* has completely disappeared and it has been replaced by *C. gigas*.

In this region two other molluscs are pests: the clam *Scafarea inequivalvis* and the snail *Rapana venosa* (Valenciennes). An important task was achieved in Italy in the last year with the publication of the checklist of animals living in Italian territory. For the marine environment, 8,089 species (Protozoa excluded) were listed. G. Relini is on the Scientific Editorial board of the Atlas of Alien Species in the Mediterranean Sea, prepared by CIESM (Monaco). The volumes (Fishes, Crustacea Decapoda, Molluscs) are in progress with the participation also of Italian authors. As President of the Italian Society for Marine Biology and Italian Focal Point for Protected Areas and Biodiversity in the Mediterranean (Barcelona Convention), G. Relini hopes to be able to organize a group of Italian scientists for the study of introduced species and, in particular, for the problem of ballast waters.

THE NETHERLANDS

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

Vibrio vulnifucs was found in the Amsterdam-Ryncanal and caused a near fatal accident after a fisherman had cut his hand while gutting an eel.

3.1 Fish

An adult female specimen of American sole (*Achirus fasciatus*), measuring its maximum length (13 cm), has been caught live on 1 August 1996, at 52°30'N x 3°30'E. The specimen is now in the collection of the Institute of Taxonomical Zoology (ITZ/ZMA, number 121.678), Department of Fisheries (ZMR publication in progress).

On three occasions over the last two years, live houting (*Coregonus oxyrinchus*) were caught in Yssel Lake. It is likely that the Danish restocking of this species is responsible. Until this recapture, the species was extinct in Dutch waters (de Groot and Nijssen, 1997).

A number of 'new' fish species, now indigenous, entered Dutch rivers from the Rhine River system: the asp (*Aspius aspius*), the big-head carp (*Hypophthalmichthys nobilis*), the silver carp (*Hypophthalmichthys molitrix*), and a few

aquarium species from Southeast Asia, via Romania through the Danube and into the Rhine River system, have become established (*Pseudorambara parva*).

Sturgeon hybrids are caught regularly. Fifteen specimens were checked. The ornamental (petfish) trade is responsible for the releases. People have bought the fish for various reasons and then dumped the specimens afterwards.

3.2 Invertebrates

Since 1995, the worm *Marenzelleria* has been found in the western Scheldt estuary. For a number of years, an increase in the amphipod *Corophium curvispinum* and the clam*Corbula gibba* has been noted in the Rhine River(up to the German border at Nymegen).

The eel nematode *Anguillicola* has established itself in all Dutch waters and it seems to be on the decline. However, eel stocks are down as well.

3.3 Algae and Higher Plants

American grasses are/were used to stabilise sandy soil. *Spartina townsendii* is at present not in use but has established itself very well. *Ammophila arenaria* is still used widely in sandy areas (dunes).

NORWAY

1 LAWS AND REGULATIONS

Regulations of marine enhancement and sea ranching have been proposed and are under evaluation. The Ministry of Fishery is developing a schedule for review in the Parliament. An expert group has considered potential problems associated with the commercial import of ornamental fish and a report, including a number of recommendations, was drafted in September 1997. The report is now under evaluation in the Ministry of Agriculture.

2 DELIBERATE RELEASES

2.1 Fish

The large-scale Norwegian Sea Ranching Program (PUSH) was completed in 1997. The detailed results from the releases of two fish species (*Salmo salar; Gadus morhua*) are now compiled in final reports in spring 1998. Both species have been recruited from national stocks. The results and conclusions will be a baseline for the evaluation of the potential for commercial activities.

2.2 Invertebrates

130,000 microtagged lobster (*Homarus gammarus*) juveniles were released around the Kvitsøy islands from 1990 to 1994, and a comprehensive recapture system is now being conducted during the commercial fishery in the area. The cultured lobsters have been identified by a microtag detector, and in the autumn fishery 1997, the fraction of cultured lobsters above legal size was 43 %. The lobsters below legal size, however, were dominated by cultured lobsters (73 %).

A number of studies on the introduced Red King crab (*Paralithodes camtschatika*) in the Barents Sea and northern Norwegian and Russian coastal area, are carried out jointly between PINRO (Murmansk), Institute of Marine Research, IMR (Bergen) and Fiskeriforsk (Tromsø). The distribution of crabs is increasing in the western areas, suggesting active migration (M. Hufthamar, IMR, pers. comm.). The mature crab population includes big crabs, compared with native populations in the northern Pacific. Large females with eggs have been found both in Varangerfjord and recently also in Tanafjord. Discrete areas with high densities of small crabs have been observed in these regions, demonstrating successful reproduction of King crab in Norwegian areas. The increase in population and distribution is also observed in the long-line and net fisheries where crabs were taken as by-catch. This represents a number of practical problems for the fishermen, and a systematic collection of information from the fishery (Jan Sundet) suggests that a significant fraction of the crab population is taken in this fishery.

A number of studies on King crab are carried out by PINRO in Murmansk. Also in the Russian areas there has been observations of migration, mainly in an easterly direction. Detailed investigations on food preferences have been

conducted (O. Gerasimova), demonstrating that Echinodermata, molluscs, and worms occurred more often than other foodstuffs in the stomachs of king crab. A number of research cruises and trial fisheries were carried out by PINRO in 1997 (S. Kuzmin), and the results were presented to the Norwegian/Russian Fisheries Commission. PINRO has also initiated a tagging programme of crabs (1200 spec.) as well as parasitological investigations, genetic and physiological studies.

Two commercial hatcheries started cultivation of the Manila clam (*Ruditapes philippinarum*) in 1987–1991. Juveniles were released into the wild at five different localities along the Norwegian coast. Recently, large live specimens of Manila clam were found at three of the most southern localities. These individuals were all mature, but no successful reproduction in term of juveniles was detected (Mortensen and Strand, submitted).

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

The first specimen of the slipper limpet (*Crepidula fornicata*) was found in 1962 in Norwegian waters at the Skagerrak coast, and several observations of this species have been reported since then, mainly in the same region. In summer, 1996, a new live individual was found at Kvitsøy, in the western part of Norway (K. Sjøtun, IMR, pers. comm.), indicating an increase in the distribution area.

The first specimens of snow crab (*Chionoecetes opilio*) were taken in bottom trawl catches at Goose Bank in the southeastern part of the Barents Sea in 1996 (S. Kuzmin/PINRO, Murmansk), and later four additional specimens (all males) were caught mainly in the same region. No systematic investigations have, however, been carried out during 1997.

3.3 Algae and Higher Plants

Sargassum muticum is well established in the southern part of the Norwegian coast (Skagerrak). Recently, the alga was also found in large quantities along the western coast in Rogaland and Hordaland. A northern movement in the establishment of the species is suggested by new observations on the northern side of Sognefjord (T.E. Lein), indicating that the alga has the potential to spread even further.

7 MEETINGS

The first international symposium on 'Stock Enhancement and Sea Ranching' was held in Bergen, 8–11 September 1997.

A national workshop on the 'Introduction and spread of alien species in Norway' was conducted in Trondheim in September 1997.

SWEDEN

1 LAWS AND REGULATIONS

Policy developments

SEPA Policy on Introduced Species and GMOs

The Swedish Environmental Protection Agency has finalized its 'Policy on the Introduction and Spread of Non-Native and Genetically Modified Organisms' (Naturvårdsverket 1997).

NBF Policy on translocations and releases of fish

The National Board of Fisheries is developing a policy for translocations and releases of fish, including native species.

2 DELIBERATE RELEASES

2.1 Fish

Salmon, sea trout; elvers imported from England (Severn).

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Cercopagis pengoi

This cladoceran (waterflea), previously found in the eastern part of the Baltic Sea, was observed at the Askö Research Station, Stockholm archipelago, in 1997, by a visiting scientist from Estonia.

Marenzelleria viridis

Further expansion (or rather first records) of polychaetes identified as *Marenzelleria* cf *viridis* have been made at Forsmark nuclear power plant (approximately 100 km north of Stockholm), and north of Västervik (some 200 km south of Stockholm) (S. Smith, National Board of Fisheries, pers. comm., data from the 1997 monitoring programme). (For further information on distribution in Swedish waters, *cf.* last year's report).

Polydora redeki

This polychaete was observed as early as the 1950s in southwestern Finland, and from the late 1970s in the Åland archipelago. In 1997 it was observed at Östhammar, close to the Forsmark plant. This introduction could be due to natural dispersal from Åland, or dispersal by ship.

3.3 Algae and Higher Plants

Sargassum muticum

No major changes have been reported for the distribution of the Japanese brown algae *Sargassum muticum* along the Swedish west coast, previously reported as far south as the middle part of the province of Halland south of the city of Varberg (the eastern Kattegat) and common in many areas further north.

Phytoplankton

In early May 1997, regional authorities on the Swedish west coast sent out a warning of high PST-levels in mussels coinciding with high frequencies of the dinoflagellates *Alexandrium tamarense*, being listed as *possibly introduced* on the Swedish west coast, together with *A. ostenfeldi*. The potential PST-producer *Alexandrium minutum* was last year reported for the first time as abundant at the Swedish west coast (the eastern Skagerrak), and it was also a dominant species during June 1997.

4 LIVE IMPORTS

4.1 Fish

Elvers from England (Severn). Quarantine regulations followed.

4.2 Invertebrates

For consumption: lobsters from the USA and Canada. Oysters from France.

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES

5.1 Fish

Eggs	To ICES Countries	Eggs	Outside ICES
Artic charr	Canada	Rainbow trout	Chile
Salmon	Denmark	Rainbow trout	Czech Republic
Arctic charr, salmon	Germany	Rainbow trout	Greece
Trout	Poland	Rainbow trout	Montenegro
		Trout	Taiwan

Live eels for consumption:

To ICES Countries	Outside ICES
Denmark	Israel
Germany	Italy
The Netherlands	
Poland	
Spain	

5.2 Invertebrates

Blue mussels to Denmark and The Netherlands.

7 MEETINGS

- Workshop on invasive *Caulerpa* species in the Mediterranean, Iraklio, Crete (Greece), 18–20 March 1998
- Alien species and marine litter; one day seminar hosted by the Swedish EPA at Expo 98, Lisbon (Portugal), 30 June 1998. Presentations include 'Alien species—why is it a problem?'/Inger Wallentinus, Göteborg University, Sweden, and 'Solutions—the Australian experience'/Denis Paterson or Penny Lockwood, AQIS, Australia.

UNITED KINGDOM: ENGLAND AND WALES

1 LAWS AND REGULATIONS

Previously, the diseases bonamiosis and marteiliosis (caused by the pathogen *Marteilia refringens*) were the only diseases notifiable under EU Directive 91/67/EC. Now, additional powers have been given to Fisheries Departments under EU Directive 95/70/EC for control of diseases that are currently exotic to Great Britain but which have been associated with exotic bivalve species (*Crassostrea gigas, Crassostrea virginica, Tiostrea chilensis*, Argentine flat oysters and abalone). Diseases are haplosporidiosis, marteiliosis (caused by *Marteilia sidneyi*), perkinosis, iridovirosis, and mikrokytosis. The controls provided for in the EU Directive are based on the establishment of a surveillance programme to detect and, if appropriate, monitor for the presence of these diseases in shellfish farms and natural beds. The EU Directive was given legal force in Great Britain through the Fish Health Regulations 1997, which came into effect on 21 August 1997. The directive is applicable throughout the EU.

The UK has recently announced the listing on Schedule 5 of the Wildlife & Countryside Act 1981 of the introduced marine hydroid, *Clavopsella navis,* as a protected species. The hydroid is under threat worldwide and the UK is one of only 3 sites from which it is known. The other sites are the Kiel Canal and Cape Town. It is not known from where it originates or its natural distribution. Affording this species protection within Great Britain is quite an exceptional case, based on its rare occurrence on a global scale.

2 DELIBERATE RELEASES

2.2 Invertebrates

Commercial hatcheries in England and Guernsey continued to produce Pacific oyster and Manila clam seed. Oysters were produced for farming purposes at sites around the coasts of England and Wales; Manila clams for farming in Poole Harbour. Significant numbers of seed of both species were exported to Ireland for cultivation (see Table 2). Approximately 100 tonnes of Pacific oysters and 90 tonnes of Manila clams were harvested from aquaculture sites.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

The beds of wild Manila clams in Poole Harbour that have become established after the successful recruitment of seed from intentional introductions for aquaculture purposes (as reported in 1997 ICES Annual Report) were fished on a limited commercial basis. Approximately 40 tonnes of clams were fished. As a result of a local management plan, there is some control of this new fishery.

In Scotland, a small number (7) of live Magellan mussels (*Aulacomya ater*) were caught in the Moray Firth in winter 1997. These were believed to have been introduced by a Chilean barge but there may now be a recruiting population in the area. Also, a sighting of a deep-water scyphomedusa *Solanema corona* was reported from the Shetlands in autumn of 1997.

The population of the American brackish water mussel *Mytilopsis leucophaeta* first reported to be present in Cardiff Docks at the end of 1996, appears to be recruiting as specimens from a number of year classes are now present.

3.3 Algae and Higher Plants

Undaria pinnatifida has appeared in one or two other sites close to those reported in earlier reports. *Sargassum muticum* is removed each year from the site in Strangford Lough, Northern Ireland where it was introduced in an attempt to prevent its further spread.

4 LIVE IMPORTS

4.1 Fish

Rainbow trout eggs were imported from disease-free sources in Northern Ireland, Denmark, and South Africa.

An importation of 1 million salmon eggs from Tasmania was planned for summer 1997 (source: trade press article in Fish Farming International, July 1997, 24 (7)). The eggs were from broodstock grown in New South Wales, Australia, which in turn were first introduced to Australia from British Columbia.

Trade in wild-caught marine ornamentals continued but interest in the production of ornamentals in the UK is increasing. A wide range of ornamental fish, soft corals, molluscs, and crustacea was imported, many (approximately 75 %) to be re-exported to European and world-wide markets on a regular basis.

4.2 Invertebrates

The market for seed Pacific oysters was satisfied by home-produced seed. There were no imports from Guernsey this year.

There is increasing interest in scallop aquaculture in southwestern areas of England but supply from local spatfalls is irregular and generally small. One consignment of 250,000 seed (10–15 mm) were air-freighted from Mulroy Bay, Ireland to Portland Harbour for on-growing (Table 1). (Note: This represents a transfer although there is scientific evidence to suggest that the Mulroy Bay stock is genetically distinct.)

Table 1. Imports from 1 January –31 December 1997.

Species	Country	No. of Imports	Reason
Scallop	Ireland	1	Aquaculture
Ormer	Guernsey	20	Consumption
Octopus	Spain	9	Specified
Turbot	France	113	Consumption
Turbot	Isle of Man	38	Consumption
Torpedo marmorata	France	9	Research

5 LIVE EXPORTS to ICES MEMBER COUNTRIES

5.1 Fish

Trade in live elvers (glass eel trade) was continued. Elvers are caught for export within England and Wales, e.g., in the Severn River. Also, over 100 tonnes are transported between November and March during the elver season (source - trade press article, Fish Farming International, November 1997, 24 (11)). One UK company is reported to pick up elvers in Portugal, rest them in the UK before sending them to Sweden. Journeys across Europe include France, Germany, Portugal, Spain, Ireland, Greece, Denmark, Sweden, and Holland. The company has introduced air-freighting of elvers in preference to road transport.

5.2 Invertebrates

All exports were of seed or half-grown bivalves for farming (Table 2).

Table 2. Exports From 1 January-31 December 1997.

Species	Destination	No. of Consignments	Approx. Total Quantity
Crassostrea gigas	Eire	76	60 million
Crassostrea gigas	Guernsey	2	1.3 million
Crassostrea gigas	N. Ireland	6	0.5 million
Tapes philippinarum	Eire	15	18 million
Ostrea edulis	Eire	2	40 thousand
Ostrea edulis	N. Ireland	3	40 thousand
Mytilus edulis	Gurensey	3	13 tonnes

6 PLANNED INTRODUCTIONS

An English Company (name unknown) has acquired a fish farm in South Carolina, USA, and will be mainly concerned with production of ornamental fish species (freshwater and/r marine species?) for UK and European markets.

UNITED STATES OF AMERICA

1 LAWS AND REGULATIONS

Extensive work continues at the federal level to carry out the mandates and regulations called for in The National Invasive Species Act of 1996 (NISA 1996), copies of which were distributed at the 1997 WGITMO meeting. This law updated the 1990 Nonindigenous Aquatic Nuisance Prevention and Control Act, and upgrades the level of ballast water management. A. Cangelosi will present a detailed summary of NISA 1996 as a separate agenda item, specifically relative to ballast water regulations.

2 DELIBERATE RELEASES

2.3 Algae and Higher Plants

Work continues in the State of Maine with outplantings of cultured red algae *Porphyra yezoensis*. Reference is made to a separate report filed by Coastal Plantations, Inc., based on an update presented by I. Levine as a separate agenda item.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

Ballast Water Update

Ballast water research relative to the transport of nonnative species and to management prospects remains an intensive area of study in the USA. At the ICES/IOC/IMO Study Group on Ballast Water and Sediments meeting immediately preceding the 1998 WGITMO meeting, copies of the USA BALLAST BOOK were distributed, which summarizes United States research activity for the period 1997 to 1999. Please refer to the Table of Contents of that book for an overview of this research.

3.2 Invertebrates

The South African sabellid worm in California abalones

A subject of rapidly growing concern over the past several years has been the appearance of a South African species of parasitic 'fan worm' (Polychaeta, family Sabellidae) in the California abalone aquaculture industry. First noted in the late 1980s, nearly a decade has passed since the first extensive report on this invasion has appeared (Culver *et al.*, 1997). The worm is an undescribed genus and species. Its larvae settle on the growing edge of the abalone shell; the abalone then coats the mucous tube formed by the worm with its own calcareous shell material, resulting in the formation of a more permanent tube for the worm to live in, feed (as a tentacular filter feeder), and reproduce. The results are extensive deformation and malformation of the abalone shells, to the point that the abalone's growth 'slows or virtually ceases' (Culver *et al.*, 1997). The worm does not affect the quality of the abalone's meat, nor is it a human health issue. Heavily infected abalones 'remain too small to be marketable, with shells that are brittle, unsightly, or grossly deformed' (Culver *et al.*, 1997). Current management activities include eradication of the worm from individual aquaculture operations through total stock destruction (a very expensive procedure that can result in economic catastrophe), cessation of releasing unfiltered or otherwise untreated (such as chlorination) effluent to the ocean (sabellids are reported to be locally established in the wild in intertidal molluscs near the site's outfall), cessation of moving infected abalone between abalone farms, cessation of outplanting infected abalones in the wild for growth, and so forth.

Japanese Crab *Hemigrapsus sanguineus*

The range and ecological impacts of this recently introduced crab on the Atlantic American coast continue to attract a great deal of interest in the academic community.

Lohrer and Whitlatch (1997) present the first detailed ecological view of this crab, which has become an abundant omnivore. Its ecological impacts remain uncertain at this time; however, it appears to be locally outcompeting the previously introduced European green crab *Carcinus maenas* in some regions. In many areas of the rocky intertidal shore of Long Island Sound, it is now the *only* abundant crab as of spring, 1998 (J.T. Carlton and students, personal observation). It seems probable, moreover, that the other species of Japanese crab now invading western Europe, *Hemigrapsus penicillatus*, will be inevitably transported to Atlantic America via ballast water, and the dual impact of both species of *Hemigrapsus*, as well as the interactions between the two (which naturally co-occur in Japan) will be of the great interest. *H. sanguineus* now occurs from north of Cape Cod to North Carolina.

Chinese Mitten Crab *Eriocheir sinensis*

The Chinese mitten crab is now well established and continues to expand its range within San Francisco Bay, California. A single specimen was reported to have been captured in the Columbia River sometime in 1997.

3.3 Algae and Higher Plants

The Pacific Ocean red alga *Grateloupia doryphora* is well established on the Atlantic American coast south of Cape Cod. Populations at the moment are restricted to Narragansett Bay, in Rhode Island (Villalard-Bohnsack and Harlin, 1997), but are expected to spread throughout Long Island Sound (Massachusetts, Connecticut, and New York) relatively soon. It has been introduced previously to the Mediterranean Sea, to the Eastern Atlantic Ocean from the British Isles to Angola, and to the Western Atlantic Ocean from Florida to Uruguay. It was first discovered in July 1996 in Rhode

Island, and may have been present in 1995. Large numbers of the native snail *Lacuna vincta* are reported to graze on the algae (Villalard-Bohnsack and Harlin, 1997), but the ecological impact of this grazing is not known. The species was likely introduced by shipping, but whether from Europe, Asia, or southern American waters, remains unknown at this time.

7 MEETINGS

The Second Northeast Conference on Nonindigenous Aquatic Nuisance Species was held 18–19 April 1997 in Burlington, Vermont.

Green crab (*Carcinus maenas*): Potential Impacts in the Pacific Northwest Workshop was held 9–10 February 1998 in Vancouver, Washington. Sponsored by Washington Sea Grant Program, Oregon Sea Grant Program, and the Environmental Protection Agency (Region 10).

An Aquatic Nonindigenous Species Workshop for the Gulf of Mexico was held 4 March 1988 in Houston, Texas. The Worlshop was sponsored by the Gulf of Mexico Sea Grant College Programs.

The Eighth International Zebra Mussel and Aquatic Nuisance Species Conference was held 16–19 March 1998.

Invasives and Global Change Workshop was held 2–5 April 1998 in San Mateo, California. This workshop forms part of a larger program which aims to develop a Global Invasive Species Strategy. The workshop aims to draw together a variety of specialists from a number of countries to explore the question of how problems associated with invasive species are liable to interact with global change drivers. The organizers are Richard Hobbs (CSIRO, Wildlife and Ecology, Midland, WA, Australia) and Harold Mooney (Department of Biological Sciences, Stanford University, Stanford, California).

Controlling Established Populations of Alien Marine Species is scheduled from 28–30 May 1998 in Seattle, Washington. A workshop sponsored by the Marine Conservation Biology Institute (MCBI), headed by Dr E. Norse, and based in the state of Washington, USA.

First National Conference on Marine Bioinvasions, early January 1999, Cambridge, Massachusetts. In the early planning stages, this conference will be sponsored in part by the MIT Sea Grant College Program (Massachusetts) and by the National Sea Grant Program. For information contact Dr J. Pederson at jpederso@mit.edu.

PREPARERS OF NATIONAL REPORTS FOR 1997–1998

Australia	Chad Hewitt and Ronald Thresher
Canada	Malcolm Campbell
France	Philippe Goulletquer
Germany	Stephan Gollasch and Harald Rosenthal
Ireland	Dan Minchin
Israel	Bella Galil
Italy	Giulio Relini
The Netherlands	S.J. de Groot
Norway	Knut E. Jorstad and Anders Jelmert
Sweden	Bo Holmberg, Kristina Jansson, and Inger Wallentinus
UK: England and Wales	Susan D. Utting
United States	James T. Carlton

ANNEX 4

PORPHYRA REPORT

March 17, 1998

Dr. James T. Carlton, Chairman
ICES Working Group on Introductions & Transfers of Marine Organisms
Maritime Studies Program, Williams College - Mystic Seaport
50 Greenmanville Avenue
P.O. Box 6000
Mystic, CT 06355-0990

Dear Dr. Carlton:

As per the letter dated January 10, 1994 from Emory D. Anderson, General Secretary of the International Council for the Exploration of the Sea (ICES) to Mr. William Brennan, Commissioner of the Maine Department of Marine Resources (MDMR), the following is Coastal Plantations International's (CPI) fifth annual report to the ICES - Working Group on Introductions and Transfers of Marine Organisms (ICES-WGITMO).

Culture Sites

1992: Two culture sites were established; Johnson Cove and Mathews Island (See Figure 1, "92" delineation's). In Johnson Cove a 24 net system was assembled. The system was removed within 60 days of assemblage due to regulatory restraints. A 30 net system was established just off of Mathews Island which was maintained from July - December, 1992.

1993: Three culture sites were established. Two sites in waters off Eastport, Maine USA and one site in Harbour de Lute, Campobello Island, New Brunswick Canada (See Figure 1, "93" delineations). The Eastport sites, just east and north of Goose Island, were established in June and removed in December, 1993. The Canadian effort was established in late September 1993 on the aquaculture lease site of Mr. John Mallack.

1994: The two Maine lease sites established in 1993 were utilized in 1994. The lease site just north of Goose Island has been shifted approximately 600 feet due west. The lease site east of Goose Island has been shifted approximately 300 feet to the east to establish a 1320 foot buffer zone between CPI cultivation lease sites and the seabird nesting areas on Goose and Spectacle Islands. An additional 80 acre tract, Huckins Ledge, was permitted and utilized as CPI's nursery tract. It is located 4000 yards west south west of Goose Island, just west of Seaward Neck on "Huckins Ledge" in waters off of Lubec, Maine (See Figure 1,"94" delineation). Six experimental nori (*Porphyra yezoensis*) nets were placed out in the waters adjacent to Blue Hill, Maine by the Blue Hill Nori Farming Cooperative (See Figure 2).

COASTAL PLANTATIONS INTERNATIONAL, INC.
4 MOULTON STREET ■ SUITE 440 ■ PORTLAND, ME 04101
PHONE 207-761-1777 ■ FAX 207-761-1811

1995: The three 1994 CPI culture lease sites were similarly utilized in 1995. Additionally, as part of a National Marine Fishery Service (NMFS) grant, CPI established a small, 15 net, pole farm during the 1995 growing season. The farm was located just north of Mathews Island and is designated by "T" in Figure 1. The experimental system was reassembled in 1996 at the company's Goose Island Aquaculture lease site. Eight experimental nori (*Porphyra yezoensis*) nets were placed out in the waters adjacent to Blue Hill, Maine by the Blue Hill Nori Farming Cooperative (See Figure 2).

1996: CPI efforts included the establishment of a 20 net test polyculture system at the Connors Aquaculture Deep Cove, Eastport, Maine salmon lease site, and the licensing of a 100 net effort by a fisherman in Grand Manan, New Brunswick. The nori:finfish integrated polyculture system was installed relatively late in the 1996 growing season (October) but the nori quality, as measured by color, growth rates and nitrogen content was significantly greater than the Maine Nori Company's nori harvested from its monoculture operations. A cooperative study of nori samples from the mono and polyculture systems was initiated by researchers from the University of Connecticut (Dr. Charles Yarish) and University of New Brunswick (Dr. Thierry Chopin). The study clearly indicated the ability of *Porphyra* to rapidly and continuously absorb high amounts of nitrogen and phosphorous, making *Porphyra* an ideal bioremediation candidate. Significant increases (> order of magnitude) in phycoerythrin content was recorded.

The progress made by the Peninsula Nori Farming Cooperative (formerly Blue Hill Nori Farming Cooperative) was impeded by permitting difficulties which resulted in zero cultivation during the 1996 cultivation season.

1997: The three 1996 CPI culture lease sites were not similarly utilized in 1997. The company's Spectacle Island lease site was not utilized in 1997 and may be abandoned due to extreme hydrographic conditions. As in the previous year, CPI established a 30 net, pole located at the company's Goose Island Aquaculture lease site. The pole farm was the only utilization of the Goose Island site also due to extreme hydrographic conditions. Twenty-five nori (*Porphyra yezoensis*) nets were placed out in the waters of the Bagaduc Rive, Maine by the Peninsula Nori Farming Cooperative (See Figure 2). Five experimental nori (*Porphyra yezoensis*) nets were placed out in the waters off of Grand Manan Island, New Brunswick, Canada. A modified pole farm was established in Grand Manan by a commercial fisherman. Significant staffing and financial difficulties were experienced by this operation future participation is questionable.

Cultivation/Reproduction:

The *Porphyra yezoensis* cultivation season is limited by the minimum growing temperatures of 6-7° C. The cultivation season in the waters of Cobscook Bay usually comprises the first week in June to the first week in December. The 1997 season commenced June 1, 1997. The nets deployed were seeded in September 1996 at our Eastport facility and the Huckins Ledge nursery site. The nets were then returned to shore and stored in the company's freezer awaiting

the following cultivation season. Monospore production was observed from both our indoor facility in addition to the outdoor nursery site (Huckins Ledge). Evidence of monospore production was observed from June through November during the nursery phases of 1997's seeding process. Successful recruitment was evident upon the seeded nets, cultivation system support ropes and the anchor lines.

Adjacent salmon cages were examined monthly for evidence of successful monospore recruitment. Two sets of salmon cages adjacent to our nori sites consist of 1. 2500 yards south and 2. 3500 yards west, southwest of our Spectacle and Goose Island Sites. Cages 1 and 2 are 6000 yards west and 2000 yards south, respectively, of our Huckins Ledge site. No evidence of *Porphyra yezoensis* on either the cage structure or mooring lines was observed.

As stated in CPI's previous reports to the ICES WGITMO, a study entitled "Establishment of a Monitoring Program for the Mariculture of the Non-Indigenous Seaweed *Porphyra yezoensis* in the Gulf of Maine" has been and continues to be sponsored by CPI. The study, conducted by Dr. Donald Cheney and a graduate student from Northeastern University, has completed its' second phase (Appendix I). Their conclusions reflect similar results as those previously reported by CPI. The conclusions are: 1) *P. yezoensis* plants are present but uncommon on the shoreline adjacent to the CPI farm during the farming season, 2) local *Porphyra* species out-recruit *P. yezoensis* on our netting substrates, and 3) there is no evidence to date that *P. yezoensis* will over-winter in Cobscook Bay and replace local *Porphyra* species. CPI will continue to support this study and the research grant which expands the original Northeastern University study entitled "Effect of Nori Aquaculture on the Marine Flora of Cobscook Bay and Selected Sites Within the Gulf of Maine" funded by the University of New Hampshire/Maine Sea Grant College Program by multiple Principle Investigators from University of New Hampshire and Northeastern University (Grant Proposal submitted as Appendix II of the March 17, 1997 report to Dr. Carlton).

Recruitment:

Determination of natural or anthropogenic dispersal of *Porphyra yezoensis* has been accomplished this year by the participants of the Northeastern University study. Artificial substrates were placed adjacent to CPI's Goose Island site < 100 yards from CPI nets. (Figure 1, Appendix I). From prepared substrates samples were collected in the fall of 1996 which resulted in the identification of *P. yezoensis* in 5 of 47 nori plants collected and analyzed. Over-wintering potential of *P. yezoensis* was examined from the March 1998 collections analyses, which resulted in zero *Porphyra* plants being classified as *P. yezoensis.* Additionally, in the Fall of 1997, CPI seeded nori (*P. yezoensis*) net strands were tied to the sampling substrates and allowed to over-winter. The strands were collected (March 10, 1998) and microscopically examined both in Eastport and again at the Northeastern University laboratory. Analyses of the strands revealed zero evidence of P. yezoensis thalli or holdfasts. These tests reinforce the company's initial

conclusions that the local environmental conditions do not support independent existence by the introduced species.

Future Plans

CPI is in the secondary stages of planning nori cultivation efforts outside of the ICES WGITMO's mandated "waters of the Gulf of Maine". Sites off the coasts of Massachusetts, Connecticut and New York are being considered. *Porphyra yezoensis* is **NOT** intended for these cultivation initiatives at this time. Results from the Sea Grant College Program research grant have been the domestication of indigenous New England *Porphyra* species. CPI anticipates its next farming effort will be installed prior to the 2000 cultivation season.

Presently there is keen interest in the establishment of *Porphyra* cultivation efforts in the Provinces of Nova Scotia and Newfoundland. CPI requests a clarification concerning the northern extent of the introduction of *Porphyra* yezoensis or an extension permitting introduction into the Maritime coastal waters which experience similar environmental parameters as the Gulf of Maine. The introduction has received Canadian Federal and Provincial New Brunswick approvals.

Please feel free to contact my office if you, the working group or ICES have any questions concerning this matter. A letter of confirmation to the present commissioner of the Department of Marine Resources is all that the MDMR requires for CPI to proceed. We appreciate the time and effort on our behalf and welcome a site inspection by any and all of the members of the ICES working group.

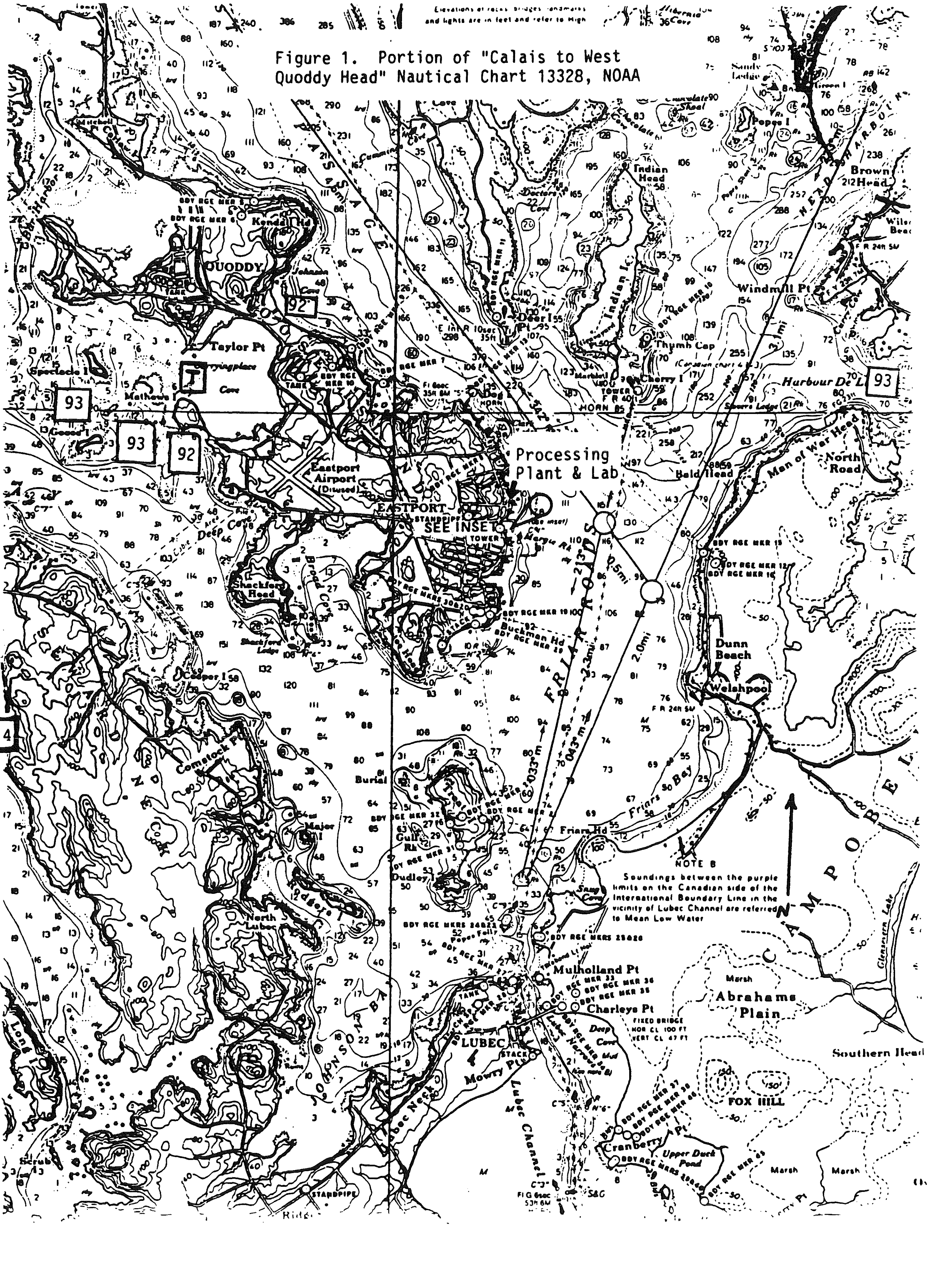
Yours very truly,

Ira A. Levine, Ph.D.
President

IAL:dmh
Enclosures

cc: Penn Esterbrook, Acting Commissioner, Maine Department Marine Resources

Figure 1. Portion of "Calais to West Quoddy Head" Nautical Chart 13328, NOAA



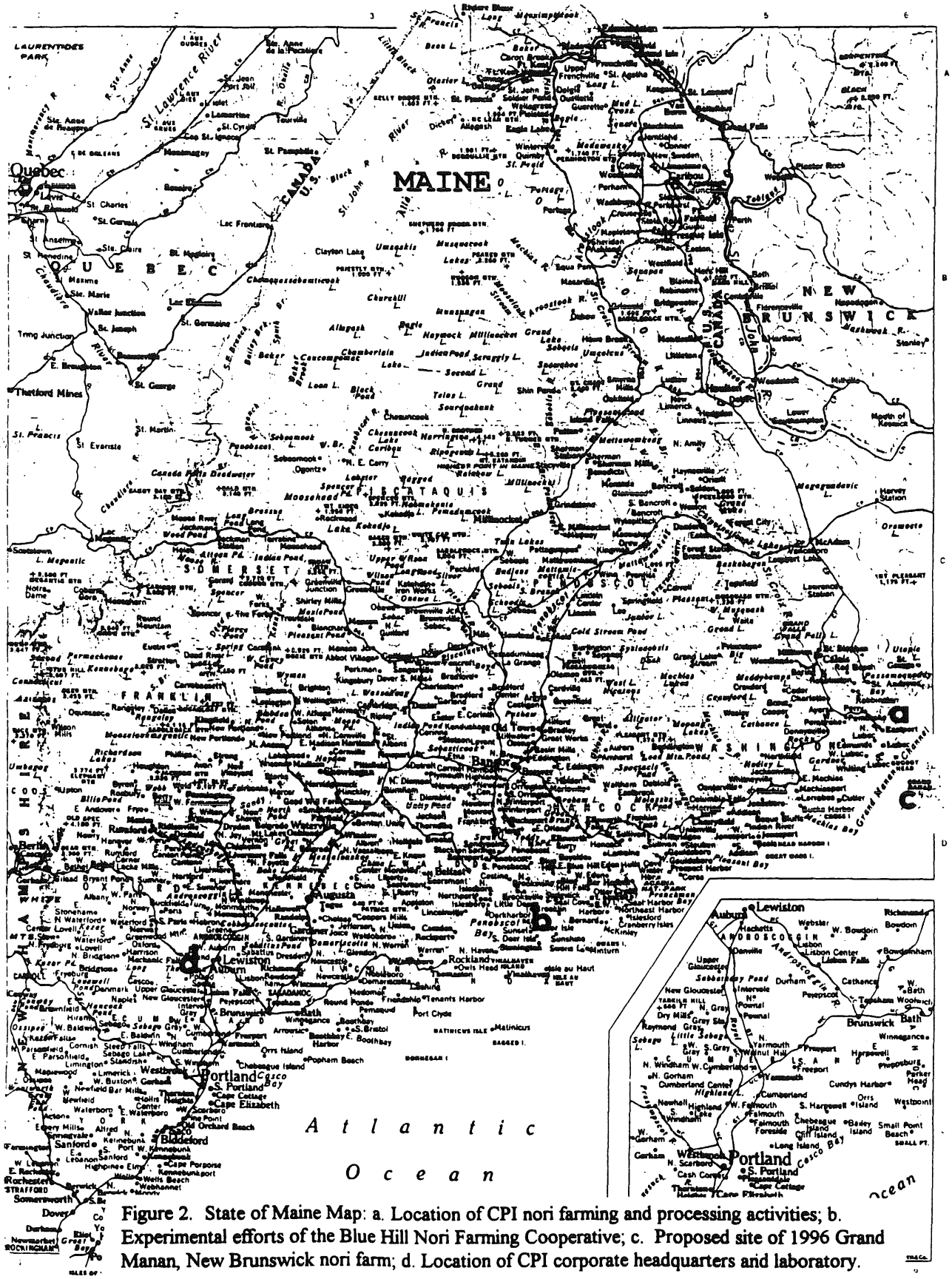


Figure 2. State of Maine Map: a. Location of CPI nori farming and processing activities; b. Experimental efforts of the Blue Hill Nori Farming Cooperative; c. Proposed site of 1996 Grand Manan, New Brunswick nori farm; d. Location of CPI corporate headquarters and laboratory.

Monitoring Program for the Mariculture of the Non-Indigenous Seaweed *Porphyra yezoensis* in the Gulf of Maine: Year Two

Katherine Watson, Donald Cheney
Marine Science Center, Northeastern University
Nahant, Ma 01908

and

Ira Levine
Coastal Plantations International
Portland, ME 04101

Prepared March 17, 1998

ABSTRACT

A program to monitor the effects of Coastal Plantations efforts to farm *Porphyra yezoensis* in Cobscook Bay, Maine was begun in 1996. A year-long survey of the Mathews Island farm site found the rare occurance of *P. yezoensis* in the surrounding intertidal and no plants were observed after the winter season. A new and more extensive monitoring program was initiated in August, 1997, this time focusing on CPI's nursery site at Huckins Ledge. Transect samples taken before winter revealed no *P. yezoensis* plants, while 5 plants were found on artificial substrates. These results were similar to those of las year. Over-wintering and freezing tolerance studies currently in progress should conclusively answer whether or not *P. yezoensis* blades can survive annually in Maine.

BACKGROUND

In 1990, Coastal Plantations International received state, federal, and international permits to introduce the Japanese *Porphyra* species, *P. yezoensis,* to the Cobscook Bay region of Maine for the purpose of aquaculture. Coastal Plantations is the first American commercial enterprise to successfully farm *Porphyra* outside the Orient, representing a rare case where an intentional introduction of an exotic species has been permitted for commercial farming in open coastal waters. Permitting was granted based on temperature restrictions in the reproductive cycle of the alga.

A preliminary monitoring study was conducted in 1996-97 to assess the recruitment of *P. yezoensis* on specialized netting placed around the Mathews Island farm site (Roberts et al, 1997a, 1997b) . These studies concluded that *P. yezoensis* "escapes" were rare, and that there was no evidence for its over-wintering. The scope of this preliminary study was limited to one year and the farm site only.

Coastal Plantations has a nursery location at Huckins Ledge, where seeded nets are grown to the stage where they are releasing asexual monospores, which give rise to new blades. This is critical in nori cultivation for the production of nets with uniform *Porphyra* coverage. It is in this location that the greatest potential for spore dispersal and settlement exists along the associated intertidal zone. A monitoring program is being conducted to determine if asexual monospores can successfully recruit, and if their blades are capable of overwintering in the intertidal zone. The probability of *P. yezoensis* reproducing sexually, via fertile conchosporangial filaments, is small due the temperature restrictions inherent in the life cycle of this species as previously mentioned. This report describes the findings to date of the monitoring study initiated in August to evaluate the potential recruitment

occurring at Huckins Ledge and address concerns about the ecological impact of farming this introduced seaweed.

METHODS

New field studies conducted at Huckins Ledge will use the same plus some methods developed during the preliminary study conducted at Mathews Island in 1996-97. *Porphyra yezoensis* recruitment is being monitored by analyzing for recruits in three ways: 1). on artificial substrates (netting) deployed around the farm site, 2). on tagged natural macroalgal substrates (*Ascophyllum*), and 3). using transect surveys.

In this study, specialized netting (imported from Japan and obtained from Coastal Plantations) is being suspended between poles in low and high tide locations at various distances around the Huckins Ledge site. The Japanese netting has been formulated with specific synthetic fibers to which *Porphyra* spores readily attach. Netting pieces 2 meters by 1 meter ware being suspended vertically between metal sign posts, approximately 0.5 meters off the substrate, and distributed upstream, midstream and downstream of the farm site (Figure 1). In August, eight artificial substrates were deployed. The four locations chosen surrounded the farm site intertidally on three sides (the fourth side being open water). Ten meter transect lines were laid in the high and low intertidal at three locations and *Porphyra* plants were collected. Sampling coincided with the start of CPI's Autumn growing season. In addition, natural substrates at each location consisting of tagged *Ascophyllum nodosum* plants, upon which *Porphyra* can grow epiphytically, were monitored. Also, ten meter transect surveys in both the high and low intertidal zones were made upstream, midstream and downstream of the farm site, in the vicinity of the artificial and natural tagged substrates (Fig. 1). Plants from both natural and artificial substrates were collected before and after the farming season and samples were identified by electrophoretic analysis. The preliminary study (1996-1997) established the use of isoenzyme electrophoresis and the use of phosphoglucose isomerase (PGI) markers to differentiate *P. yezoensis* from local *Porphyra* species. *P. yezoensis*' PGI band consistently shows lower migration distances than the local species (Fig 2). All *Porphyra* plants collected in the field are first by examined microscopically and then by electrophoresis.

In order to further test the over wintering ability of *P. yezoensis*, we have intiated two new investigations. Firstly, eight strands of netting with established *P. yezoensis* plants were affixed to bare netting suspended between poles at high and low intertidal locations at all four sites in November, 1997. The nets will be collected and analyzed in March, 1998, for survival of the original blades, as well as any potential growth from holdfasts. The strands will be cultured in the labortaory and examined microscopically. Secondly, laboratory freezing studies are also being conducted at this time to determine the tolerance of *P. yezoensis* blades and monospores, as compared to that of local *Porphyra* species, to determine whether the freezing and thawing they would experience in the winter limits their survival.

RESULTS

In August, 1997, transect samples were collected and artificial substrates were deployed. The distribution and density of *Porphyra* plants in the transects varied with location and intertidal height, as seen in Table 1. Size, color and shape of the blades also varied, with most light to dark brown in color, lanceolate, and 5 - 35 cm long. All were epilithic on small cobble.

Table 1

Number of Plants Collected in 3 Transects at Huckins Ledge in August, 1997

Location	# Collected	# Analyzed	# *P. yezoensis*
I: High	3	3	0
Low	1	1	0
II: High	0	0	0
Low	0	0	0
III: High	1	1	0
Low	51	14	0
Total:	56	19	0

Microscopic evaluation of cross sections revealed the blades were monostromatic, which is true for both *P. yezoensis* and most local species. Electrophoretic analysis was conducted on all plants in the small sample sizes, and on 14 random blades from Transect 3- low intertidal. A *P. yezoensis* marker was run on each gel. None of the samples tested shared the *P. yezoensis* band, previously designated as PGI-1 (Table 2). Herbarium specimens of representative low and high intertidal plants were evaluated and designated

Porphyra purpurea, based on morphology and seasonal occurrence with the assistance of Dr. A. Mathieson, at the University of New Hampshire.

Table 2

Number of Plants Collected in 3 Transects at Huckins Ledge in November, 1997

Location	# Collected	# Analyzed	# *P. yezoensis*
I: High	0	0	0
Low	2	1	0
II: High	4	3	0
Low	1	1	0
III: High	4	4	0
Low	0	0	0
Total:	11	9	0

In late November, 1997, artificial substrates deployed in August were collected and 10 meter transects were repeated at the locations sampled previously. All the *Porphyras* electrophoretically tested migrated to the PGI-3 or PGI-4 location, which we have designated as potentially *P. purpurea.* The artificial substrates recruited a total of 61 Porphyras; 47 were successfully run electrophoretically (Table 3). Of the 47 plants analyzed from the artificial substrates, 39 plants shared the *P. pururea* banding pattern (PGI-3&4), 3 shared the *P. umbilicalis* pattern (PGI-2&3) and 5 shared the *P. yezoensis* pattern (PGI-1). It should be noted that the majority of the *P. yezoensis* were found at Site D; this location will be more extensively surveyed during the next sampling. These results are similar to last autumn's findings, in which a small number of *P. yezoensis* were also found, however, plants were not observed the following spring.

Table 3

Number of Plants Collected and Analyzed from Artificial Substrates in November, 1997

Location	# Collected	# Analyzed	# *P. yezoensis*
SITE A: High	0	0	0
Low	29	18	1
SITE B: High	3	3	0
Low	16	13	0
SITE C: High	0	0	0

	Low	9	9	0
SITE D:	**High**	0	0	0
	Low	4	4	4
	Total:	61	47	5

As a final note, during the first week of March, 1998, Kathy Watson retrieved six (of the eight) strands of netting that were covered with *P. yezoensis* plants on them when installed in her artificial substrates last November. Two of the eight artificial substrates set out were lost over the winter. There is no visible sign of any *Porphyra* plants left on the six strands retrieved, suggesting that the *P. yezoenis* plants (which had to number in the hundreds) had since November. We are in the process of culturing these strands to determine if there are any viable holdfasts of *Prophyra yezoenis* that survived. However, these results clearly provide strong additional evidence that *P. yezoensis* plants do not over -winter nor pose an environmental threat to the CPI farm site area and probably northern Maine.

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Roberts, K., K. Watson, D. Cheney and I. Levine. 1997b. Establishment of a montoring program for the mariculture of the non-indigenous seaweed, *Porphyra yezoensis*, in the Gulf of Maine: Year One. ICES Report prepared on April 2, 1997.

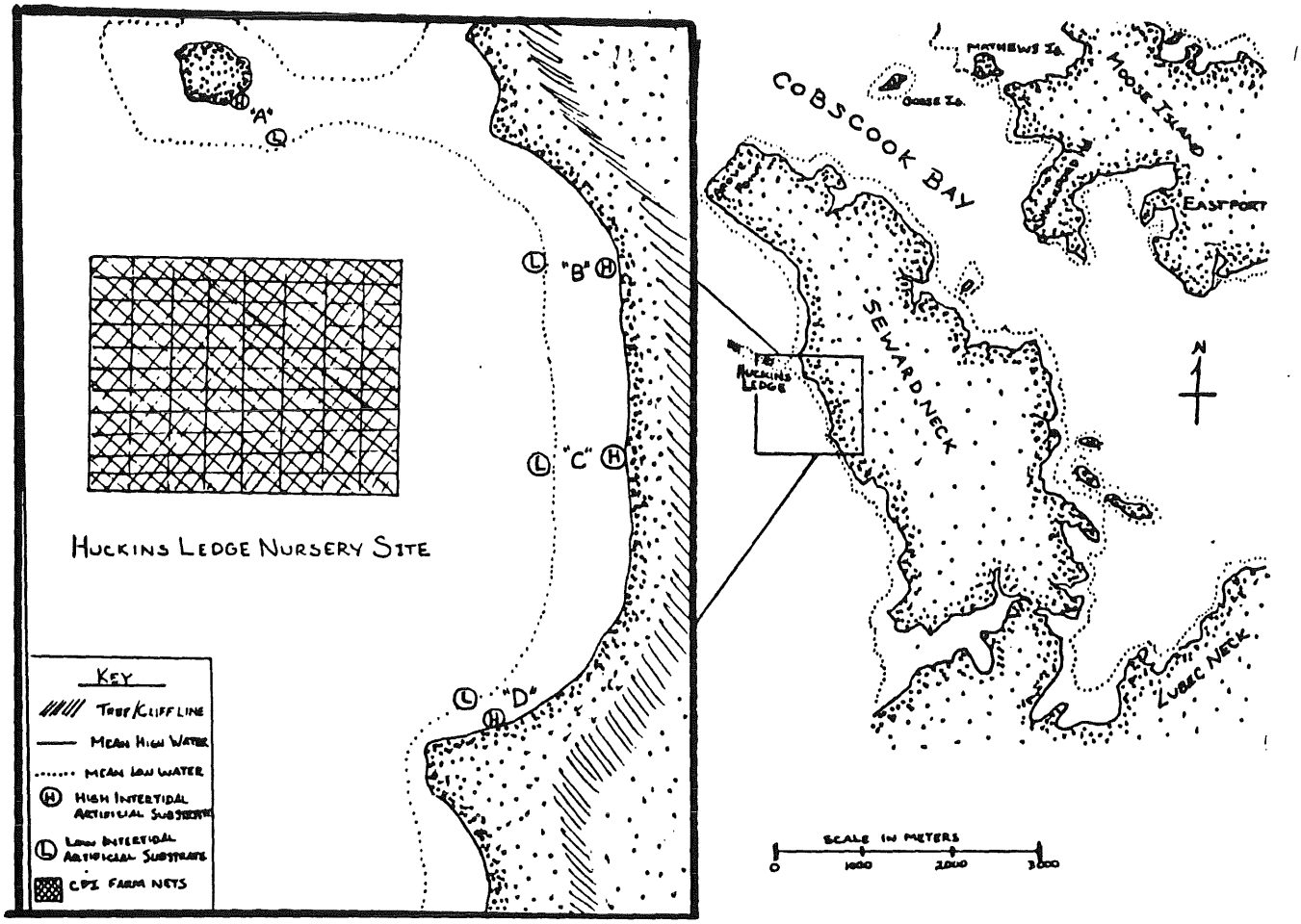
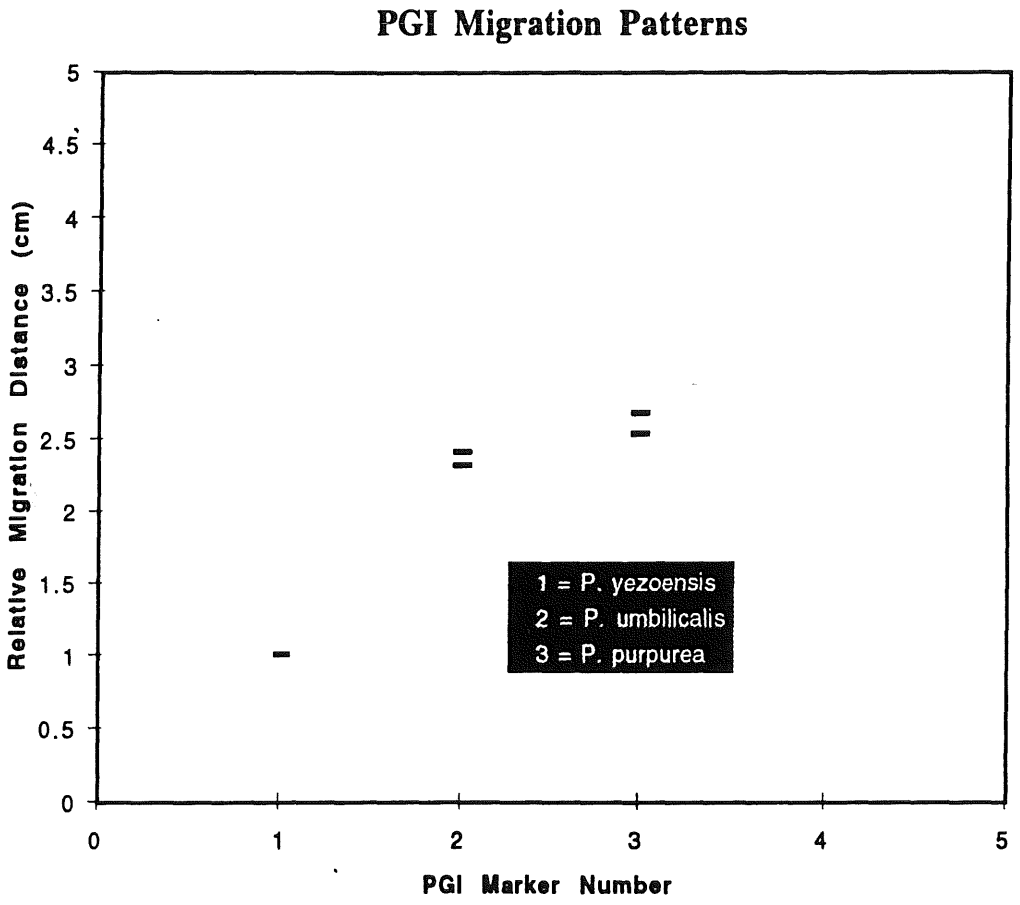

"A"
"B"
"C"
"D"
HUCKINS LEDGE NURSERY SITE
KEY
TREE/CLIFF LINE
MEAN HIGH WATER
MEAN LOW WATER
HIGH INTERTIDAL ARTIFICIAL SUBSTRATE
LOW INTERTIDAL ARTIFICIAL SUBSTRATE
CPI FARM NETS
COBSCOOK BAY
SEWARD NECK
MATHEWS I.
GOOSE I.
MOOSE ISLAND
EASTPORT
HUCKINS LEDGE
N
SCALE IN METERS
0
1000
2000
3000

Figure 1

Figure 2


PGI Migration Patterns
Relative Migration Distance (cm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5
PGI Marker Number
1 = P. yezoensis
2 = P. umbilicalis
3 = P. purpurea

ANNEX 5

BIBLIOGRAPHY

Section 1: Partially Annotated Bibliography on *Marenzelleria viridis*[*]

Aniansson, B.H., Jansson, K. (1995). Marine biologists consider an area that is extraordinarily invasion-prone. Aliens 1995(2), p.4–5. (*)

The Baltic Marine Biologists (BMB) Working Group on Non-indigenous Estuarine and Marine Organisms (NEMOs) held its first meeting in June 1995. It was stated that up to now more than 60 introduced species have been found in the Baltic Sea. It is noted that *Marenzelleria viridis* has developed into a dominating species in the Vistula Lagoon, where it now constitutes 97 % of the biomass of bottom-living macrofauna.

Arndt, E.A. (1991). Long-term investigations on the macrozoobenthos in the oligohaline Saaler Bodden south of the peninsula Darss-Zingst and the invasion of *Marenzelleria viridis* in the late 1980s. 12th Baltic Marine Biology (BMB) Symp., Helsingør, Denmark, pp. 25–30. (*)

Biomass of *Marenzelleria viridis* increased rapidly in the central part of the Bodden chain. The author reported wet weights of up to 82 g/m2 in the Saaler Bodden.

Arndt, E. A. (1996): Struktur und Dynamik des Makrozoobenthos in der Darss-Zingster Boddenkette im Laufe der letzten 25 Jahre unter besonderer Beruecksichtigung der Makrozoobenthos -- Entwicklung im Saaler Bodden von 1986–1990. [Structure and dynamics of macrozoobenthos in the Darss-Zingst Bodden chain in the last 25 years with special regard to macrozoobenthos -- development in the Saaler Bodden from 1986–1990]. ROSTOCK.-MEERESBIOL.-BEITR. 1994(2), 93–120

Atkins, S.M., Jones, A.M., Garwood, P.R. (1987). The ecology and reproductive cycle of a population of *Marenzelleria viridis* (Annelida, Polychaeta, Spionidae) in the Tay Estuary. Proc. Royal Soc. Edinburgh 92B: 311–322. (*)

The author describes the distribution and behavioural aspects of the species in the new habitat. The worm shows unbranched burrows with depth of up to 10–30 cm and about 2 mm wide in the Tay estuary (Scotland). About 75 % of adult *M. viridis* were deeper than 10 cm and 35 % deeper than 20 cm. In contrast, over 90 % of the juveniles of M. viridis and adult H. diversicolor were found in the top 10 cm of the sediment.

Bastrop, R., Röhner, M., Jürss K. (1995). Are there two species of the polychaete genus *Marenzelleria* in Europe? Marine Biology 121: (3): 509–516. (*)

Marenzelleria viridis occurs naturally on the east coast of North America from where it was probably introduced. Another species, and arguably a synonymous form, *Marenzelleria wireni,* is found in the European Arctic. North Sea and Baltic Sea populations reproduce at different times. Enzyme separation by starch gel electrophoresis revealed major differences between specimens from the Baltic Sea and those from the North Sea (collected in 1992 and 1993) but a high degree of homogeneity among populations from the same sea. The identified genetic differences between the two geographically distinct populations could be due to environmentally induced selection or genetically different origins of the populations. The pros and cons are discussed.

Bastrop, R.; Röhner, M.; Sturmbauer, C. & Jürss, K. (1997): Where did *Marenzelleria* spp. (Polychaeta: Spionidae) in Europe come from?. Aquat. Ecol., 31(2): 119–136.

Bick, A. (1995): Entwicklungsbedingte Veränderungen von morphologischen Merkmalen bei *Marenzelleria viridis* (Verrill), (Spionidae) und *Manayunkia aestuarina* (Bourne), (Sabellidae). [Development-related changes in morphological features of *Marenzelleria viridis* (Verrill), (Spionidae) und Manayunkia aestuarina (Bourne), (Sabellidae).] Mitt. hamb. zool. Mus. Inst., 95, 41–53 pp. [In German]

[*] by Stephan Gollasch, references marked with an (*) were taken from Prof. H. Rosenthal's database

Bick, A., Bochert, R., Zettler, M.L. (1993). *Marenzelleria viridis*, an invader among the benthic community in Baltic coastal inlets - distribution and reproductive strategy. 28th European Mar. Biol. Symp., Crete, Greece: 55. (*)

Bick, A., Burckhardt, R. (1989). Erstnachweis von *Marenzelleria viridis* (Polychaeta, Spionidae) für den Ostseeraum, mit einem Bestimmungsschlüssel der Spioniden der Ostsee. (First record of *Marenzelleria viridis* (Polychaeta, Spionidae) in the Baltic Sea, with key to the Spionidae of the Baltic Sea). Mitt. Zool. Mus. Berlin 65: 237–247. [In German]. (*)

The first record of *Marenzelleria viridis* in the Baltic Sea reported from shallow waters of the German coast. No indication is given as to the origin of the introduction or invasion. A polychaete new for the Baltic Sea was recorded during routine sampling in the Darss-Zingst bodden chain (southern Baltic) in 1985. It was identified as *Marenzelleria viridis*. Since 1987, the species has been numerous in this estuary, with densities up to 740 ind. x m-2. In April 1988, its expansion into the oligohaline parts of the bodden chain was recorded. The species inhabits sandy and muddy sediments. No relationship between abundance and type of sediment could be found. The most important taxonomic characters of this polychaete are described and figured. 8 scanning electron micrographs complete the diagnosis. An identification key to the 13 spionid polychaetes known from the Baltic Sea is presented.

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Marenzelleria viridis in the UK has been found in the Firth of Forth, Firth of Tay and in the Humber estuary. It is also found in estuaries on the European side of the North Sea and also in the Baltic. In the Ems, increasing densities of *M. viridis* in a sandy habitat coincided with a reduced abundance of the worm *Hediste diversicolor*, and density fluctuations of *M. viridis* and the amphipod *Corophium volutator* showed a significant positive relationship (Essink & Kleef 1993). However, the cause of these effects is not understood, and may be due to environmental factors rather than a causal relationship. At the sandy habitat palps and anterior parts of *M. viridis* made up 4–11 % of the stomach content of juvenile plaice (*Pleuronectes platessa*). In juvenile flounder (*Platichthys flesus*) only in April about 10 % of the stomach content consisted of *M. viridis*. During 1983–1990 increasing densities of *M. viridis* at the sandy habitat coincided with a reduced abundance of *Nereis diversicolor*, however, this inverse relationship was not found to be statistically significant.

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The polychaete *Marenzelleria viridis* is a common infaunal species in estuaries along the East Coast of North America, ranging from Georgia to Nova Scotia and Newfoundland. Recently *M. viridis* has been recorded in northern European waters, its dispersal is believed to have been aided by human transport. Despite its broad distribution, the species has infrequently been studied. In this study, the authors investigated the population dynamics and production of the spionid polychaete at Great Sippewissett salt marsh (Massachusetts, USA) for two years.The worm was the main contributor in biomass and production to the macroinfaunal assemblages of the sandy organic sediments of the marsh. The species spawns in winter and settled larvae appear between January and May. The number of recruits seems largely to be governed by meteorological conditions. The numbers of recruits are then affected by competition for resources, and later, as predators become active, predation pressure determines the abundance of the population of *M. viridis*.

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Marenzelleria viridis, a North American spionid polychaete that immigrated to brackish water ecosystems of the North and Baltic Seas in the early eighties has rapidly spread along European coasts. It is now a dominant species in several regions. First record in the Darss-Zingst bodden chain dates back to 1985. Continuous monitoring from 1991 to 1994 documented the spreading of the species within the Baltic. Its highest abundance and biomass were found in the inner part of the estuary along the Darss-Zingst bodden. Significant positive correlations exist between the adult abundance and subsequent occurrence of chironomid larvae (*Chironomus plumosus* and *Ch. halophilus* types). Negative correlations were found between the spionid and both *Corophium volutator* and the naidids.

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The horizontal mesoscale distribution of *Marenzelleria viridis*, a spionid polychaete introduced from North American coastal waters during the 1980s, was studied in shallow water in the southern Baltic (German coast). The polychaete achieved an individual dominance of 80 % and abundances up to around 8500 ind./m super(2). Samples taken from a small (1.2 m x 1.2 m, 6 x 6 samples, depth 0–35 cm) and a large station grid (5.5 m x 5.5 m, 11 x 11 samples, depth 0–35 cm) were used to calculate dispersion indices for subpopulations of adult and juvenile *M.*

viridis and subdominant chironimids (the *Chironomus plumosus* and *Ch. halophilus* complexes). The distribution patterns were significantly patchy. The patch sizes were estimated with the help of the dispersion indices and by analysing the correlograms in which spatial autocorrelations such as Moran's I and Geary's c values were plotted versus the field distance k. The patch sizes were heterogeneous. The smallest patches found were 0.04 m super(2). The largest sizes observed were 9 m super(2). It is conceivable that smaller patches merge to form larger aggregations. Calculation of the abundance and rank correlations between subpopulations revealed significant positive relationships. These indicate principal suspension feeding. Sediment structure, substrate preference, feeding mode and biotic or abiotic attraction centres are considered to be the main causes of aggregation and the positive correlations.

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ANNEX 6

RECOMMENDATIONS TO THE ICES COUNCIL

The following recommendations to the Advisory Committee on the Marine Environment (ACME) were formulated by the WGITMO:

1) WGITMO recommends that a Theme Session, entitled 'Marine Biological Invasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' be convened for the 2000 ICES Annual Science Conference in Belgium. The Theme Session will focus on ecological, environmental, and economic impacts (pro and con) of exotic species invasions in marine ecosystems, including dispersal vectors such as ballast water, the use of nonnative species in aquaculture/mariculture systems, the mechanical and biological control of invasive species.

2) WGITMO recommends that ICES increase dissemination of the 1994 Code of Practice on a worldwide basis by placing the Code in its full bilingual format on the ICES website.

3) On the basis of newly reported invasions (e.g., a South African parasitic worm in abalone aquaculture in California and the Eurasian zebra mussel transported to Ireland), and noting earlier commerce-mediated invasions (e.g., the oyster parasitic copepod *Mytilicola orientalis* transported to Ireland with commercial oysters), WGITMO recommends that ICES establish a dialogue with international agencies, such as the European Commission, with respect to the increasing movements of commercial goods, aquaculture products, and other merchandise, often due to increasing trade agreements that foster freer enterprise, which concomitantly may inadvertently foster the spread of aquatic organisms and their disease agents.

4) WGITMO notes an increasing pattern of the novel expansion or population blooms of long-established alien species in the North Atlantic Ocean and in the Mediterranean Sea (for example, the tubeworm *Ficopomatus* in France and Ireland, the Lessepsian alga *Caulerpa racemosa* (as well as the native *Caulerpa prolifera*) in the northern Mediterranean, possibly the shipworm *Teredo navalis* in the Baltic Sea, the expansion of the alga *Codium fragile tomentosoides* in the Gulf of St. Lawrence, the population increases in the Chinese mitten crab *Eriocheir sinensis* in Germany and England, the continued expansion of the alga *Sargassum muticum* in Scandinavia) and urges ICES Member Countries to alert ICES of any additional records of unexplained changes in the abundance or distribution of non-native species (as well as any unusual changes of ranges or population sizes of native species, that may elucidate the patterns and possible causes of range expansions or population changes now being seen with nonindigenous taxa).

5) WGITMO noted that many current records of new populations of invasive species are a result of spread from the primary site of first establishment, and recommends that ICES Member Countries, as potential donor regions, undertake proactive management to alert potential receiving countries (such as those that may take up ballast water in ICES Member Countries harbours and ports) of the presence of new and previously established species invasions based, for example, on information obtained from port and marina surveys and associated monitoring programmes.

WGITMO will meet at the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in Conwy, Wales, from April 14–16 1999 to:

a) review the value in promoting the establishment of reference collections of the alga *Caulerpa* based on specimens now being moved through the aquarium trade;

b) finalize plans for a Theme Session on 'Marine Biological Invasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' to be convened for the ICES Annual Science Conference in Belgium in 2000;

c) continue work on a 'Directory of Dispersal Vectors' as an ICES Cooperative Research Report, including a continued review of aquarium-related transportation of exotic species;

d) discuss the rationale for listing as endangered or protected species, or under other actual or proposed conservation measures, non-native species in ICES Member Countries;

e) report on the current status of fish, shellfish, algal and other introductions in and between Member Countries, through:

   i. submission of National Reports, to further newly include information on genetically modified organisms,

   ii. standardization of a database questionnaire,

   iii. review the status of selected current invasions, as well as any biocontrol programmes that are under consideration,

   iv. continued coordination with the Baltic Marine Biologists' Working Group on Nonindigenous Estuarine and Marine Organisms (NEMO) and the EU Concerted Action Plan on ballast water,

   v. review information on unprocessed and partially processed materials (e.g., fish, algae) as a dispersal vector for invasive species (such as pests, parasites, and disease agents) and to describe any potential impacts,

   vi. assemble a comprehensive list of the major invasive marine and estuarine animal and plant taxa of Europe and Atlantic America as a basis for interannual tracking through the National Reports.