ICES WGITMO Report 2007

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Report of the Working Group on Introductions and Transfers of Marine Organisms (WGITMO)

21–23 March 2007

Dubrovnik, Croatia

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

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1 Summary

In 2007 the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) met in Dubrovnik, Croatia with Judith Pederson (USA) as Chair and Amy Williams (Canada) as Rapporteur. The meeting venue was the University of Dubrovnik Rector Palace, Dubrovnik, Croatia with Marijana Katic Peravic and Josko Miskus (University of Dubrovnik) as hosts. Representatives and guests from Belgium, Canada, Croatia, France, Germany, Italy, Sweden, United Kingdom, and the United States of America contributed to the discussions.

Terms of Reference

a) To identify and report on changes in the distribution, population abundance and condition of introduced marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature;

b) consider and report on the utility and content of the National reports (TORs a and b) and the format and publication of the New Species Alerts;

c) synthesise and evaluate National Reports, after intersessionally restructuring the report format to ensure consistency for ease of assessment and to include geographic information (latitude and longitude) for rapid tracking of the spread of invasive species;

d) develop a 5 year summary of National Reports (2003–2007) with the aim to prepare a 25 year summary based on earlier reports at a future meeting (intercessional preparation of draft material is essential),

e) finalize a report for rapid response and control options, including

- invitation of an internationally recognized expert to develop a risk assessment strategy for the rapid response including likelihood of success of eradication, impact of the invasive species on species in the area of introduction and impact of control methods (e.g. chemical eradication) on non-target species and habitat in the receiving environment;
- contribute intersessionally to the database (Excel spreadsheet) for the rapid response account (e.g. case histories);

f) develop Alien Species Alert reports including evaluation of impacts and to increase public awareness. WGITMO suggests preparing intersessionally a Species Alert Report on the Pacific oyster *Crassostrea gigas* with the aim to finalize the report at next years meeting. Other candidate species are the Chinese mitten crab and *Didemnum* sp. (intercessional preparation of draft material is essential);

g) review the impact of targeted fisheries on non-indigenous species (e.g. King crab, Chinese mitten crab, Green crab, Manila clam);

h) consider and respond to the recommendation from ACME to merge in 2008 WGITMO and WGBOSV into a single working group with a broadened mandate for the occurrence and impact of marine invasive and/or pest organisms.

2 Meeting attendance, adoption of agenda, appointment of rapporteur, and review of terms of reference

In 2007 the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) met in Dubrovnik, Croatia with Judith Pederson (USA) as Chair. The meeting venue was the University of Dubrovnik Rector Palace, Dubrovnik, Croatia with Marijana Katic Peravic and Josko Miskus (University of Dubrovnik) as hosts. Representatives and guests from Belgium, Canada, Croatia France, Germany, Italy, Sweden, United Kingdom, and the United States of America contributed to the discussions (see Annex 1 for participant's names and addresses).

Apologies were received from WGITMO members Dorothee Kieser and Anne-Margaret McKinnon, Canada; Henn Ojaver, Estonia; Jorn Gessner, Germany; Dan Minchin, Ireland; Jan Sundet; Norway; Anna Szaniawska, Poland; Jesus Cabal and Santiago Fraga, Spain; Clare Eno and Tracy McCollin, United Kingdom; and James Carlton and Greg Ruiz, United States of American and observers Chad Hewitt, Australia.

Amy Williams, Canada agreed to serve as rapporteur. The agenda was adopted (Annex 2).

3 Progress with Terms of Reference at the WGITMO 2007 Meeting

This section addresses the terms of reference discussed at the meeting. All terms of reference were discussed with comments reported in this and the following sections. The highlights of the Terms of Reference are as follows:

3.1 A joint letter from the Working Group Introductions and Transfers of Marine Organisms (WGIMTO) and the Working Group on Ballast and Other Vectors (WGBOSV) was sent to Paul Keiser recommending to not merge the two working groups.

3.2 A revised National Report format was recommended along with a datasheet for reporting coordinates to assist with mapping new invasions. Several options for communicating the findings from the National Reports and the Alien Species Reports were discussed.

3.3 A report was submitted to OSPAR on changes in distribution and reproductive periods that are probably related to warmer temperatures.

3.4 A draft invertebrate section of the five-year report was reviewed by members at the meeting, but the sections on fish, algae, parasites, pathogens, and other diseases were not completed and will be worked on intersessionally.

3.5 Rapid Assessment Guidelines final report was accepted by the working group, but the risk assessment discussion will be continued in future sessions after a more thorough review of current and pending approaches used by Canada, the U.S., and European countries.

3.6 A report was made on the upcoming Alien Species Alert Report, *Crassostrea gigas*. No formal decision was made on changing the format. Because of the ongoing consideration of releasing *Crassostrea ariakensis* for aquaculture in the Chesapeake Bay, a presentation on the role of ICES Code of Practice guidelines was discussed.

3.7 An outline for developing a report on the impact of targeted fisheries on nonindigensous species was developed and will be addressed at future meetings. An assessment of the Code of Practice will be included in the report.

3.8 Although not a Term of Reference, a brief discussion was held on topics for the upcoming joing meetings between WGITMO, WGBOSV and PICES Working Group 21 on invasive species.

4 Merger Consideration Discussion

ToR h consider and respond to the recommendation from ACME to merge in 2008 WGITMO and WGBOSV into a single working group with a broadened mandate for the occurrence and impact of marine invasive and/or pest organisms.

At a joint meeting with the WGITMO and the WGBOSV, a thoughtful and rational discussion on the pros and cons of merging were discussed. The group reached consensus and recommends that we remain as two working groups that meet back to back with a shared day of joint issues. We think this approach meets our working groups' respective priorities, is efficient in that we share members, and would result in a productive output from both groups. A copy of the letter signed by the Chairs of the two Working Groups on behalf of the members is attached (see Annex 3.)

5 National Report Synthesis, Revision of Format, and Adoption of Matrix with Locations

ToR b consider and report on the utility and content of the National reports (ToRs a and b) and the format and publication of the New Species Alerts; and

ToR c synthesise and evaluate National Reports, after intersessionally restructuring the report format to ensure consistency for ease of assessment and to include geographic information (latitude and longitude) for rapid tracking of the spread of invasive species;

The following countries submitted National Reports: Australia*, Belgium, Canada, Finland*, France, Germany, Ireland*, Italy, Norway, Poland*, Spain*, Sweden, United Kingdom, and United States of America. Asterisks indicate that reports were received by correspondence; reports are in Annex 4. A summary of the National report information is given below.

5.1 National Report Format

After presentation of the reports, the merit of the national reports and the current format was discussed by the group. The following questions were considered: Who is the audience for the information in the reports? Does the current format meet the needs of the audience? What can be done to improve the report and what are the obstacles to gathering data?

It was agreed that the information in the reports has merit, but accessing and analyzing the data is a cumbersome process. Of significant value are the new records of deliberate and accidental introductions, particularly to neighboring countires that may be impacted by the invader.

The consensus was that there are many different audiences. Scientists are interested in following the dispersion of introduced species (hence a geographic information systems (GIS) format would be helpful with dates associated with locations). The aquaculture industry should find the information on parasites, pathogens and other disease organisms useful, and but it is uncertain that they are receiving the information. Agencies who manage introduced species would be interested in the fate of nonindigensous species, the risk associated with the invaders, and what options exist for managing the species.

In terms of the content, the most difficult information to gather is the statistical data on imports and exports. Many countries do not keep records in ways that communicate at the level of detail initially intended for the report. For example, in the US imports do not distinguish between different species of bivalves and often lump live, fresh and frozen into one category. Other countries have more detailed information, but it may be difficult to access or locate. One question raised at the meeting is whether there is a Working Group or other

ICES entity that could provide information or links to detailed information on live imports and exports for each country?

The format of the National Reports was reviewed and minor changes recommended. The changes include the addition of an excel sheet to capture latitude/longitude as well as other data for easy mapping and analysis. The recommendation for the content of the reports is as follows:

- **Highlights** – a short summary of important issues
- **Laws and Regulations** – a short summary of important changes in laws and regulations on marine introductions including ballast water, hull fouling, and related topics. This section would be of value to the WGBOSV and would not be a duplication of effort.
- **Deliberate Releases and Planned Introductions** - Deliberate releases of finfish, invertebrates, and algae should remain, but this has been problematic as many countries do not keep good or centralized records. *Note: This is the section where advice from ICES would be useful on who is interested in this information and whether there are groups that have the data.* Although the information is useful, this section will continue to vary with each country. It is not expected that working group members will report on number of eggs released, etc. where data are difficult to obtain but instead focus on planned introductions and report on whether the ICES Code of Practice or similar approaches have been used in evaluating the efficacy of the release.
- **Accidental introduction and transfers and information on the spread of previously accidentally introduced species** - Accidental transfers of finfish, invertebrates, parasite pathogens and other diseases, and algae will remain. Latitude and longitude will be added to the observed sightings. This section is of interest to scientists, government agencies, and aquaculturists.
- **Live Imports** – Live imports is another section where data are difficult to obtain. Continued reporting of live imports will result in spotty records until better record keeping by government makes the data available. This is another area where ICES countries may be able to help with identifying who has this information and keeps these records.
- **Excel Worksheet** – An excel worksheet format to accompany the National Report was adopted to assist with mapping and data analysis. Information in the matrix includes: [Reporting] Country, Genus, Species, Taxon, Location, Latitude, Longitude, Population status, 1st Record, Observer [Person who reports the finding], Taxonomic certainty, Native range, Potential vector [will be developed to indicate whether accidental or deliberate (and if so was the Code of Practice used)], Invasive status [worldwide], Synonyms, Reference, Notes.

A draft excel format was sent to countries before the meeting, some data are recorded and will be mapped intersessionally. WGITMO is interested in developing a data base and mapping the introductions and will explore options for long-term management during the intercession with ICES.

5.2 Communicating with ICES Members about Introduced Species

Several options for improving communication were discussed, i.e. informing others about introduced species, alerting others to those likely to cause problems, and informing appropriate ICES working groups about our information on pathogens, parasites, and other diseases. We are proposing to have a one page "press release" for each country to be prepared by representatives of each country. During intercession, a list of recipients would be prepared and a one page flyer prepared that identifies newly introduced species and species that have arrived in neighboring countries.

Also discussed by the working group was the need for a broader "press release" document. A draft "press release" highlighting three species, the Chinese mitten crab (*Eriocheir sinensis)*, the ctenophore (*Mnemiopsis leidyi)*, and the brackish water clam (*Rangia cuneata*) was prepared and will be finalized during intercession. These three species were chosen because they appear to be spreading and have the potential cause economic and/or environmental harm. Several options for distribution were offered for consideration, including ICES newsletters, the ICES web site, and a distribution list for each country. This request is included in the 2008 TOR.

In addition to the above, it was discussed that WGITMO would develop fact sheets on selected species to complement the Alien Species Reports. We find value in the more detailed reports, but recognize that there are many species where brief information would be used by government agencies and others. A process for implementing the development of these facts sheets was discussed and will be addressed in the future.

5.3 Highights of the national reports

Australia, 2006

Prepared by: Invasive Marine Species Program, Australian Government Department of Agriculture, Fisheries and Forestry

- Currently, Australia is considering legislative changes required to give effect to the International Convention for the Control and Management of Ships' Ballast Water and Sediments. These changes will also require the management of ballast water between Australian domestic ports. These changes are expected to be completed by July 2008.
- Australia is also developing legislation and best practice management guidelines to control biofouling. Legislation to control biofouling will be implemented through the *Quarantine Act 1908* from mid-2007.
- Asian green mussel (*Perna viridis*) was detected during an inspection on a dredge vessel at Dampier Port, Western Australia in November 2006. In response to the detection, the vessel was sent to Singapore where fouling was removed by heat treatment and physical removal.
- In November 2006, three specimens of New Zealand green lipped mussel (*Perna canaliculus*) were found on a vessel in dry dock. Survey work is being undertaken at Port Kembla and Westernport to determine the status of the species.
- In July 2006, visual surveys of seven foreign fishing vessels (FFVs) conducted by divers detected the black-striped mussel (*Mytilopsis sallei*) and Asian green mussel (*Perna viridis*). The FFVs were apprehended and escorted to Darwin Harbour to have the hulls treated to kill the mussels
- *Grateloupia turuturu* has been collected from the Bicheno area of eastern Tasmania.

Belgium, 2006

Prepared by: F. Kerckhof, MUMM/BMM

- During 2006, two new invasive species, namely the Asian shore crab *Hemigrapsus sanguineus* and the brackish water clam *Rangia cuneata* (Atlantic Rangia) have been recorded. When discovered both species had already formed well-established populations.
- All introduced species that were reported during previous years are still present and seem to be well-established and thriving.

Canada, 2006

Complied by: Amy Williams

- While a number of activities and introductions are described in this report, these are primarily updates on issues reported in past years. Canada continues to import a range of organisms for aquaculture as described in this report. The pattern of these imports is much the same as in past years, and no new activities were reported in 2006 that would raise particular concerns with respect to risks to aquatic resources.
- Tunicates, which have invaded Prince Edward Island waters, continue to affect the shellfish aquaculture industry by fouling production facilities and increasing the costs of harvest and cleaning. The affected region has introduced measures to contain the organisms, and other regions are monitoring for possible, natural spread.
- Viral hemorrhagic septicemia (VHS) was discovered in the Great Lakes region in late 2006. The Ontario and Canadian governments are working together to better understand the significance of the increased observations of VHS in various fish species. Border controls have been put in place pending these investigations.
- In April, the Department of Fisheries and Oceans (DFO) officially launched its Centre for Expertise in Aquatic Risk Assessment (CEARA). CEARA is mandated to develop a national standard for conducting biological risk assessments of aquatic invasive species; to educate practitioners on the risk assessment process; to develop a process for prioritizing risk assessment needs; to provide advice to headquarters; and to coordinate and track progress of national risk assessments and ensure that deliverables are met. To date CEARA has completed two risk assessments – one on five species of Asian carp, and one on northern snakehead (*C. argus*). Their 2007 work plan includes completing risk assessments on five species of tunicates, Ponto-Caspian fishes to the great lakes, and national pathways for aquarium fish, live fish for food, water garden fish and baitfish.

Croatia, 2006

Prepared by: Josip Mikuš, Marijana Pećarević and Ana Bratoš Cetinić

- In summer 2005 several specimens of *Lappanella fasciata* (Cocco, 1833) (Labridae) were observed in the southeastern part of the island of Sušac (Cape Triščavac). This represents the first confirmed records of *L. fasciata* for the entire Adriatic Sea.
- The Atlantic lumpsucker *Cyclopterus lumpus* (L., 1758) (343 mm of total length) was recorded for the first time in the Mediterranean Sea. This record may be a case of a vagrant specimen.
- More then 127 specimens of the bivalve mollusc *Idas simpsoni* (Marshall, 1900) were collected from the skull of a fin whale *Balaenoptera physalus*. (L. 1758). This is first finding of *I. simpsoni* in the Adriatic Sea.
- *Ficopotamus enigmaticus* (Fauvel, 1922) (Polychaeta, Serpulidae) was recorded for the first time in the Bay of Šibenik (Middle Adriatic) in 2006. A possible vector of introduction is ships transporting stone from Middle Dalmatia.
- Occurrence of blue crab *Callinectes sapidus* (Rathbun, 1896) in the southern part of the Eastern Adriatic Coast was first recorded in the mouth of Neretva River and Mali Ston Bay.
- During the 5th Working Group Meeting on Invasive *Caulerpa* Species in September 2006, a program to monitor and suppress the of expansion of invasive *Caulerpa* in the Croatian part of the Adriatic Sea was discussed. The project, carried out by the Institute of Oceanography and Fisheries in Split, is ongoing with respect to controlling the expansion of and continuing the eradication of existing communities.

Finland, 2006

Prepared by: Ari Laine and Lauri Urho

- No new species of invasive fish were recorded. However there were new records of Prussian carp, *Carassius auratus*; and starry sturgeon, *Acipenser stellatus.*
- No new individuals of round goby, *Neogobius melanostomus*, have been recorded since the first report in 2005.
- No new species of invertebrates were recorded in Finnish waters in 2006 but two recently introduced species (the amphipod *Gammarus tigrinus* and Conrad's false mussel, *Mytilopsis leucophaeata)* were found to expand their distribution.

France, 2006

Prepared by: Laurence Miossec

- In 2006 two veined whelk adults *Rapana venosa,* were recorded in the Bay of Quiberon, successively in June and August. No additional information is available regarding weight and length.
- *Hemigrapsus sanguineus* was reported in summer 2006 near Luc sur mer (Normandie) and in the North of France (Pas de Calais) in 2006. Ballast water is suspected to be the vector.
- *Bonamia ostreae* was identified for the first time in the Granville area (Normandie- 48°50.80N lat-0°37.98W long WGS 84 system) in September 2005 and confirmed in November 2005 and July 2006.
- *Bonamia ostreae* was also detected for the first time in Lough Swilly (North of Ireland near the border between Ireland and Ulster in 2006 – see Report 2007 from Ireland) and in UK in May 2006 in a wild oyster stock situated in Cleddau River (Wales). It was also confirmed for the first time in Loch Sunart (Scotland, UK) in April 2006.
- PROGIG – A French programme on causes and consequences of the pacific oyster (*Crassostrea gigas*) proliferation in France (program 2006-2008) is ongoing.
- The European project DIPNET, a two-year project started on October 2004, was finalized in 2006. It aimed to integrate current knowledge on the transfer of pathogens between wild and cultured aquatic animal populations. It addressed key issues needed to ensure sustainability and responsible exploitation of aquatic environments.

Germany, 2006

Prepared by: S. Gollasch and H. Rosenthal

- *Pachygrapsus marmoratus* was found in the German Wadden Sea in Lüttmoorsiel, Nordstrand on September 29, 2006 on a blue mussel bed. This range expansion may have been enabled by unusually warm water temperatures.
- In October 2006 the invasive ctenophore *Mnemiopsis leidyi* was first recorded in the Kiel Bight (western Baltic Sea). Its abundance increased from less than 30 individuals per meter cubic in mid-October to more than 90 in late November 2006. Its occurrence in the Baltic Sea is of great concern as this invader is assumed to have contributed to the decline in fishing harvest in the Black Sea.
- A guidance document for new alien species imports was prepared as an IUCN contract to provide a brief review of existing structures that might be useful in aiding an evaluation, and to provide a simplified list of considerations for undertaking an assessment of new aquatic species imports.
- A new EU-funded project was launched in December 2006 entitled "Environmental impacts of alien species in aquaculture" (IMPASSE). Two

German partners are involved. The key objectives include to review and assess the impact of alien species in aquaculture.

Italy, 2006

Prepared by: Anna Occhipinti-Ambrogi

SUMMARY: New findings of alien species in Italian marine waters are reported for the year 2006. No new species is known to have been deliberately introduced. Comments on the spread and ecology of established alien species are listed and discussed, and information on ongoing research activities is provided.

- One specimen of the lessepsian clupeid *Etrumeus teres* was caught for the first time in Italy in 2005, off the island of Lampedusa, in the Sicily strait.
- The first record of the dwarf flathead *Elates ransonnetii* in the Mediterranean Sea was reported in 2005 along the southern coast of the Gulf of Taranto (North-western Ionian Sea).
- The specific digenean trematode parasite *Allolepidapedon fistulariae* was reported for the first time in the Mediterranean Sea, from the bluespotted cornetfish *Fistularia commersonii*, caught in Sardinia in 2005.
- A new polychaete species, *Novafabricia posidoniae,* has been described. The genus was not represented in Italy and its origin is probably from the Atlantic.
- Several individuals of the bivalve *Mercenaria mercenaria* were caught from 2002 to 2005 in two lagoons of the Po River Delta where the Manila clam is harvested.
- A new alien decapod pilumnid, *Actumnus globulus,* was reported from the Mediterranean Sea. It was collected in 1978 off Punta Ala, Tuscany (Tyrrhenian Sea) but only recently identified. From the same sample another alien crustacean *Menaethius monoceros*, known from the Indopacific, was described in 2003.
- The red alga *Heterosiphonia japonica* has been present in the Lagoon of Venice since the 1990s, but was misclassified until recently due to taxonomic complexity, which is not yet completely clarified.
- Ecological studies on the most important invasive species established along the coasts of Italy have progressed, in particular with respect to the mechanisms underlying the success of the algae *Caulerpa racemosa* var. *cylindracea* and *Codium fragile* ssp. *tomentosoides.*

Ireland, 2006

Prepared by Dan Minchin

In a rapid assessment survey of twenty-nine sites with floating pontoons from all Irish coasts in 2006, twenty species were targeted. Ten were known to occur in Ireland and ten were known only from Europe or Britain. Twenty-seven new range distributions of species expanding their range in Ireland were found including *Caprella mutica* from Cork the south coast and in the northern Irish Sea. Four species not previously found in Ireland included (1) amphipod *Corophium insidiosum* from Belfast Lough, (2) the southern hemisphere tunicate *Corella eumyota* from the Irish Sea and the south coast. (3) the colonial tunicate *Botrylloides violaceus* from the Irish Sea, and (4) the colonial tunicate *Didemnum* sp. from the Irish Sea. Samples of *Didemnum* has been sent to Plymouth and to New Zealand respectively for genetic and biochemical investigations.

At least five specimens of the Chinese mitten crab have been captured over ca. 20 km stretch of the Waterford Estuary on the south Irish coast during 2006.

Bonamia ostreae is now confirmed from Lough Swilly on the Northern Irish coast.

Norway, 2006

Prepared by: Anders Jelmert

- The alien comb jelly *Mnemiopsis leidyi* continued its spread into Norwegian Waters after its discovery in The Netherlands, Germany and Sweden (likely also Denmark). Fairly high numbers of adults (>6 cm) were found in the "Coastal current "from the Oslofjord area, outside Skagerrak, and outside Bergen.
- Except a number of singular (likely human-translocated specimen, no apparent southwest-ward expansion of the red king crab *Paralithodes camtschaticus* have been observed.
- The snow crab *Chionocetes opilio* are sporadically found outside the Coast of Finnmark County, but the main population is still concentrated in the eastern part of the Barents Sea. Of a total of 11 suspects, 3 specimen of American lobster were found in Norwegian waters in 2006, 2 outside Alesund, and 1 outside Kristiansand.
- Norwegian web-based Alien Species Database has been established. A thorough revision of the "Red list" have been finished and published, and an "Alien List is being finalized. The alien list includes risk assessment and a web-based map application for national distribution. It is complete for terrestrial, limnic and marine species, but does not include protists, bacterial and viral species other than known pathogens. The revised Norwegian alien list now contains 47 marine/brackish water species.

Poland, 2006

Prepared by: A. Szaniawska and J. Hegele-Drywa

- Deliberate releases of salmon (*Salmo salar),* sea trout (*Salmo trutta morpha trutta*), and whitefish were consistent with previous years.
- In May 2005 24 specimens of *Platorchestia* were found beneath stones and debris wedges within a stone coastal defense structure on the southern shore of the Hel Peninsula at Kuźnica (Puck Bay).
- In 2002 *Hemimysis anomala* was found in the Odra Estuary (Gruszka *et al.*, 2003), where it had probably arrived via canals and rivers.
- The first recording of *Neogobius gymnotrachelus* in Poland was during 1995 in the River Bug. Then this species was founded in Włocławski reservoir where it has formed a vivid, abundant self-sustaining population. At present the species has spread to the middle and lower section of the Vistula River, down to the vicinity of Toruń.

Spain, 2006

Prepared by Jesus Cabal

In the 2005–2006 six new records from molluscan, crustacean and tunicate were recognized in the Atlantic coast of Spain (Table I). These include established populations of *Xenostrobus securis and Callinectes sapidus* and "present" populations of *Hemigrapsus takanoi*, *Hexapleomer robusta*, *Hyale spinidactila*, and *Corella eumyota*.

Table I. First records from Spain (2005-2006)

Genus	Species	Common na	Locality	Latitude	longtitude	comments	date
Xenostrobus	*securis*	mollusca	Ria de Vigo	42°13´34"	8°48´29"	established	2005
Callinectes	*sapidus*	crustaceans	Gijón (Port of Musel	43°33´42"	´5°45´40"	individual	2005
Calllinectes	*sapidus*	crustaceans	Sevilla (Guadalquivi	37°23´07"	6°00´03"	established	2005
Hemigrapsus	*takanoi*	crustaceans	Guipuzcoa	43°19´40"	2°04´24"	present	2006
Hexapleomer	*robusta*	crustacean	Guipuzcoa	43°19´40"	2°04´24"	present	2006
Hyale	*spinidactila*	crustacean	Guipuzcoa	43°19´40"	2°04´24"	present	2006
Corella	*eumyota*	tunicate	Guipuzcoa	43°19´40"	2°04´24"	present	2006

Sweden, 2006

Prepared by Inger Wallentinus and Susanna Pakkasmaa

- The comb jelly *Mnemiopsis leidyi* was recorded at the northern part of the Swedish Skagerrak coast from mid-September to November 2006; the large population size indicates that the species had arrived before 2006.
- In 2006, many more individuals of the Chinese mitten crab, *Eriocheir sinensis* were recorded in Lake Vänern than previously.
- In 2006, the Japanese red alga *Heterosiphonia japonica* was recorded much further south (ca. 140 km) on the Swedish west coast in the NE Kattegat (Göteborg), previously only seen in the northernmost part of the Skagerrak.

United Kingdom, 2006

Compiled by: Gordon Copp, Ian Laing, and Tracy Edwards

- Deliberate releases of Pacific oysters *Crassostrea gigas* for cultivation continue at a similar level to that in previous years.
- A survey of the distribution of *Styela clava* (leathery sea squirt) in Europe has been completed. In all, 260 harbors and marinas in Europe (excluding Denmark); from Scotland in the North to Portugal in the South, and from Ireland in the West to Italy in the Mediterranean Sea, Finland in the Baltic Sea and Romania in the Black Sea in the East were visited. Populations were found in only 64 of the sites.
- Of the seven species most closely monitored by the Marine Aliens Project (www.marlin.ac.uk/marine_aliens): (1) *Caprella mutica* has still only been found on artificial structures to date. The global status of *Caprella* is highlighted by a publication (in press); (2) *Styela clava* and *Perophora japonica* ranges do not appear to have extended over the last year; (3) Chinese mitten crab *Eriochier sinensis* has been reported as now reaching the River Dee (Wales), which suggests a clockwise extension around the UK; (4) *Corella Eumyota* (tunicate) has been reported along the south coast of England; and (5) slipper limpets *(Crepidula fornicate)* have recently been found in the Menai Strait (Wales), most likely introduced with mussel seed (Countryside Commission for Wales, personal communication).
- The zebra mussel *Dreissena polymorpha* has been found at Monks Pool in Johnstown. This is the first confirmed sighting in North Wales.
- There were five records of non-native signal crayfish (*Pacifastacus leniusculus*) extending their range into new areas of Great Britain in 2006. These are likely to have been the result of transfers by people in ignorance of the laws designed to prevent such movements. There were also three incidences non-native crayfish turning up in the ornamental fish trade.
- *Sargassum muticum* range appears to have remained stable in Wales, though increased abundances (in North Wales) have been anecdotally recorded. However, in Scotland, it has now appeared in Loch Fyne (summer of 2006). This is the fourth report of this alien species in Scotland since it was first recorded in Loch Ryan in 2004.

- A draft document for the Global Biodiversity Sub-Working group of the UK Global Environmental Change Working group has suggested research priorities for invasive alien species. Although priorities have not yet been assigned, trade patterns, projections, island endemism, research into impacts and control are all being considered.
- The GB Strategy Working Group has recently published the draft 'GB Invasive Nonnative Species Framework Strategy' for consultation (closes 23rd May 2007). This consultation document suggests ways by which the actions of government departments, their related bodies and key stakeholders can be better coordinated. Its overall aim is to minimize the risks posed, and reduce the negative impacts caused, by invasive non-native species in Great Britain.

United States, 2006

Prepared by Gregory Ruiz, Paul Fofonoff and Judith Pederson

- The range and abundance of *Pterois miles/volitans complex* (Red Lionfish) continues to expand in the Northwest Atlantic. In 2006, specimens have been captured as far north as Waquoit Bay, Massachusetts, and the first records were reported from the Gulf of Mexico, and Treasure Island, Florida.
- *Rhinogobius brunneus* is now established and reproducing in drainages of the Columbia River in Washington State.
- *Phyllorhiza punctata* (Australian spotted jellyfish) appeared for the first time in Galveston Bay, Texas. and in July it extended its range about 200 km north to Guana Lake, a lagoon near Augustine Inlet, Florida
- *Mytella charruana* (Charru mussel), was found "growing heavily on floating docks" on the Medway River, flowing into St. Catherines Sound, Georgia.
- *Perna viridis* (green mussel) continues to expand its range northward along the Atlantic Coast. In October, 2006, it was collected for the first time in South Carolina waters, in Charleston Harbor and surrounding waters.
- A single specimen of *Cancer magister* (Dungeness crab) was caught in the Atlantic Ocean off Gloucester, Massachusetts. This specimen was apparently discarded or escaped from a live-seafood market. There are no other documented reports of this crab from the Atlantic.
- Specimens of *Eriocheir sinensis* (Chinese mitten crab) were caught in the Patapsco River, near Baltimore, on the upper Chesapeake Bay. This was the first known collection of this invasive crab on the US Atlantic Coast, although this crab had been collected several times in the Great Lakes and tidal St. Lawrence River, and once in Louisiana.
- *Didemnum* sp. is expanding its range on Georges Bank. At some of the surveyed sites, *Didemnum* covered 50–75% of the gravel bottoms, approximately doubling the amount of coverage seen in 2005 and earlier in 2006. It was also found in Mission Bay, San Diego.
- *Clymenella torquata* was found to be abundant in Samish Bay, Washington, where it is interfering with culture of the Pacific Oyster (*Crassostrea gigas)*

6 OSPAR Report

ToR a To identify and report on changes in the distribution, population abundance and condition of introduced marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature

Summary of findings

Currently, papers that identify range expansion, change in reproductive periods, alterations in other life history traits, or other non-native related changes due to climate change are rare in the published literature. Perhaps the best example is *Crassostrea gigas*, which was introduced

as aquaculture, but has since become established and is spreading throughout Europe. *Crassostrea gigas* will be the featured Alien Species Alert organism and more information will be available next year. Barnacles are other species for which observational data on range expansion and extended reproductive periods are available from long-term monitoring for both the UK and Belgium. Published reports and sampling data on non-native species found in the Helgoland area, suggest several species are responding to warmer temperatures. However, some of the species listed are considered native or Lusitanian expansions. One fish species was found in the Gulf of Finland and attributed to warmer temperatures. Other papers provide information on species in and around northern Europe, including Iceland. Models of potential range expansion were developed by scientists for the UK and focused on two algae (*Codium* sp. and *Sargassum muticum*) and one barnacle (*Elminius modestus*). These three species are likely to increase their range with increasing temperatures. It is also worth noting that the barnacle *E. modestus* was mentioned in three reports as responding positively to temperature increases and has shown the greatest impact on a native species for which we have data.

The exercise underscores the limited information on climate change impacts. Species range expansions are not well-documented as responses to temperature, salinity, and/or other climate change impacts. There is some evidence that changes in the rates of reproduction are related to warmer temperatures, e.g. the oyster *Crassostrea gigas* and the barnacle *Elminius modestus.*

7 Draft 5-year summary (ToR d)

ToR d develop a 5 year summary of National Reports (2003–2007) with the aim to prepare a 25 year summary based on earlier reports at a future meeting (intercessional preparation of draft material is essential).

A draft of the invertebrate section was prepared by Stephan Gollasch, Germany and distributed at the meeting. However, the section on fish, algae, and pathogens, parasites and other diseases was not completed prior to the meeting. Because these sections were not completed before the meeting (the 2006 National Reports were not ready until the meeting), the draft report is not included. The sections on fish, algae, and pathogens and parasites are nearly completed and will be reviewed intersessionally. Susanna Pakkasmaa, Sweden offered to write the fish section, Ian Laing, UK and Laurence Missosec, France, offered to write the parasite, pathogens and other diseases section, and Judith Pederson (with review by Inger Wallentinus) will prepare the algae section. To the extent possible, the reports will provide locational data (if it exists) and maps will be prepared. Once all sections are together, the format will be reviewed to maximize communicating information to other countries. Each country will need to review each section before the document is ready for distribution.

Several highlights emerged from the five year report. Most deliberate introductions were for aquaculture, specifically for human consumption or recreational purposes (see U.S. report on lion fish, *Pterois* complex). Two species of concern are the predatory whelk *Rapana venosa* and the king crab *Parathithodes.* New findings of concern are *Mnemiopsis leidyi* in the North and Baltic Seas and the Chinese mitten crab, *Eriochier sinensis* in North America and Europe and the American lobster in Europe.

8 Rapid assessment report (ToR e)

ToR e finalize a report for rapid response and control options, including

- invitation of an internationally recognized expert to develop a risk assessment strategy for the rapid response including likelihood of success of eradication, impact of the invasive species on species in the area of introduction and impact of control methods (e.g. chemical eradication) on non-target species and habitat in the receiving environment;

- contribute intersessionally to the database (Excel spreadsheet) for the rapid response account (e.g. case histories);

The final report for the Rapid Assessment is attached in Annex 4. Below is a summary of the report. Judith Pederson presented a summary of the Rapid Response Guidelines. Additional suggestions were made and added to the report. Below is an abstract of the guidelines; the report was accepted as a final with the new revisions.

Summary of Rapid Response Guidelines

Rapid Response efforts require cooperation and coordination at all levels of government and often involves several political entities. Making the decision to eradicate is as much a political decision as a scientific one. The scientific information should be the basis for the decision and provided to policy makers, politicians and the public. To be most effective, preliminary information on potential invaders should be documented along with basic physiological and ecological information that includes impacts of the invaders in other countries. The risk assessment will include information on the likelihood of reintroduction risk, related taxa, and the ability to quarantine the area during eradication.

The generic approach described above does not include the regulatory and permitting requirements that vary considerably by country. Thus, each country or region should consider pre-approval for actions that require lengthy approval processes. Keeping both the public and policy-makers informed throughout the process is considered a key component in the decision-making process. Several countries are developing risk assessment approaches to guide management decisions. Gordon Copp, UK reported on the approach being developed by the UK (see Annex 6) for his power point presentation.

There are no international standards on ecological risk assessment, it is not considered important enough. There are some exceptions, for example risk assessment on plant pests due to the economic ramifications are accepted internationally. However, for aquatic animals the process is much further behind. The UK has pending legislation on alien species in aquaculture. Using the Exotic Plant Pest approach (EPPO) as the management scheme, testing for 33 non-native species, and 12 taxon-habitat combinations are underway. There are a number of sub routines testing for invasiveness, parasites and pathogens, and economic impact assessment based on Bayesian statistics. Information on species attributes and pathways is examined in sub modules. The output is a spreadsheet that assesses the vulnerability of a facility, summarizes risk, and economic impact over time. The process was applied to the top gudgeon (fish) to demonstrate its strengths and weaknesses. A review of the UK legislation and the IMPASSE objectives for reviewing introductions and translocations were discussed.

Following Gordon's presentation, a discussion ensued about next steps. It was agreed that WGITMO should review risk assessment in a systematic way. Because of the complexity and assumptions of the risk assessments, it was recommended to invite additional risk assessment experts to attend the meetings and participate in the discussions and reviews. One suggestion was to choose a species and use the IMPASSE risk assessment approach to understand how it is applied. Unfortunately, IMPASSE will not be ready next year. Another aquatic invasive species risk assessment by Canada will be ready at the end of March, and the US is preparing an approach that will also be ready soon. It was suggested that experts from both countries run through an example, e.g. using *Crassostrea gigas* and discuss the approach and outcome in a half day workshop.

9 Status of development of ICES Alien Species Alert reports (ToR f)

ToR f develop Alien Species Alert reports including evaluation of impacts and to increase public awareness. WGITMO suggests preparing intersessionally a Species Alert Report on the Pacific oyster *Crassostrea gigas* with the aim to finalize the report at next years meeting. Other candidate species are the Chinese mitten crab and *Didemnum* sp. (intercessional preparation of draft material is essential);

9.1 General comments

The *Undaria pinnatifida* Alien Species Alert Report, prepared by Inger was submitted in 2006 and published by ICES. It is available on the ICES web site (http://www.ices.dk/pubs/crr/crr283/CRR283.pdf). Hard copies were distributed to WGITMO members at the meeting.

As part of our discussion on the format and value of the Alien Species Alert discussion, it was suggested that we consider developing, one or two page fact sheets on species of interest, as discussed above and suggested in our 2008 ToR. We also recognize that some taxonomic groups are more likely to be introduced deliberately as food, or accidentally by other vectors. In either case, these species may spread to new areas and often have similar impacts on ecosystems and may positively or negatively impact the economy of the area. This year's Alien Species Alert report will be undertaken by Laurence Missosec, Ifremer, and will focus on *Crassostrea gigas,* the Asian oyster that is spreading beyond its aquaculture locations. Currently, the U.S. (or rather states within the U.S.) is considering introducing *C. ariakensis*, primarily as non-sterile triploids. This deliberate introduction offers an opportunity to evaluate how well the Code of Practice is being followed, what are the Code's strengths and weaknesses, and what can be said about the risks involved in the process that the US adopted. Roger Mann, Virginia Institute of Technology presented a short discussion and a draft paper on this topic. It was suggested that we review the Chinese mitten crab as the next Alien Species Alert.

9.2 Alien Species Alert Report: *Crassostrea gigas*

The Alien Species Alert Report will be on *Crassostrea gigas*, the Asian oyster that has become established outside the permitted aquaculture locations and is appears to be impacting the native community, especially mussels. Laurence Miossec made a presentation on the issues that would be considered for the report. Her abstract is given below (See also Annex 6).

Alien Species Alert Report – *Crassostrea gigas*

Laurence Miossec
Ifremer – France

The pacific oyster, *Crassostrea gigas*, was introduced worldwide into a number of countries, including USA, Canada, UK, France, Netherlands, South Africa South America, Korea, China, New Zealand and Australia. In 2002, *C. gigas* aquaculture has reached a 4 216 300 metric tons record high, representing 97.7% of the total oyster culture production in the world (FAO, 2004). In Europe the pacific oyster was massively introduced in the seventies of the last century especially in France following mass mortality in *Crassostrea angulata*. Good environmental conditions in some French areas south of the Loire River on the Atlantic coast induced successful recruitments in the following years. The population became established in the mid 1970s. Since the 1990s successful recruitment, associated with the global warming, has been observed northward and consequently wild populations were established in many areas where *C. gigas* was introduced for aquaculture as in areas far from farms due to larvae

colonisation. Now this species has become a permanent member of the coastal ecosystem. This phenomena is not limited to the French Atlantic coasts but is also observed in northern European countries (i.e., UK, Belgium, The Netherlands, Germany and Denmark and Scandinavian countries) but also in different countries worldwide where the species was introduced in the past. The status of this invasion, its dynamics and the ecological and socio-economical consequences of this phenomenon are under-investigation in these countries.

We propose to review the current status of knowledge concerning the *Crassostrea gigas* invasiveness. The following tentative table of contents provides additional information on the chapters which will be developed in the expected document.

Alien Species Alert: *Crassostrea gigas* (Pacific oyster): Proposed Table of Contents

Table of contents

1 - Introduction

2 - Identification (FAO card)

3 - Biology (general data)

- Environmental tolerance (with a special attention to the native range)
- Respiration
- Nutrition
- Reproduction
- Growth rate
- Genetic characteristics
- Disease status and predation

4 - Introduction for aquaculture purpose

- 4.1 Historical data and actual non-native distribution (including map)
- 4.2 Grow-out production systems (worldwide)

5 – Consequences of Pacific oyster introduction

- 5.1 Environmental impact
  - Geographical expansion of *C. Gigas*
  - Habitat modification (sediment process)
  - Ecological competition and community structure modification
  - Ecosystem carrying capacity
  - Genetic evolution
  - Diseases and parasites
- 5.2 Economical impact
  - Worldwide production
- 5.3 Social impact
  - Farming activity (lease development, shellfish areas development)

Recreational activity

Public health issue

6 – Mitigation and restoration

Technical solutions to limit the extension

7 – Prospective

- impact of the global change:
    - Problem associated with calcification process related to CO2 cycle
    - Further potential expansion of the species

9.3 Examination of the Code of Practice in the proposed introduction of *Crassostrea ariakensis* in the US

In addition to a discussion of *Crassostrea gigas*, we recognize that other bivalve species are also spreading throughout the world (e.g. *Perna viridis*) and/or being released on a trial basis as triploids (e.g. *Crassostrea ariakensis*). Roger Mann, USA presented information on *Crassostrea ariakensis,* including results from early trials, the environmental impact statement and other issues. His abstract is given below; see Annex 7 for a copy of his report.

Consideration of the oyster *Crassostrea ariakensis* for introduction to the Chesapeake Bay, USA and the utility of ICES Code of Practice guidelines **

Roger Mann, Virginia Institute of Marine Science

The ICES Code of Practice guidelines were developed over three decades ago to assist the process of consideration of marine species for intentional introductions beyond their native range. The guidelines have been updated and revised throughout their working life in response to both needs and the development of new technologies such as ploidy manipulation. A program is currently underway in the Mid Atlantic region of the United States wherein a non-native oyster, *Crassostrea ariakensis*, is being considered for introduction to the Chesapeake Bay for both ecological and fishery enhancement purposes. The oversight mechanism is through formal development of an Environmental Impact Statement (EIS) by the US federal government, represented by the Army Corps of Engineers (USACOE), in collaboration with the State of Maryland and the Commonwealth of Virginia. This is probably the most comprehensive evaluation of a potential introduction that this author is aware of in over three decades of working in this field, and provides an opportunity to critically evaluate the most recent revision of the ICES Code of Practice in a contentious and high stakes debate. Four questions are posed. These are (1) what similarities and dissimilarities exist between the process pursued in the current evaluation and the WGITMO the revised Code of Practice, (2) has the current process defined limitations or inadequacies that the ICES Code should incorporate, (3) has the current evaluation failed to address issues that are presented by the current Code of Practice, and (4) what is the time frame for completion of the current EIS and is any scientific consensus emerging at this time on the risks and benefits of the considered introduction.

**This presentation was invited by Judith Pederson, WGITMO Chair, ICES USA representative.

10 Review impact of targeted fisheries species on nonindigenous species (ToR g)

Tor g review the impact of targeted fisheries on non-indigenous species (e.g. king crab, Chinese mitten crab, green crab, Manila clam);

Nonindigenous species may be introduced intentionally or unintentionally to enhance fisheries. Intentional introductions are required to meet permits and licenses of member countries in order to develop a "wild" or aquaculture fishery. WGITMO was established to provide advice to prevent unintentional releases that would harm the ecosystem and valued species by predation, competition, or introduction of diseases, parasites and pathogens. Thus, WGITMO identified a process for reviewing new proposed releases to the environment through the ICES Code of Practice for Introductions and Transfers of Marine Organisms. Although not always referred to, many countries have adopted their own Code of Practice, e.g. Canada and or adopted the intent of the ICES Code in reviewing new introductions. To date there have been limited evaluation of the impact of the Code and the effect on ecosystems where introductions have occurred outside the formal review process.

This summary is the first phase of preparing a review of case studies of introductions, planned and approved and unplanned before and after the Code was adopted and available. It provides an annotated outline for intersessional contributions to the case studies and identifies questions to be answered by those preparing case studies. Because no formal assessments were made for many introductions, data are lacking. However, we have prepared some qualitative comments on several of these fisheries, presented below in an annotated form. This outline will serve as a basis for preparation of a document addressing this issue. The consensus was to use deliberately introduced species as the initial focus. Thus the Chinese mitten crab is not recommended to be included; in this case controlled research in the U.K. seems to depend on using it as a fisheries to control it.

The question is how to define a negative impact in environments that are already degraded. The general attitude is that an introduced species has a negative connotation a priori if we are concerned about ecosystem processes, but if we used their associated values then the impact of an introduction is harder to define.

For each case study we would use the same format as proposed for the press release, e.g. 1. Background (where is the species from, where was it introduced, what was the vector); 2. Biology (environmental requirement, identification of species, reproduction, etc.); 3. Impacts (ecological, economic and human health).

Emerging issues for introductions of fisheries species (not necessarily in order)

Economic costs of introduced species

- To non-fisheries areas, e.g. power plants
- Ecological costs in economic terms

Economic benefits of introduced species

- Increased fisheries and satellite industries
- Diversification of industry
- Reduction of pressure on traditional fisheries
- Revitalization of rural communities
- Commercial and recreational fisheries
- Aquaculture revenues, etc.

Ecological impacts (negative) of introduced species

Does it out compete local species?
Does it change physical environment?
Are there genetic impacts?
Does it introduce diseases?
What are the impacts into systems that are degraded?

Ecological impacts (positive) of introduced species

Improve water quality
Filling an empty niche
3-D structuring of the water column
Increasing biodiversity (e.g. *Sargassum muticum* on hard bottom)
Provide shelter
Nutrient cycles and water chemistry

Assessing economic value on ecological impacts

Evaluation of the studies (e.g. experimental, observational, correlative, speculative, etc.)

What are the consequences when a species does not establish, e.g. *Porphyra yezoensis*

Green crab (*Carcinus maenas*) fisheries

Problematic predator, often of commercially important shellfish (economic impacts) and as an ecological engineer in native communities

Soup fish base France and Norway
Bait
Sold in Asian markets in the US
Failed attempts to market as "soft shelled" crabs

King crab – *Paralithoides camtschaticus*

King crab is edible – fisheries, data are not developed
Effects on clam and sea urchin harvest
Impacts to kelp
Damage to net fisheries (e.g. cod grown in cages); including scale of the problem, mitigation costs etc.
New aquaculture infrastructure
Impact to non-fisheries – e.g. electric power plants, etc.
No top predator once they reach full size (except humans)

Asian oyster - *Crassostrea gigas* and *Venerupis philippinarum* (=*Tapes philippinarum; T. japonica; V. japonica* and more)

C. gigas changed the ecosystem – is this a negative impact;
Impacted system later when it became naturalized
Venerupis introduced because the natural species was fished out.

Some specific species causing problems in specific areas

Undaria – Spain,
Porphyra – US
Venerupis - Manila clam - Wales

Other considerations and examples to follow-up for the report

Changes in biodiversity – when species moved out of the aquaculture system into areas, they may or have displaced native species.

Restocking projects can be negative if there is no top down (native) predator – example – Baltic Sea Salmon breeding grounds are destroyed – need to restock otherwise; there are no fisheries

Claim that polypoloidy oysters farmed that bred with native species (hybridized), this has not demonstrated to WGITMO farmers (Australia is trying to follow-up on this will be added if there is information)

Catfish – territorial non-fertile genetically modified organisms take over native species (keep as good example, even though it is a fresh water species).

Developing a draft report on this topic is a proposed ToR for 2008. Several WGITMO folks have volunteered to write various sections.

11 Discussion on cooperation and communication with PICES WG21

Darlene Smith, co-chair of the PICES Working Group 21 (WG 21), described the working group and its purpose. WG-21 is a fairly new PICES working group and is not as far advanced in its terms of reference as the WGITMO and WGBSOV (e.g., it has not considered ballast water as a major priority at this time). She noted that there will be a joint meeting with ICES WBITMO and WGSOBV and PICES WG-21at the end of the Marine Bioinvasions Conference in May 2007 in Cambridge, Massachusetts. The March meeting afforded an excellent opportunity to develop a joint agenda and discuss how to facilitate communication and cooperation.

Agenda items for the joint May meeting and proposed topics for Japanese initiative

- Joint projects and topics for joint meeting
- West Coast effort that is looking at watersheds using the US Environmental ProtectionAgency data. Henry Lee will be attending the Conference and joint ICES/PICES meeting and presenting a poster of his work.
- Review studies of biological surveys of vessels between Russia and Japan
- Review whether a database of harmful algal blooms and nonindigenous species (does one already exist with IOC?)
- Identify keys and manuals for harmful algal blooms and nonindigenous species
- Review risk assessment methodology and share information and conduct workshop
- (Eco-niche modeling could be a joint project)
- Support post-doctoral students to go to labs to become taxonomic experts. Training people is better than another manual or key which becomes out-of-date (nomenclature changes, reclassification of species, etc.)
- Early detection and rapid response will be addressed differently in each country. There are technical differences, different structures within government for addressing EDRR, and different countries have different priorities. A lot of Pacific countries does not understand the definition of invasive species and need supporting data for decisions.

Judith Pederson, chair WGITMO; Anders Jelmert, chair WGBOSV; and Darlene Smith, chair PICES WG-21 will develop an agenda for the May meeting.

12 Other topics

This section briefly notes other items discussed by members.

Several databases were identified.

DAISIE (http://www.europe-aliens.org/)
Dipnet http://www.dipnet.info/ Harmonia
NISBase (http://www.nisbase.org/nisbase/index.jsp)
MITIS (http://chartis.mit.edu/mitis/)
The Norwegian Species Databank (http://www.biodiversity.no/default.aspx?m=23)

12.1 Future meetings

The fifth International Marine Bioinvasions Conference will be held at the Massachusetts Institute of Technology (MIT), Cambridge, Massachusetts on May 21–24, 2007. Conference information and registration details can be found at http://web.mit.edu/seagrant/bioinvasion2007/index.html.

The 2nd International Invasive Sea Squirt Conference II will be held in Charlotteville, Prince Edward Island, Canada, October 2–4, 2007 (http://www.whoi.edu/institutes/OLI/activities/seasquirt-2007.html).

Symposium for Coastal Zone Management, Arendal, Norway on June 11–14, 2007 (http://www.imr.no/iczm).

Comments from WGITMO

1) We propose to remain as two separate groups.
2) We propose to meet back to back with WGSOBV during the week of March 10, 2008 in Denmark.
3) We ask ICES to consider providing a web page that would support making WGITMO meeting reports for reference (e.g. summary reports and other documents) longer than the 3 years currently available.
4) Some of the proposed activities would be greatly enhanced by putting data (e.g. from the national reports) into a database that would produce GIS maps and analyses to better respond to OSPAR, communicate information to various countries, etc. Does ICES have a mechanism for managing such a database? If not, are there funds available to support such an effort?
5) We would like to develop communication with other working groups, e.g. mariculture.
6) WGITMO requests ICES cooperation in preparing and distributing through the ICES newsletter and web site, a "press release" on three invaders of concern.

12.2 Proposed Terms of Reference for 2008

a) to synthesize and evaluate national reports using the new format for reporting and contributions to the database that includes species, locations (latitude and longitude), status of invasion and other relevant information, and prepare a press release of highlights for distribution,

[WGITMO recognizes that there are data gaps in the national reports and are anticipating that the use of the database and ease of submission will facilitate closing gaps in the data base. This helps in collation of the data and subsequent use of the data by interested parties. It is suggested that we have the national reports completed by the end of January to prepare short summaries to be distributed within each country. WGITMO also proposes to develop annual "press releases" to be distributed to inform countries of species of concern. The choice of species for highlighting in a "press release" will be identified based, in part, on the national reports.]

b) to finalize the five year summary of national reports (2003–2007) with the aim to prepare a 25-year summary based on earlier reports at a future meeting (intercessional editing of draft report after the meeting),

[The final draft of the invertebrate section is completed and other sections will be ready for review intersessionally. The development of the 25-year report will require re-evaluating information, analyzing data, and developing summaries that reflect changes in status of species over time and space. WGITMO anticipates that it will take more than one year to complete this task.]

c) to conduct a half day workshop on risk assessment using the Canadian and/or U.S. and/or U.K. and/or other risk assessment approaches using a specific example (e.g. *Crassostrea gigas*; *Didemnum* sp.)

[WGITMO recognizes that there are numerous risk assessment approaches and that individual countries may choose one method over another. The workshop we propose will help us understand the processes involved and data used in preparing risk assessment approaches that are used by different ICES countries. A summary will be prepared for the annual report. Both Canada and the U.S. should have their risk assessment approaches ready for using one or two species to understand the details of each approach. We propose to ask experts to attend the meeting. This would help to determine which species should be included in a list for consideration of rapid response and complement the Rapid Response Guidelines. IMPASSE will not be adopted by next year, but it will be included in the discussion.]

d) to prepare a draft Alien Species Alert report on *Crassostrea gigas* with the aim of editing and finalizing a report for next year's meeting and develop an outline for an Alien Species Alert report for the Chinese mitten crab *Eriocheir sinensis*;

[Laurence Miossec will lead the effort to develop a report on *Crassostrea gigas*. We will continue to follow developments in the proposed introduction of *C. ariakensis*.]

e) to develop joint projects (e.g. database management, taxonomic experts,) with PICES WG 21 during intersession that furthers cooperation and communication for resources sharing and information on introduced species.

[Based on the outcome of the ICES/PICES meeting in Cambridge, Massachusetts in May 2007, we will identify one or two areas where we can cooperate on joint projects. These may initially be identifying databases, taxonomic experts, and other activities.]

f) To prepare a draft document on the impact of targeted fisheries on non-indigenous species (e.g. king crab, Chinese mitten crab, green crab, Manila clam);

[The request this year to review the impact of targeted fisheries on nonindigenous species was seen as an opportunity to evaluate the effectiveness of the Code of Practice and modified approaches used by countries before deliberately introducing species. We propose to develop this into a document summarizing our findings.]

Annex 1: List of participants at the meeting of WGITMO 2007

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Annex 2: Agenda

Agenda

Working Group on Introductions and Transfers of Marine Organisms

2006/2/ACME/05 The **ICES Working Group on Introduction and Transfers of Marine Organisms (WGITMO)** (Chair: Judith Pederson*, USA) will meet in Dubrovnik, Croatia from 22–23 March 2007 in conjunction with the meeting of the ICES/IOC/IMO Working Group on Ballast and other Ship Vectors (WGBOSV) to:

a) To identify and report on changes in the distribution, population abundance and condition of introduced marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature;

b) consider and report on the utility and content of the National reports (TORs a and b) and the format and publication of the New Species Alerts;

c) synthesise and evaluate National Reports, after intersessionally restructuring the report format to ensure consistency for ease of assessment and to include geographic information (latitude and longitude) for rapid tracking of the spread of invasive species;

d) develop a 5 year summary of National Reports (2003–2007) with the aim to prepare a 25 year summary based on earlier reports at a future meeting (intersessional preparation of draft material is essential),

e) finalize a report for rapid response and control options, including

- invitation of an internationally recognized expert to develop a risk assessment strategy for the rapid response including likelihood of success of eradication, impact of the invasive species on species in the area of introduction and impact of control methods (e.g. chemical eradication) on non-target species and habitat in the receiving environment;
- contribute intersessionally to the database (Excel spreadsheet) for the rapid response account (e.g. case histories);

f) develop Alien Species Alert reports including evaluation of impacts and to increase public awareness. WGITMO suggests preparing intersessionally a Species Alert Report on the Pacific oyster *Crassostrea gigas* with the aim to finalize the report at next years meeting. Other candidate species are the Chinese mitten crab and *Didemnum* sp. (intersessional preparation of draft material is essential);

g) review the impact of targeted fisheries on non-indigenous species (e.g. King crab, Chinese mitten crab, Green crab, Manila clam);

h) consider and respond to the recommendation from ACME to merge in 2008 WGITMO and WGBOSV into a single working group with a broadened mandate for the occurrence and impact of marine invasive and/or pest organisms.

Draft Agenda

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Agenda

Wednesday, March 21, 2007

Joint Meeting with Working Group on Ballast and Other Shipping Vectors

2:00 PM

Introductions and Review of Agenda Items

Anders Jelmert and Judith Pederson will give an overview of the issues relating to the two Terms of Reference (see above).

d) prepare a draft ICES Code of Best Practice for the Management of Ships Hull Fouling;

f) consider and respond to the recommendation from ACME to merge in 2008 WGITMO and WGBOSV into a single working group with a broadened mandate for the occurrence and impact of marine invasive and/or pest organisms.

WGBOSV will report by 2 April 2007 for the attention of ACME.

2:15-3:15 PM

WGBOSV is to prepare a draft ICES Code of Best Practices for the Management of Ships Hull Fouling. This Code of Practices should cover both recreational and commercial vessels, sea chests and other structures that are fouled or may be fouled.

- Discussion of approach, information on policies, regulations (if existing), and new technologies.
- Discussion of case studies.

3:30-5:00 PM (ToR h)

WGITMO and WGBOSV are asked to consider merging into a group with a broadened mandate for the occurrence and impact of marine invasive and/or pest organisms. The WG21 of PICES is a joint working group covering ballast water issues and general marine invasion topics.

- Review topics that are relevant to both Working Groups (SGBOSV and WGITMO)
- Discussion of what are the advantages and disadvantages of meeting a one Working Group
    1. Criteria for making recommendations
    2. What would be the mandate of a merged group?
- Recommendation preparation by group to ACME/ICES

5:00-6:00 PM

WGITMO, WGBOSV and PICES WG21 (introduced species issues working group) will be meeting in May. There will be an opportunity to discuss how we can collaborate and share information, and ways to collaborate.

Adjourn

Dinner with Group

Thursday March 21, 2007

9:00 AM Introductions and logistics

- Brief introductions of participants
- Review of the Terms of Reference
- Review and adoption of the Agenda
- Status of WGITMO/ICES Publications

Undaria Report Status

1. ICES/PICES Collaboration (Pederson; Smith)
    1. PICES Annual Meeting in Yokahoma 2006
    2. PICES Annual Meeting in British Columbia 2007
    3. ICES/PICES meeting in Cambridge, Massachusetts, USA May 24-25, 2007.

Discussion of proposed topics for the joint meeting:

Taxonomy

Data information exchange; data management

Joint ICES/PICES Activities

Lessons learned from Fifth International Conference on Marine Bioinvasions

Ballast Water issues: standards, technologies, alternative exchange zones, outreach

Early Detection/Rapid Response

2. Other meetings, publications, and/or general topics
3. National Reports: Continuing the tradition of 5 minute summaries of relevant new projects, new species or new range expansions, new legislations to prevent introductions (ToR b).
    1. Australia

2. Belgium
3. Canada
4. Estonia
5. Finland
6. France
7. Germany
8. Ireland
9. Italy
10. Netherlands
11. New Zealand
12. Norway
13. Poland
14. Sweden
15. United Kingdom
16. United States of America

10:30-11:00 AM Coffee Break

11:00AM-1:00PM Lunch

- National Report Highlights continued (ToR d)
- Discussion of how we can maximize the impact of our national reports (ToR b,c,d). The following items are part of our discussion. How can we make our efforts more useful to ICES members? To this end we will discuss
    1. who is the audience of our national reports
    2. how can we communicate new found
    3. what is need to ensure accurate taxonomy and verified introductions quickly,
    4. what is needed to communicate risk to neighboring countries
    5. and other relevant issues

1:00-2:15 PM Lunch

2:15-4:00 PM

- Discussion of current five year report and response to developing a 25 year report

    1. Stephan Gollasch: 5 year report

- Discussion of how to present our information from the national reports

    1. Web site
    2. Maps
    3. Fact sheets
    4. Taxonomy
    5. References

4:00-4:30 PM Coffee Break

4:30-6:00 PM (ToR e)

- Working session to develop ideas discussed earlier on presentation of our information on introduced species

Friday March 23, 2007 9:00-10:00 AM

Review of the previous day's discussions.

10:00 PM-12:30 PM

Discussion of new Special Advisory Report (ToR f; e)

Based on the discussions of the previous day,

- The Undaria report was completed in 2006 by Inger Wallentinus, Sweden

- We selected *Crassostrea gigas* as the next Alien Species Alert Report, but because of other bivalve species we may want to revisit how to address other bivalve issues.

    1. Laurence Miossec: *Crassostrea gigas*
    2. Roger Mann: *Crassostrea ariakensis*
    3. Other bivalves of concern, e.g., *Mytilus galloprovincialis; Perna viridis, Mya arenaria;* etc.

- Rapid Response report will be reviewed with incorporated comments from all countries (whether you attend the meeting or not.).

    1. Judith Pederson: Rapid Response Report

- Review Impact of targeted fisheries on non-indigenous species (ToR g)

12:30-1:30 PM Lunch

1:30-3:00 PM Report to OSPAR

In order to provide information for the request from OSPAR, we will review the 10 and 5 year reports, data from ICES Cooperative Research Report No. 280, August 2006 (please review before the meeting), on temperature and circulation patterns. We do not need to summarize species distributions for all species, but should select a few. We will break into small groups to write various sections of the presentation.

3:00-3:20 PM Coffee Break

3:20-5:30 PM

- New Business
- WGITMO recommendations

  Discussion
- Concluding Remarks
- Planning of next meeting (Request from ICES to have meeting in Copenhagen)

Annex 3: Letter to Paul Keiser from WGBOSV and WGITMO Regarding the Request to Consider Merging the two Working Groups

April 12, 2007

Paul Keizer
ICES
H. C. Andersens - Boulevard 44-46
DK-1553
Copenhagen V
Denmark

Dear Paul:

As was requested in the terms of reference for the ICES Working Group on Ballast and Other Shipping Vectors (WGBOSV) and Working Group on Introductions and Transfers of Marine Organisms (WGITMO), the issue of whether we should merge or remain as two separate groups was discussed in a joint session. Although pros and cons were presented for both merging and remaining independent of each other, it was agreed that it would be in the best interest of both groups to remain separate, but continue to meet back to back. There were several main reasons for this:

1. There is a clear, logical distinction between the mandate and activities of each group. WGBOSV work on specifically identified vectors - ballast and hull fouling, whereas WGITMO's work focuses on the aquaculture vector and what happens when an invasive species is found in a water body (no matter what vector is involved) – status of the invasion, potential impacts, options for mitigation and/or eradication, and sharing information with other countries.

2. The future direction of each group is very distinct; and diverging workloads are expected. WGITMO is more concerned with ecological risk assessments, ploidy science, population modelling, documenting the impacts of species and communicating this information with ICES countries. WGBOSV is moving towards technological and engineering studies, with biological input. The somewhat dissimilar expertise needed to address each working group's workload will likely continue into the future. Although interesting synergy might emerge if the Working Groups merged, the sentiment in the groups was that a substantial number of experts will only have time to meet for the most relevant part of the meeting.

3. If groups were merged, but the Terms of Reference were kept the same it would result in a reduction in the amount of "real" work being completed during meetings and intersessionally.

4. The proposed EU legislation on introduction of alien species in aquaculture clearly establishes the need for a specialist group of experts on this issue within ICES (reference **Proposal for a COUNCIL REGULATION concerning use of alien and locally absent species in aquaculture, Number: 10922/7/06,)**:

    - *Article 10*

      Decision period

1. The applicant shall be informed in writing within a reasonable time of the decision to issue or refuse a permit, and in any case shall not be informed later than six months from the date of application, excluding time when an applicant provides additional information if the advisory working group so requests.

2. Member States which are signatories to ICES may request to have applications and risk assessments regarding marine organisms reviewed by ICES prior to the issuing of an opinion by the advisory working group. In such cases an additional period of six months shall be allowed.

WGITMO has and is prepared to continue to serve in that role.

The consensus was that although the groups should remain separate, because of the overlapping membership between the groups it would be logical and cost-efficient to hold back-to-back meetings with one overlapping day in which issues of joint concern could be discussed. The issues of joint concern are vectors, cooperation and communication with PICES Working Group 21 on biological invasions, sharing data and databases, experts, information on invasive species, risk assessment, and implications of ballast water management standards and new technologies to address these standards.

We therefore request that ICES consider our request to remain as two separate working groups, but that we continue to meet back to back with a day of overlap to exchange information and communicate with our colleagues on matters of shared interest.

On behalf of the working group members from the two Working Groups, we submit this letter.

Sincerely yours,

Judith Pederson, WGITMO Chair

Anders Jelmert, WGBOSV Chair

Cc: Hans Lassen, ICES

Adi Kellermann, ICES

Annex 4: OSPAR Report

WGITMO Report to OSPAR report

Judith Pederson[1], Francis Kerckhof[2], Tracy Edwards[3], Stephan Gollasch[4], and Susanna Pakkasmaa[5]

[1]MIT Sea Grant College Program, 292 Main Street, Cambridge, Massachusetts, USA; [2]Management Unit of the North Sea Mathematical Models, Linieregimentsplein, 8400 Oostende, Belgium; [3]Joint Nature Conservation Working group, Dunnet House, 7 Thistle House, AB10 1UZ Aberdeen, UK; [4]GoConsult, Grosse Brunnen Street 61, 22763 Hamburg, Germany; [5]Swedish Board of Fisheries P.O. Box 423, SE-401 26 Gothenburg, Sweden

In addition, to the above the following WGITMO members also contributed comments and references: Jesus Cabal, (Spain) Gordon Copp, (UK) and Adi Kellerman, (ICES, Denmark) provided comments and references.

This document responds to a Term of Reference request to the WGITMO by OSPAR. The request by OSPAR was to identify and report on changes in the distribution, population abundance, and condition of introduced marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature.

Summary:

Currently, papers that identify range expansion, change in reproductive periods, alterations in other life history traits, or other non-native related changes due to climate change are rare in the published literature. Perhaps the best example is *Crassostrea gigas*, which was introduced as aquaculture, but has since become established and is spreading throughout Europe. *Crassostrea gigas* will be the featured Alien Species Alert organism and more information will be available next year. Barnacles are other species for which observational data on range expansion and extended reproductive periods are available from long-term monitoring for both the UK and Belgium. Published reports and sampling data on non-native species found in the Helgoland area that suggest several species are responding to warmer temperatures. However, some of the species listed are considered native or Lusitanian expansions. One fish species was found in the Gulf of Finland and attributed to warmer temperatures. Other papers provide information on species in and around northern Europe, including Iceland. Models of potential range expansion were developed by scientists for the UK and focused on two algae (*Codium* sp. and *Sargassum muticum*) and one barnacle (*Elminius modestus*). These three species are likely to increase their range with increasing temperatures. It is also worth noting that the barnacle *E. modestus* was mentioned in three reports as responding positively to temperature increases and has shown the greatest impact on a native species for which we have data.

Approach:

This document provides a list of some of the many nonindigenous species that are deemed to be established (i.e., they are reproducing in the new location), appear to show range expansion, and/or show changes in reproductive periods over the last several years. The list is compiled from the best professional judgment of the WGITMO attendees at the March 2007 meeting and from some literature reviews.

The published literature is sparse on documented climate change impacts on non-native species. The findings are relatively limited because of limited spatial and long-term sampling. Some barnacles and algae are showing range expansions probably related to warming. In addition, there are several vagrant species that expand ranges but are probably not related to climate change. In reviewing the literature and discussions, two issues emerge that the larger biological community should address. One, there are different interpretations on what are vagrants and what are introduced species with expanding ranges. The range changes of Lusitanian species in particular were interpreted differently by different investigators[4,5,12,13]. In addition, taxonomic accuracy remains a problem.

For this report, there are several caveats regarding the list. The selected species are based, in part, on records provided in our national reports. However, the long term records are incomplete, as some countries may not have reported each year. Thus, some species are overlooked in this process, and other species may have been present in the past but were not recorded, but now may be reported as range expansions. A second caveat is the lack of information on many of the species native range and potential range, i.e. their physiological tolerance that often is greater than their distribution in their native range. The native range for a species is usually limited by physical and biological interactions, but many introduced species face fewer predators, disease and competitors. Thus, the potential range (i.e. the temperature and salinity tolerances) of a species may be greater than the observed native range. A third issue to be addressed is to separate out those species found at the edge of their tolerance range (vagrants) that expand and contract with climate fluctuations. Where known, some of these factors have been taken into account. Where additional sources may be helpful to OSPAR countries, we have included links to other programs.

Species with expanding ranges and changes in reproduction:

The following nonindigenous species are observed to have expanded their range and/or shown changes in their reproductive cycles that may be related to climate change. The list was submitted by members of WGITMO and based selected published references; the numbers refer to the source(s) of information.

ALGAE

Green Alga

Codium fragile[1] Origin: Japan[2,3]	*Codium* sp. (along with *Sargassum muticum* and *Elminius modestus*) show range expansions around the UK under three different projected climate change scenarios (increase in SST between 0.41 to 0.80 °C by 2020, 1.01 to 1.98 °C increase by 2080 and 1.67 to 3.28 °C by 2080), with the most significant expansion under the highest increase scenario. There appears a general northern expansion with increasing severity of scenario.

Brown Alga

Sargassum muticum[1,5,6] Origin: Asia[3]	See comments after *Codium* for information on future scenarios in the UK. This brown alga was reported in 1988 and since then has expanded its range around Helgoland Island.

MOLLUSCS

Gastropods

Crepidula fornicata (L.)[1,5]
Origin: Northwest Atlantic[3]

In the 1870s, the American slipper limpet was accidentally introduced to Europe; is common in low numbers around Helgoland with its northern limit apparently limited by low winter temperatures.

Bivalves

Crassostrea gigas[3]
Origin: Japan[3]

This oyster species reproduces in the wild and is exhibiting an extended reproductive period as observed along the Belgium coast and in German waters.

ARTHROPODS

Barnacles

Megabalanus tintinnalulum[4]
Origin: Cosmopolitan[2]

This species was often transported to Europe as fouling species on ships hulls survives now and is reproducing in the southern North Sea, e.g. Belgium region

Balanus amphitrite[3]
Origin: Pacific[6]

This species is now found outside of artificially heated habitats and has expanded to southern North Sea marinas.

Solidobalanus fallax[4]
Origin: West Africa[4]

This warm water West African species that could be regarded as a vagrant has spread into Europe (viz Lusitanian species are spreading through the English Channel and into the North Sea.

Elminius modestus[1,4,5]
Origin: Australia[7]

This species has demonstrated extended reproductive periods due to warmer sea temperatures. In 1954, this barnacle was first recorded in Helgoland. It competes with S*emibalanus balanoides,* the native intertidal barnacle. Warm winter temperatures appear to favour *E. modestus*, where as severe weather favors *S. balanoides.* Franke and Gutow report that in 2003 after several warm winters *S. balanoides* abundance was about 5% whereas it was 85% of the barnacle cover during cold winters of 1995/96. This species has demonstrated reproductive periods during warmer sea temperatures. See also notes under *Codium* sp.

BRYOZOANS

Bugula neritina[4]
Origin: Unknown[3]

This bryozoan species *Bugula neritina* has a wide spread distribution in Europe; its range may be expanding with warmer temperatures.

FISH

Carassius gibelio[8]
Origin: Asia: Siberia[9]

The Prussian carp, *Carassius gibelio* was observed in the Gulf of Finland as reported in the Finland and Estonia National Reports and other literature[14,15,16]. It is suggested that warm summers favored its appearance.

Over 22 southern species of fish were identified in Icelandic waters based on an ICES CM 2006 report[10]. In the report species were identified as annually recorded species, first time records, and others. Species that are now recorded annually include the twaite shad *Alosa fallax*; mackerel *Scomber scombrus*; sea lamprey *Petromyzon marinus* and garpike *Belone belone*. Nine species are first time records, flounder *Platichthys flesus*, blue shark *Prionace glauca*, violet cuskeel *Brotulotaenia crassa*, blackdevil angler fish *Melanocetus johnsonii*, pink sabertooth *Evermannella balbo*, palebelly searsid *Barbantus curvifrons*, *Lycodes terraenoae, Poromitra megalops,* and *Chaunax suttkusi*. Some of these fish were seen in more than one location or over several years. Other species extending their ranges are the snake pipe fish *Enterlurus aequoreus*, greater fork beard *Phycis blennoides*, and blue antimora *Antimora rostarata.* It is interesting to note that of these only *Chaunax suttkusi*, *Petromyzon marinus*, and *Platichthys flesus* have been recorded as introduced in the WGITMO ICES Ten Year Report 1992-2002.

Other species of barnacles expected in Europe that will survive and eventually spread include: *Balanus reticulatus* and *Balanus trigonus* both of which are warm-water species[4].

Several Lusitanian species have spread into the Eastern Channel into the North Sea (Helgoland region)[5] and are considered indicators of warming; however many of these are considered vagrants[4,11,12,13]. The following are "Lusitanian species" and should be classified as vagrants; red algae *Mastocarpus stellatus*[4] and two crab species *Liocarcinus depurator* and *Diogenes pugilator*[4]. Other species that are identified for this report as possibly expanding their ranges, but not clearly related to climate change include four species of red algae *Asparagopsis armata*, *Antithamnionella ternifolia*, *Bonnemaisonia hamifera*, and *Neosiphonia* (=*Polysiphonia*) *harveyi,* three species of polychaetes *Hydroides dianthus, Hydroides ezoensis,* and *Ficopomatus enigmaticus;* a crab *Eriocheir sinensis*; and a tunicate *Styela clava*[1]. Seven species of amphipods on floating seaweeds were reported in samples taken from 1998–2000, but none appear to have established in the North Sea[4]. The tunicate, *Botrylloides violaceus* is reported to be expanding its range due to warmer temperatures[17].

Sources of Information

[1]Edwards, Tracy, U.K., WGITMO member who contributed comments on available information from the UK. Two UK projects have been identified as relevant to the OSPAR request. These are the Marine Climate Change Impacts Partnership (www.mccip.org.uk) and the MarClim Project (http://www.mba.ac.uk/marclim/index.php?sec=pub). The MCCIP has developed an annual 'scorecard' mechanism to present data collated by the group, which includes climate change in the marine environment. For the 2006 scorecard, impacts of climate change on non-natives were specifically investigated. The scorecard reported that evidence that climate change has affected invasive species is rare (Elliot, 2006). Consequently, the project evaluates the literature to postulate which marine non-native species already present in the UK may be further spread and/or affected by changing water temperatures. Furthermore, the report suggested that, with rising seawater temperatures, introductions of potentially damaging warm-water species may occur. The MarClim project modeled the predicted range extensions of certain marine species resident in the UK, some of which were non-natives, as are noted above.

[2]Algaebase (http://www.algaebase.org/)

[3]ICES Ten Year Summary of National Reports 1992-2002.

[4]Kerckhof, Francis, Belgium, WGITMO member.

[5]Heinz-dieter Franke & Lars Gutow 2004. Long-term changes in the macrozoobenthos around the rocky island of Helgoland (German Bight, North Sea) *Helgol. Mar. Res.* 58:303-310. The paper includes other references.

[6]Carlton, James T. 2003. A check list of introduced and cryptogenic marine and estuarine organisms from Nova Scotia to Long Island Sound, Second Edition, May 19, 2003.

[7]Joint Nature Conservation Working group (http://www.jncc.gov.uk/page-0).

[8]Pakkasmaa, Susanna, Sweden, WGITMO member.

[9]Fishbase (http://www.fishbase.org/search/php).

[10]Astthorsson, O.S. and J. Palsson 2006. New fish records and records of rare southern species in Icelandic water in the warm period 1996-2005. ICES CM 2006/C:20.

[11]Herbert, R.J.H, S.J.Hawkins, M. Sheader, and A.J. Southward 2003. Range extension and reproduction of the barnacle B*alanus perforatus* in the Easter English Channel. *J. Mar. Biol. Ass. U.K.* 83:72-82.

[12]Southward, A.J., K. Hiscock, F. Kerckhof, J. Moyse, and A.S. Elfimov. 2004. Habitat and distribution of the warm-water barnacle *Solidobalanus fallax* (Crustacea:Cirripedia). *J. Mar. Biol. Ass. U.K.* 84:4734/1-9.

[13]Hiscock, K., Southward, A.J., Tittley, I. & Hawkins, S.J., 2004. Effects of changing temperature on benthic marine life in Britain and Ireland. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **14**, 333-362.

[14]Copp G. H., P. G. Bianco, N. G. Bogutskaya, T. Eros, I. Falka, M. T. Ferreira, M. G. Fox, J. Freyhof, R. E. Gozlan, J. Grabowska, V. Kovac, R. Moreno-Amich, A. M. Naseka, M. Penaz, M. Povz, M. Przybylski, M. Robillard, I. C. Russell, S. Stakenas, S. Sumer, A. Vila-Gispert, and C. Wiesner 2005. To be, or not to be, a non-native freshwater fish? *J. Appl. Ichthyol.* 21 (2005), 242–262

[15]Vetemaa M.J., R. Eschbaum, A. Albert, and T. Saat 2005. Distribution, sex ratio and growth of Carassius gibelio (Bloch) in coastal and inland waters of Estonia (north-eastern Baltic Sea) By M. *J. Appl. Ichthyol.* 21 (2005), 287–291

[16]Zoologisk Museum og Danmarks 2007. S*tatus for Atlas over danske ferskvandsfisk,* Fiskeriundersøgelser Forår.

[17] Stachowicz, J.J., Terwin, J.R., Whitlatch, R.B., Osman, R.W., 2002. Linking climate change and biological invasions: ocean warming facilitates nonindigenous species invasions. *Proceedings of the National Academy of Sciences of the United States of America* 99:15497–15500.

Annex 5: National Reports

NATIONAL REPORT Australia, 2006

Prepared by: Invasive Marine Species Program, Australian Government Department of Agriculture, Fisheries and Forestry

Highlights

- Currently, Australia is considering legislative changes required to give effect to the International Convention for the Control and Management of Ships' Ballast Water and Sediments. These changes will also require the management of ballast water between Australian domestic ports. These changes are expected to be completed by July 2008.
- Australia is also developing legislation and best practice management guidelines to control biofouling. Legislation to control biofouling will be implemented through the *Quarantine Act 1908* from mid-2007.
- Asian green mussel (*Perna viridis*) was detected during an inspection on a dredge vessel at Dampier Port, Western Australia in November 2006. In response to the detection, the vessel was sent to Singapore where fouling was removed by heat treatment and physical removal.
- In November 2006, three specimens of New Zealand green lipped mussel (*Perna canaliculus*) were found on a vessel in dry dock. Survey work is being undertaken at Port Kembla and Westernport to determine the status of the species.
- In July 2006, visual surveys of seven foreign fishing vessels (FFVs) conducted by divers had detected black-striped mussel (*Mytilopsis sallei*) and Asian green mussel (*Perna viridis*). The FFVs were apprehended and escorted to Darwin Harbour for have the hulls treated to kill the mussels
- *Grateloupia turuturu* has been collected from the Bicheno area of eastern Tasmania.

1.0 Laws and regulations

Since 2001 the Australian Government, through the *Quarantine Act 1908*, has regulated internationally sourced ballast water coming into Australian territorial waters. The requirements ensure that foreign ballast water is managed appropriately before permitting its discharge with Australia's territorial sea. The Australian Quarantine and Inspection Service administer these requirements.

Currently, Australia is considering legislative changes required to give effect to the International Convention for the Control and Management of Ships' Ballast Water and Sediments. These changes will also require the management of ballast water between Australian domestic ports. These changes are expected to be completed by July 2008.

Australia is also developing legislation and best practice management guidelines to control biofouling. Legislation to control biofouling will be implemented through the *Quarantine Act 1908* from mid-2007. National best practice management guidelines have been finalised for:

- Commercial non-trading vessels;
- Commercial vessels;
- Commercial trading ports;
- Boat harbours, marinas and boat maintenance facilitates;
- Abandoned, unseaworthy and poorly maintained vessels;

- Domestic recreational vessels;
- Domestic commercial fishing vessels; and
- Apprehended and international vessels less than 25 metres in length.

National best practice management guidelines for the aquaculture and petroleum industries are still being finalised.

2.0 Deliberate releases and planned introductions

2.1 Fish

No deliberate releases or planned introductions known.

2.2 Invertebrates

No deliberate releases or planned introductions known.

2.3 Algae & higher plants

No deliberate releases or planned introductions known.

3.0 Accidental introductions and transfers

3.1 Fish

No accidental introductions or transfers are known.

3.2 Invertebrates

Asian green mussels (*Perna viridis*) were detected during an inspection on a dredge vessel at Dampier Port, Western Australia in November 2006. In response to the detection, the vessel was sent to Singapore where fouling was removed by heat treatment and physical removal. Targeted surveillance occurred in areas exposed to risk and inspection of the vessel occurred every 4 weeks while it operated in Western Australian waters. Prior to arrival in Western Australia, the vessel had previously operated at two Queensland locations: Weipa, where it first entered Australia; and, the Brisbane River. The vessel also stopped at Gladstone for refuelling on route from Queensland to Western Australia. Preliminary investigations for Asian green mussel were undertaken at Weipa, Brisbane and Gladstone. No Asian green mussels were found. Queensland is preparing a 12 month active monitoring program for Asian green mussel, using a risk based approach to monitor at the ports of Weipa, Brisbane and Gladstone.

In November 2006, three specimens of New Zealand green lipped mussel (*Perna canaliculus*) were found on a vessel in dry dock. The main trading route of the vessel is between Port Kembla in New South Wales and the Port of Hastings in Westernport Bay, Victoria. Survey work is being undertaken at Port Kembla and Westernport. Hard mooring, ropes deployed at the Port of Hastings and port structures, including floating structures around the port, will be surveyed for *P. canaliculus* in February 2007. Targeted searches for *P. canaliculus* in Port Kembla in January found no *P. canaliculus*. Data from an ongoing study sampling fouling organisms in Port Kembla for the last two years has also been reviewed, including the sampling of fixed and floating settlement plates at the wharf where the vessel normally operates, and has not reported any findings of *P. canaliculus*. Additional ropes and existing settlement panels will be examined for *P. canaliculus* periodically over a period of 8 months (commencing January 2007).

In July 2006, seven foreign fishing vessels (FFVs) were apprehended and escorted into Darwin *Harbour*. Visual survey of the FFVs was conducted by divers and black-striped

mussel (*Mytilopsis sallei*) and Asian green mussel (*Perna viridis*) were detected. A 'skirt' was used to surround the vessel hulls and house a chemical treatment to kill the mussels – a solution of sodium hypochlorite, which was applied at high concentrations, to kill mussels.

3.3 Algae and higher plants

Grateloupia turuturu has been collected from the Bicheno area of eastern Tasmania (Saunders & Withall 2006).

3.4 Parasites, pathogens and other disease agents

No accidental introductions or transfers are known.

4.0 Live imports

During the period 2006/07, no marine species were imported live into Australia for the purposes of release into open water or were imported directly for consumption that could have been released into the marine environment.

4.1 Fish

No information available.

4.2 Invertebrates

No information available.

4.3 Algae and higher plants

No information available.

5.0 Live exports

5.1 Fish

No information available.

5.2 Invertebrates

No information available.

5.3 Algae and higher plants

No information available.

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NATIONAL REPORT Belgium, 2006

Prepared by: F. Kerckhof, MUMM/BMM

Highlights

- During 2006, two new invasive species, namely the Asian shore crab *Hemigrapsus sanguineus* and the brackish water clam *Rangia cuneata* (Atlantic Rangia) have been recorded. When discovered both species had already formed well-established populations.
- All introduced species that were reported during previous years are still present and seem to be well-established and thriving.

1.0 Laws and regulations

There is no new legislation to report.

2.0 Deliberate releases

2.1 Fish

A private company, the N.V. Joosen-Luyckx Aqua Bio in Turnhout, is still cultivating 6 species of sturgeons, including *Acipenser baeri* (Siberian sturgeon), *A. gueldenstaedti* (Russian sturgeon, Osietra) and *A. ruthenus* (sterlet). The firm uses *A. baeri* for the production of caviar (Royal Belgian Caviar). Research is ongoing on the production of caviar from other species and some species are cultivated for ornamental use. The sturgeons grow to mature fish in ponds and the firm controls the complete fish-breeding cycle from egg to mature animal.

3.0 Accidental introductions and transfers

3.2 Invertebrates

Rapana venosa: This species has been found in the southern North Sea twice in 2005 (Kerckhof *et al.*, 2006). An alerting campaign has begun however there have been no new records of this species.

Mytilopsis leucophaeata (=*Congeria cochleata*): This species has long been present in the port of Antwerpen, causing nuisance by the obstruction of water intake pipes of some chemical plants. A Ph.D. study aiming to find a possible biological control of the problems caused by this species was recently finished at the University of Gent (Verween, 2007).

Rangia cuneata: A vast population of this estuarine bivalve is present in the port of Antwerpen. This species is new to the European brackish water fauna.

After initially finding only a few small individuals in August 2005, *R. cuneata* was frequently encountered in the pipes of the cooling water system of an industrial plant from February 2006 onwards (Verween *et al.*, 2006).

However, the species was already present in the Antwerp harbour region. Empty specimens and loose valves had previously been collected – but not reported – in February 2001 on the banks of the Verrebroekdok, a large container dock with a Ro-Ro terminal. The species is very abundant in the Verrebroekdok and has been sampled through the subsequent years. In April 2004 juveniles were found (F. Jacobs pers. comm.)

Before the Belgian records, *R. cuneata* was only known from the Gulf of Mexico and the Atlantic coast of North America.

Crassostrea gigas: Due to the warm summer temperatures, spawning and settlement was almost 4 weeks earlier than in other years, allowing young oysters to grow to a large size before winter.

Young pacific oysters are colonising novel subtidal substrates, even on more sandy substrates, such as living wedge shells (*Donax vittatus*) and empty shells of, amongst others, *Ensis directus*. Although the currents and wave action along Belgian beaches are strong and thus prevent the rapid forming of oyster reefs, continuous large spat falls could, over time, result in the forming of reefs in the more sandy areas of the Belgian shallow littoral zone.

Caprella mutica: This species was first recorded in 1998 when it was present on several buoys marking the entrance to the harbour of Zeebrugge. The species is abundant in the Zeebrugge marina and outer harbour and on buoys in the wider area around the Zeebrugge.

Megabalanus coccopoma: This species proved to be already present on buoys off the Dutch coast (off Terschelling) in 1976 and 1977 but was apparently not properly recognised. From 1997 *onwards* this species has been found each year in the southern bight of the North Sea, mainly on buoys but also on floating objects and even in the littoral zone. The continuous and increasing findings along the Belgian and Dutch coast prove that it is well established in this region of the North Sea. The related species *M. tintinnabulum* is also regularly observed on buoys off the Belgian coast. Both species are striking because they grow very fast and to a very large size.

Hemigrapsus penicillatus/H. takanoi. This species was recorded for the first time from the coasts of Belgium *and* Northern France in 2003. The so-called pencil-crab is now very abundant, especially in estuaries and harbour areas for instance amongst reefs of pacific oysters *Crassostrea gigas* but also between stones of the groyns. During 2006 several specimens were trawled off Oostende indicating that this species is probably not restricted to littoral artificial substrates anymore.

Hemigrapsus sanguineus: Not recorded until 2005, although it was looked for. In July 2006 two adult specimens of *H. sanguineus* were found at Knokke-Heist. During subsequent searches no more specimens were found (d'Udekem d'Acoz, 2006). However, in August and September 2006 specimens of *H. sanguineus* were also found at Nieuwpoort (Nuyten *et al.*, 2006). It appears that a population occurs between the stones of the salt water spray zone of the groyns at Nieuwpoort Beach but also along the hard banks of the river IJzer near the VVW marina.

This species could become a competitor for the indigenous shore crab *Carcinus maenas.*

Callinectes sapidus: During 2006 there were again several records of this species from the Belgian coast. Between July 28th and October 4th at least 7 specimens were brought in by coastal shrimp fishers, all females including several individuals carrying eggs. From contacts with fishermen it became clear that more specimens of this conspicuous and aggressive crab were fished. *Callinectes*, like the Chinese mitten crab, is a migratory species moving to salt water to reproduce, raising the question where these specimens originate from and whether there might exist somewhere a (small?) resident population, for example in one of the ports or estuaries along the southern North Sea coast, for example.

Palaemon macrodactylus: This Asian shrimp was first identified from Zeebrugge, were it was fished on 12 June 2004 between the epiflora and epifauna of the pontoons of the marina (d'Udecem d'Acoz *et al.*, 2005), where it also was present during 2005 and 2006.

Mnemiopsis leidyi: Although there are several reports of the recent occurrence of this comb jelly in Europe, *Mnemiopis* has not yet been reported from Belgian waters, but the species is looked for.

3.3 Algae and higher plants

Phytoplankton

Coscinodiscus wailesii: On February 27th 2006 there was a massive algae bloom off Oostende. Samples revealed that it almost solely consisted of the diatom *C. wailesii*. The status of the species in Belgian waters remains somewhat unclear and records of this species are rather scarce. Phytoplankton samples in Belgian waters are only taken on an irregular base and often later in the year, thus the presence of this species may be missed.

Macroalgae

Undaria pinnatifida: After the first record in 1999, this species is still present in the marina of Zeebrugge, but apparently not spreading.

Polysiphona senticulosa: This red alga was first recorded in March 2001 from the Spuikom in Oostende where it also was present in 2002. During the subsequent years it was not been found until March 16, 2006 when *P. senticulosa* was again very abundant.

Sargassum muticum: A large population of this large brown alga has recently been discovered in the inner port region of Zeebrugge, were it forms a large belt, just below the waterline, all along the banks of the salt water channel leading to Brugge.

In the Spuikom of Oostende the species was again obviously present.

4.0 Live imports

In Belgium there is a lot of uncontrolled import and export of a wide variety of marine and fresh water species - for research, human consumption, aquaculture and aquariums. It is almost impossible to obtain figures on quantities or on origin. For example, around Christmas, live pacific oysters form the Mediterranean were for sale in the supermarkets, with avifaunal barnacles *B. trigonus* apparently still alive.

5.0 Meetings, conferences, symposia or workshops on introductions and transfers

The Belgian Forum on Invasive Species

The Belgian Forum on Invasive Species (BFIS) is an informal structure animated by the Belgian Biodiversity Platform where scientists interested in biological invasions are involved. It encourages interdisciplinary cooperation among scientists and favours information exchange and dissemination as a support to develop measures dedicated to the prevention and the mitigation of the impacts of invasive species. The BFIS is responsible for preparing and updating the reference list of alien species invading terrestrial, freshwater and marine ecosystems in Belgium, with a focus on organisms causing a strong detrimental impact on native biodiversity. BFIS is the national node of the IUCN Invasive Species Specialist Group. It supports activities of the Belgian contact group on invasive species.

6.1 Past meetings

SOS Invasions, a scientific workshop and open conference on IAS in Belgium took place in Brussels on 9 and 10 March. The abstracts and presentations, including the presentation "Exotic invasive animals in the marine ecosystem: the situation in Belgian waters" are available on the Web through http://rivendell.vub.ac.be/conferences/2006-sos_invasions/EN/intro_en.htm

6.2 Programs in progress

The Harmonia information system

Harmonia is an information system dedicated to non-native invasive species in Belgium. It is an initiative of the Belgian Forum on Invasive Species (BFIS). This system aims at gathering knowledge about species that are invasive in Belgium at present and those that may in the future become invasive and are already present in neighbour countries (early warning system).

The database aims to cover marine, freshwater and terrestrial environments as well as a wide range of taxonomical groups, with a focus on those that pose a threat for native biodiversity (but today, it is still restricted to vascular plants and vertebrates). Collected information focuses on naturalization in Belgium/Europe, reproduction in the wild, introduction pathways, preferred habitats, as well as different kinds of impacts on native biodiversity and ecosystems. As far as possible, references from the scientific literature are linked to this information. On this basis, exotic species are allocated to different lists or risk categories, to be used for elaborating control strategies and undertaking concrete actions in the field.

A beta version of the system is actually being tested and Harmonia will be launched on the Internet in the near future.

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FIRST RECORDS FROM BELGIUM 2006

Species	Locality	Latitude	longtitude	comments	date
Rangia cuneata (Mollusca ,Bvialvia)	Antwerpen, harbour	51°21.37 N	4°17.3 E	Established	2005
	Antwerpen, harbour	51°16.00 N	4°12.5 E	Established	>2001
Hemigrapsus sanguineus (Curstacea, decapoda)	Belgian coast, Heist	51°20.5 N	003°17.00 E	Established?	21vii2006
		51°21.00 N	003°16.00 E	Established?	20vii2006
	Belgian coast, Nieuwpoort	51°09.12 N	002°43.00 E	Established	03 & 08ix2006

NATIONAL REPORT Canada, 2006

Complied by: Amy Williams

Highlights

- While a number of activities and introductions are described in this report, these are primarily updates on issues reported in past years. Canada continues to import a range of organisms for aquaculture as described in this report. The pattern of these imports is much the same as in past years, and no new activities were reported in 2006 that would raise particular concerns with respect to risks to aquatic resources.
- Tunicates, which have invaded Prince Edward Island waters, continue to affect the shellfish aquaculture industry by fouling production facilities and increasing the costs of harvest and cleaning. The affected region has introduced measures to contain the organisms, and other regions are monitoring for possible, natural spread.
- Viral hemorrhagic septicemia (VHS) was discovered in the Great Lakes region in late 2006. The Ontario and Canadian governments are working together to better understand the significance of the increased observations of VHS in various fish species. Border controls have been put in place pending these investigations.
- In April, Department of Fisheries and Oceans (DFO) officially launched its Centre for Expertise in Aquatic Risk Assessment (CEARA). CEARA is mandated to develop a national standard for conducting biological risk assessments of aquatic invasive species; to educate practitioners on the risk assessment process; to develop a process for prioritizing risk assessment needs; to provide advice to headquarters; and to coordinate and track progress of national risk assessments and ensure that deliverables are met. To date CEARA has completed two risk assessments – one on five species of Asian carp, and one on northern snakehead (*C. argus*). Their 2007 work plan includes completing risk assessments on five species of tunicates, Ponto-Caspian fishes to the great lakes, and national pathways for aquarium fish, live fish for food, water garden fish and baitfish.

1.0 Laws and regulations

In December 2006, an Act was tabled to modernize the *Fisheries Act*. The bill is currently awaiting second reading, during which the contents will be debated in the House of Commons. The revised *Fisheries Act* provides new authorities for managing aquatic invasive species. Respecting regulations, these new provisions would allow Department of Fisheries and Oceans (DFO) to manage all challenges (within its mandate) in cooperation with the provinces with respect to aquatic invasive species. These amendments would promote the implementation of the Aquatic Invasive Species Action Plan approved by the Canadian Council of Fisheries and Aquaculture Ministers.

Supporting the creation of the National Aquatic Animal Health Program (NAAHP) and associated changes to regulations under the Health of Animals Act (HAA), a Steering Working group has been formed between DFO, CFIA and representatives of the ITC's to look at how to integrate CFIA into existing I &T activities, in particular the risk assessment process. The goal of this working group is to develop a delivery framework to provide cohesive and effective control of introductions and transfers of live aquatic animals into and within Canada that are safe, sustainable, and beneficial, while ensuring that there are no gaps or overlap.

Canadian Ballast Water Control and Management Regulations were ratified in June 2006 (http://canadagazette.gc.ca/partII/2006/20060628/html/sor129-e.html).

2.0 Deliberate releases and planned introductions

2.1 Finfish

Pacific region

Approximately 11 million sockeye (*Oncorhynchus nerka*) fry were returned to systems in northern British Columbia (Tahltan Lake, Tuya Lake, Tatsamenie Lake and Trapper Lake) after initial incubation in an isolation unit at an Alaskan Hatchery. The projects must meet the requirements of the Canadian Fish Health Protection Regulations.

Atlantic region (including Quebec)

a) a) In Prince Edward Island (PEI), approximately 1300 Atlantic salmon fry (*Salmo salar*) were released for enhancement of native stocks.

b) In Newfoundland (NL), 100,000 brook trout fry (*Salvelinus fontinalis*) were stocked into Star Lake as part of the Star Lake Fish Compensation Program to compensate for loss of productive fish habitat associated with the Star Lake hydroelectricity generation project; Brook trout and ouananiche (landlocked *Salmo salar*) were transferred from three ponds in central NL to East Pond Brook and Harpoon Brook as part of a habitat compensation program associated with the a mine development project; and the Fish Friends Program released wild Atlantic salmon fry into miscellaneous rivers.

c) In New Brunswick (NB), Atlantic salmon and Brook trout were released into various rivers for enhancement purposes.

d) In Nova Scotia (NS), Speckled trout (*Salvelinus fontinalis)*, Rainbow trout (*Oncorhynchus mykiss)*, and Brown trout (*Salmo trutta)* were released into various rivers as part of the spring stocking program.

2.2 Invertebrates

Pacific region

No releases recorded.

Atlantic region (Including Quebec)

a) In NL, 600 mussels (*Mytilus sp.)* from Voisey Bay were transferred to other areas within Voisey's Bay in fulfillment of environmental effects monitoring regulatory obligations associated with the Voisey's Bay mine development; and 49 kg of blue mussels were transferred from a licensed aquaculture facility to 6 research sites in Long Harbour and Placentia Bay as part of a contaminated site evaluation program.

b) In southwest NB, Soft shell clams (*Mya arenaria)* were released into to the Eastern Charlotte waterways in for enhancement purposes.

3.0 Accidental introductions and transfers and information on the spread of previously accidentally introduced species

3.1 Finfish

Pacific Region

The recent illegal introductions of alien fish into water bodies within British Columbia have created considerable concern. While many of these fish are considered to be valuable sport and commercial fish in other parts of Canada, in British Columbia, yellow perch (*Perca flavescens*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*Micropterus salmonides*), pumpkinseed (*Lepomis gibbosus*), walleye (*Stizostedion vitreum*), black crappie (*Pomoxis nigromaculatus*), brown bullhead (*Ictaluris nubulosus*), carp (*Cyrinus carpio*) and

northern pike (*Esox lucius*) are all considered to be alien invasive species, competitors, and predators on native fish species.

Atlantic Region (Including Quebec)

One brown bullhead (*Ictalurus nebulosus*), a non-native species to the waters of NL and previously unreported, was angled from a natural water body in 2006. It is unknown at this time what the potential implications of this will be, as no other individuals have been discovered.

3.2 Invertebrates

Pacific Region

a) Pacific oysters (*Crassostrea gigas*) are an intentionally introduced species starting in the early 1900s. Manila clams (*Venerupis philippinarum*) accidentally accompanied these early introductions. Both are commercially important species now and they continue to be imported. Distribution of Manila clams and Pacific oysters appear to be stable. Manila clams are found throughout southern British Columbia and in the central coast to approximately 53°N. Pacific oysters are confined to the Strait of Georgia, Desolation Sound, Discovery Passage and the west coast of Vancouver Island north to Brooks Peninsula (approximately 50°N). Both species are limited by minimum temperature thresholds, so projected increasing trends in ocean temperature may allow opportunities to establish more northern populations, particularly as increasing aquaculture activities provide potential brood stock in northern British Columbia.

b) Varnish clams (*Nuttallia obscurata*) populations continue to increase in size in areas where they have become established. A single pair of valves found north of Vancouver Island in Rivers Inlet suggests that this species will continue to disperse northward in British Columbia.

c) Green mussels (*Musculista senhousia*) were found at two new localities. This species has been reported from several localities in the Strait of Georgia since the 1990s; the new records suggest that the species' range is continuing to expand in British Columbia.

d) European flat oysters (*Ostrea edulis*) were collected attached to hard substrate in Useless Inlet and Joes Bay in Barkley Sound; this is the first confirmation of successful reproduction and settlement in British Columbia. This species is cultured in British Columbia, and collection of unattached single oysters in Esperanza Inlet in 2006 were traced back to deliberate stocking in 1991 and subsequent human-mediated movement of adult oysters.

e) A previously unreported population of Japanese oyster drills (*Ocinebrellus inornata*) was discovered from the west coast of Vancouver Island. The drills may have been established for some time, as this is also a site of early Pacific oyster introductions.

f) Japanese mudflat snails (*Batillaria attramentaria*) were found at two new localities, both of which have long histories of Pacific oyster (*Crassostrea gigas*) culture.

g) In 2006, trap surveys for green crab (*Carcinus maenas*) were completed on the west coast of Vancouver Island and in Desolation Sound, Discovery Passage and Johnstone Strait. A total of 388 green crabs were collected from beaches in Barkley, Clayoquot, Nootka and Kyuquot Sounds and Esperanza Inlet. No green crabs were found on the East side of Vancouver Island. Length frequencies suggested at least three year classes were present which indicates that local recruitment has occurred. These populations could serve as sources of larvae which could result in continued northward expansion of green crab in British Columbia in years of strong northward current transport.

h) h) Recently there has been concern both from fisheries agencies as well as the public about the appearance of *Mytilus galloprovincialis* mussels in some harbour areas of BC.

i) During surveys of aquaculture facilities, intertidal habitats and subtidal settlement plates several species of invasive tunicates were discovered to be widespread along the coastline of British Columbia. Two colonial species (the golden star tunicate, *Botryllus schlosseri;* and the violet tunicate, *Botrylloides violaceus*) were discovered in several locations along the Strait of Georgia and the west coast of Vancouver Island. An isolated find of violet tunicates in the northern Queen Charlotte sound, indicates a potential for future dispersal. The clubbed tunicate (*Styela clava*) has been found in multiple locations along the Juan de Fuca Strait and the Strait of Georgia. *Didemnum* sp. was also recorded at several sites along the Strait of Georgia. At the current stage of research it is difficult to assess the invasion process in BC waters, as only two years of monitoring is available. Considering some potential reports for several of these species are as far north as Alaska and as far south as California, it seems likely that most of the BC coastline is potential suitable habitat. Current research within the Department of Fisheries and Oceans is developing a national risk assessment for all these species of tunicates, part of which will be a prediction of suitable habitat along the BC coastline.

Quebec Region

a) A new species of tunicate [golden star tunicate (*Botryllus schlosseri*)] was reported in Havre-aux-Maisons lagoon, Magdalen Islands for the first time in 2006.

b) The bryozoan *Membranipora membranacea* was discovered in the Baie des Chaleurs. This species was detected on kelp produced for aquaculture experiments that were completely decimated. This species was also found on wild kelp around the experimental site. The long-term impact of this bryozoan on wild populations is unknown.

c) New catches (11 individuals) of green crab (*Carcinus maenas*) were made in the Magdalen Islands in the Baie du Bassin. This species, first reported in 2004, was not seen in 2005.

d) *Codium* was observed in new areas of the Magdalen Islands in Havre-aux-Maisons lagoon, at Pointe-Basse, along the Dune du sud, in Havre-aux-Basques Bay and in the Baie du Bassin.

e) Work continued on the caprellid *Caprella mutica*, a new species originating from Asia and detected for the first time in 2003 in the Baie des Chaleurs and in 2005 in the Magdalen Islands. The caprellids infect mussel structures and the impact of their presence is not yet known on mussel farming.

f) Work has begun to identify the origin of the Chinese mitten crabs (*Eriochier sinensis*) found in the St. Lawrence through genetic studies. In addition, a female specimen was found for the first time in the St. Lawrence estuary.

Atlantic xRegion

a) PEI tunicate update: In response to direction from the PEI Aquatic Invasive Species Steering Working group (AISSC) a total of 18 bays and estuaries were monitored during the 2006 field season. This resulted in 110 individual sites being checked and the subsequent confirmation of new tunicate species in 9 different bays; more than one new species was confirmed in some bays. The level and range of new infestations, as well as those pre-existing infestations, were determined through dive surveys, eel grass surveys and checks of collector plates. Range and (in some cases) the level of infestation within monitored areas increased during the 2006 field season. The information obtained from these surveys was communicated to the aquaculture and shellfish industries. The information was used by the PEI I&T working group to assist in management decisions and shared with I&T working groups in NS and NB, on request.

b) An invasive tunicate species, golden star tunicate, *Botryllus schlosseri*, was identified in two locations in NL as part of an invasive species monitoring program.

3.4 Parasites, pathogens and other disease organisms

Pacific Region

No additional information available on the spread or lack of spread of the 2004 finding of the protozoan parasite, *Bonamia ostreae* in imported European flat oysters, *Ostrea edulis*.

Great Lakes

Viral hemorrhagic septicemia (VHS) was been discovered in fish from the lower Great Lakes. The disease was first found in Ontario in association with a die off of freshwater drum in April 2005 in the Bay of Quinte on Lake Ontario. VHS was also found in yellow perch, muskellunge and round gobies that died off in 2005 and 2006. VHS has since been found in many species of fish from lakes St. Clair, Erie and Ontario as well as from the Detroit, Niagara and St. Lawrence rivers. Most recently (2007) it has been discovered in northern Lake Huron.

The Ontario and Canadian governments are working together to better understand the significance of the increased observations of VHS in various fish species. In January, 2007, Ontario enacted interim restrictions on the transfer of live bait fish to control the potential spread of VHS from the lower Great Lakes to inland waters further north. Other potential vectors, including the live food fish industry, the aquaculture industry, etc., are also being examined.

The Ontario Ministry of Natural Resources, Ministry of Agriculture and Food, the Department of Fisheries and Oceans, and the Canadian Food Inspection Agency are working together to develop a comprehensive approach that will address live fish transfers within Ontario. This strategy will be announced in the spring of 2007.

4.0 Live imports

Importations *of Finfish and Shellfish*

Note: *Country* of origin is given in brackets.

Pacific Region

International Imports

The pattern of importation matches that of previous years including the importation of Carp (Koi only) (various locations), Dolly Varden (*Salvelinus malma)*, Dace (*Phoxinus* sp.), Rainbow trout (*Oncorhynchus mykiss),* Bull trout (*Salvelinus confluentus*), and Tilapia (*Oreochromis niloticus*), Manila clam (*Venerupis philippinarum)*, Cockles (*Clinocardium nuttallii)*, Blue mussels (*Mytilus* sp.), Pacific oyster (*Crassostrea gigas)*, Atlantic oyster (*C. virginica)*, Kumamoto oyster *(C. sikamea*) and Sea squirt (*Ciona intestinalis*) all from the USA (although the originating source may be elsewhere).

The Canadian Food Inspection Agency together with the Department of Fisheries and Oceans are evaluating the risks of importing Pacific oysters, *Crassostrea gigas* from Guernsey.

Domestic Transfers

Information not available

Atlantic Region (Including Quebec)

International Imports

PEI imported Rainbow trout from Washington, USA.

NB imported Atlantic salmon, Atlantic cod, soft shell clams and water fleas from the USA; and water fleas from Australia.

NS imported Rainbow trout, Atlantic salmon and Zebra fish from the USA; and Atlantic abalone from Iceland.

NL imported Atlantic salmon eggs from the USA.

Domestic Transfers

Atlantic halibut (*Hippoglossus hippoglossus),* Spotted wolffish *(Anarhichas minor*), winter skate *(Raja ocellata),* Rainbow trout *(Oncorhynchus mykiss*), Atlantic salmon (*Salmo salar*), Artic Charr (*Salvelinus alpinus*), Speckled trout (*Salvelinus fontinalis)*, Lake whitefish, American eel, Atlantic whitefish, Atlantic cod, Brook trout, Quahog (*Mercenaria mercenaria*), Sea scallop (*Plactopecten magellanicus*), Icelandic scallop (*Chlamys islandica*), Bay scallop (*Aequipecten irradians concentricus*), American oyster (*Crassostrea virginica*), Mussel (*Mytilus* sp.), Blue mussel (*Mytilus edulis*), Clam, Blade kelp *(*Laminariales [note genus (e.g. *Laminaria*) names have changed]*),* Sea Lice, Lobster *(Homarus americanus*).

5.0 International exports

(Require health certification only)

CANADA	TO	SPECIES	STAGE
Pacific	Italy	King salmon	Adults for human consumption
	UK	Black cod	Adults for human consumption
	Belgium	Atlantic salmon	Adults for human consumption
	Switzerland	Arctic char	Eggs
	France	Coho salmon	Adults for human consumption
	Italy	Arctic char	Eggs
	Germany	Coho salmon	Adults for human consumption
	Slovenia	Arctic char	Eggs
	France	Arctic char	Eggs
	Austria	Arctic char	Eggs
	England	Arctic char	Eggs
	Germany	Arctic char	Eggs
	Macedonia	Arctic char	Eggs
Atlantic	Germany	Atlantic sturgeon	Eggs and adult
	Poland	Atlantic sturgeon	Eggs
	Saint-Pierre-et-Miquelon (rance)	Scallop	Spat
	Saint-Pierre-et-Miquelon (France)	American oysters	adults
	Ireland	Atlantic salmon	Eggs

(Source: DFO National Registry)

Pacific Region

Live exports for aquarium trade:

Cabezon (*Scorpaenichthies marmoratus),* copper rockfish (*Sebastes caurinus),* kelp greenlings (*Hexagrammos decagramus),* silverspot sculpin (*Blepsias cirrhosus),* kelp perch (*Brachyistius frenatus),* tidepool sculpins (*Oligocottus maculosus),* mosshead warbonnet (*Chirolophis nugatory),* northern clingfish (*Gobiesox meandricus),* leather star (*Dermasterias imbricata),* tube worm cluster (*Eudistylia vancouverii),* blood star (*Henricia leviuscula),* vermilion stars (*Mediaster aequalis),* spiny star (*Hippasterias spinosa),* orange sea pen (*Ptilosarchus gurneyi),* Giant Pacific octopus (*Enteroctopus dofleini),* painted star (*Orthasterias koehleri),* sunflower star (*Picnopodia helianthoides).*

6.0 Upcoming meetings

Annual meeting of the I &T chairpersons was held in Quebec City in October 2006.

An Introductions and Transfers Risk Assessment Workshop was held in Toronto in March, 2007.

Second International Invasive Sea Squirt Conference scheduled for 2-4 October 2007 on Prince Edward Island, Canada.

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NATIONAL REPORT Croatia, 2006

Prepared by: Josip Mikuš, Marijana Pećarević and Ana Bratoš Cetinić

Highlights

- In summer 2005 several specimens of *Lappanella fasciata* (Cocco, 1833) (Labridae) were observed in the southeastern part of the island of Sušac (Cape Trišćavac). This represents the first confirmed records of *L. fasciata* for the entire Adriatic Sea.
- The Atlantic lumpsucker *Cyclopterus lumpus* (L., 1758) (343 mm of total length) was recorded for the first time in the Mediterranean Sea. This record may be a case of a vagrant specimen.
- More then 127 specimens of the bivalve mollusc *Idas simpsoni* (Marshall, 1900) were collected from the skull of a fin whale *Balaenoptera physalus*. (L. 1758). This is first finding of *I. simpsoni* in the Adriatic Sea.
- *Ficopotamus enigmaticus* (Fauvel, 1922) (Polychaeta, Serpulidae) was recorded for the first time in the Bay of Šibenik (Middle Adriatic) in 2006. A possible vector of introduction is ships transporting stone from Middle Dalmatia.
- Occurrence of blue crab *Callinectes sapidus* (Rathbun, 1896) in the southern part of the Eastern Adriatic Coast was first recorded in the mouth of Neretva River and Mali Ston Bay.
- During the 5th Working Group Meeting on Invasive Caulerpa Species in September 2006 a program to monitor and suppress the of expansion of invasive *Caulerpa taxifolia* in the Croatian part of the Adriatic Sea was discussed. The project, carried out by the Institute of Oceanography and Fisheries in Split, is ongoing with respect to controlling the expansion of and continuing the eradication of existing communities.

1.0 Laws and regulations

The Croatian Legal System (Marine Fisheries Act from 1997, updated in 2005) prohibits the introduction of nonindigenous marine species into the Adriatic Sea. Farming of nonindigenous marine species is only allowed by special permissions of Ministry of Environmental Protection, Physical Planning and Construction and Ministry of the Sea, Tourism, Transport and Development, but no such cases have yet been recorded.

2.0 Deliberate introductions and transfers

Due to restrictive Croatian legislation no deliberate introductions have been recorded.

3.0 Accidental introductions and transfers

Two major vectors of introduction of nonindigenous species into the Adriatic Sea are: 1. currents from the Eastern Mediterranean through Otranto Strait along Eastern Adriatic Coast and 2. ships (both ballast water and biofouling). Mariculture production still does not play an important role in non-indigenous species introduction but planned farming growth in some parts of the Croatian coast may have a considerable impact on the appearance of non-native species in future.

Because Croatian ports are used mostly for import, ships entering from the Adriatic Sea carry cargo and not ballast water, thus the majority of nonindigenous species found along the Eastern Adriatic Coast could be due to hull fouling. Ships that transport stone from Middle Dalmatia to Italian Ports at the Western Adriatic Coast represent a particular problem, making it easier to spread non-native species that were already introduced in the Italian (Western) part of Adriatic Sea to the Croatian (Eastern) part.

3.1 Fish

In summer 2005 several specimens of *Lappanella fasciata* (Cocco, 1833) (Labridae) were observed in the southeastern part of the island of Sušac (Cape Triščavac) at depths ranging from 65 to 77 m. During the first dive visit an approximately 10 cm long specimen was occasionally photographed at a depth of 68 m. During the following visits attempts were made to observe and photograph the species in other parts of the site as well. This represents the first confirmed records of *L. fasciata* for the entire Adriatic Sea.

The Atlantic lumpsucker Cyclopterus *lumpus* (L., 1758) (343 mm of total length) was recorded for the first time in the Mediterranean Sea. The specimen was collected in the night between 16 and 17 September 2004 off Molunat Bay, Croatia, southern Adriatic Sea. This record may be a case of a vagrant specimen.

A specimen of the oceanic puffer *Lagocephalus lagocephalus lagocephalus* (L., 1758), a

181.2 mm total length (Lt ; weight W = 100.5 g), was caught by commercial trawl, 7 nautical miles from the coast (off the Molunat Bay, southern Adriatic, Croatian coast, 42°26'N, 18°26'E) at approximately 70 m depth during night 16 - 17 September 2004. The specimen was measured and stored in the ichthyological collection of the Institute of Oceanography and Fisheries in Split (catalogue number IOR 296).

3.2 Invertebrates

More then 127 specimens of the bivalve mollusc *Idas simpsoni* (Marshall, 1900) were collected from the skull of a fin whale *Balaenoptera physalus*. (L. 1758). The skull was trawled up from a depth of 430 m near Mljet Island in the south Adriatic Sea. This is first finding of *I. simpsoni* in the Adriatic Sea.

Ficopotamus enigmaticus (Fauvel, 1922) (Polychaeta, Serpulidae) was recorded for the first time in the Bay of Šibenik (Middle Adriatic) in 2006. This tubeworm covers a great part of sea bottom near Port of Šibenik. A possible vector of introduction is ships transporting stone from Middle Dalmatia.

Occurrence of blue crab *Callinectes sapidus* (Rathbun, 1896) in the southern part of the

Eastern Adriatic Coast was first recorded in the mouth of Neretva River and Mali Ston Bay.

3.3 Algae and higher plants

Since 1994, in the Croatian part of the Adriatic Sea, two invasive species of alga *Caulerpa* were found. *Caulerpa taxifolia* (Vahl) and C. Agardh have been found in three distant areas: in Stari Grad Bay (Hvar Island) during the summer of 1994, in Malinska (Krk Island) at the end of 1994, and in Barbat Channel (between the Islands of Dolin and Rab) at the end of 1996. It was estimated that the alga was brought into the areas of Stari Grad Bay and Malinska in 1991, and into Barbat Channel in 1995. Particularly vulnerable to their presence is the common sea grass (*Posedonia oceanica*) that supports major ecosystems of the Mediterranean marine life while protecting the shores from erosion. Fauna suffers too, particularly species such as sponges and sea urchins. The algae can be vacuumed or covered by black foil which would block the light they need to blossom. Unfortunately, other organisms are also affected by these methods. The number of locations of alga *Caulerpa racemosa* (Forssk.) J. Agardh in the Croatian part of Adriatic Sea has increased since 2000 to 43 sites.

4.0 Live imports and transfers

No data available.

5.0 Live exports to ICES member countries

No data available.

6.0 Meetings, conferences, symposia, workshops, research, programs, etc.

A report on invasive species in the Adriatic Coast was given at the 9th Croatian Biological Congress in Rovinj, September 2006.

During the 5th Working Group Meeting on Invasive Caulerpa Species in September 2006 a program to monitor and suppress the of expansion of invasive Caulerpa species in the Croatian part of the Adriatic Sea was discussed. The project, carried out by the Institute of Oceanography and Fisheries in Split, is ongoing with respect to controlling the expansion of and continuing the eradication of existing communities.

As a part of scientific programs supported by Croatian Government (Ministry of Science) few projects regarding biological invasions have been carried out.

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NATIONAL REPORT Finland, 2006

Prepared by: Ari Laine and Lauri Urho

Highlights

- No new species of invasive fish were recorded. However there were new records of Prussian carp, *Carassius auratus*; and starry sturgeon, *Acipenser stellatus.*
- No new individuals of round goby, *Neogobius melanostomus*, have been recorded since the first one in 2005.
- No new species of invertebrates were recorded in Finnish waters in 2006 but two recently introduced species (the amphipod *Gammarus tigrinus* and Conrad's false mussel, *Mytilopsis leucophaeata)* were found to expand their distribution.

1.0 Laws and regulations

2.0 Deliberate releases and planned introductions

2.1 Fish

Deliberate releases into the Baltic Sea (including rivers draining into the Baltic) were for fisheries and fish stock enhancement purposes in 2006 as follows:

- 0.33 million newly hatched and 2.9 million older salmon (*Salmo salar*)
- 0.54 million newly hatched and 1.4 million older sea trout (*Salmo trutta* m. *trutta*)
- Approximately 40 million newly hatched and 10 million older whitefish (*Coregonus lavaretus*).

3.0 Accidental introductions and transfers

3.1 Fish

No new species were recorded. Prussian carp, *Carassius auratus* was caught in some new places along the south coast of Finland, with the largest individuals weighing over two kg. No new individuals of round goby, *Neogobius melanostomus*, have been recorded since the first one in 2005. In 2006, one specimen of starry sturgeon, *Acipenser stellatus* was caught off the western coast of Finland. Several specimens have been caught since the first one in 1999 and all considered as escapees from Russian fish farms.

3.2 Invertebrates

No new species were recorded in Finnish waters in 2006 but two recently introduced species were found to expand their distribution. The amphipod *Gammarus tigrinus* was relatively common in a study that sampled the shallow littoral zone of several islands in the Kotka archipelago, Eastern Gulf of Finland. The species has been previously found only close to two port areas. Conrad's false mussel, *Mytilopsis leucophaeata,* that was first found in the cooling water area of the nuclear power plant in Loviisa, Central Gulf of Finland, has now also been recorded near Olkiluoto nuclear power plant, Gulf of Bothnia. Based on intensive monitoring of the area it is known that the species was not present there prior to 2006. An empty shell of *M. leucophaeata* was also found in a new location near Kotka, Eastern Gulf of Finland. All these observations indicate that *M. leucophaeata* may colonize the northern Baltic Sea but so far all records have been associated to areas affected by warm cooling waters from power plants.

4.0 Live imports

4.1 Fish

Adult Sturgeon (*Acipenser baeri*) and its eggs were imported from Italy and France for cultivation in inland farms. Rainbow trout and its eggs were imported from Germany and Sweden to inland areas. As well various fish from Denmark and Sweden were imported to the Åland Islands. Eels that were imported from Sweden (in quarantine) originated from Great Britain.

4.2 Invertebrates

Alive crayfish were imported from EU-countries for food consumption, these were cooked in Finland.

5.0 Live imports

5.1 Fish

As in previous years, rainbow trout (*Oncorhynchus mykiss*) juveniles, eggs and sperm were exported to Russia and Estonia, but also to Sweden and Austria.

6.0 Meetings, conferences, symposia or workshops on introductions and transfers

Alien Species – Environment, Biorisks, and Future. Fifth Environment Symposium of Maj and Tor Nessling Foundation 18 – 19 January 2007, Turku, Finland. Papers will be published in BER.

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NATIONAL REPORT France, 2006

Prepared by: Laurence Miossec

Highlights

- In 2006 two veined whelk adults *Rapana venosa,* were recorded in the Bay of Quiberon, successively in June and August. No additional information is available regarding weight and length.
- *Hemigrapsus sanguineus* was reported in summer 2006 near Luc sur mer (Normandie) and in the North of France (Pas de Calais) in 2006. Ballast water is suspected to be the vector.
- *Bonamia ostreae* was identified for the first time in the Granville area (Normandie- 48°50.80N lat-0°37.98W long WGS 84 system) in September 2005 and confirmed in November 2005 and July 2006.
- *Bonamia ostreae* was also detected for the first time in Lough Swilly (North of Ireland near the border between Ireland and Ulster in2006 – see Report 2007 from Ireland) and in UK in May 2006 in a wild oyster stock situated in Cleddau River (Wales). It was also confirmed for the first time in Loch Sunart (Scotland, UK) in April 2006.
- PROGIG – A French programme on causes and consequences of the pacific oyster (*Crassostrea gigas*) proliferation in France (program 2006-2008) is ongoing.
- The European project DIPNET, a two-year project started on October 2004, was finalized in 2006. It aimed to integrate current knowledge on the transfer of pathogens between wild and cultured aquatic animal populations. It addressed key issues needed to ensure sustainability and responsible exploitation of aquatic environments.

1.0 Laws and regulations

Two new Commission Decisions amending Decision 2002/300/EC regarding the areas excluded from the list of approved zones for *Bonamia ostreae* were published respectively on 8 August 2006 and 15 February 2007 following information provided by UK and Ireland regarding *Bonamia ostreae* detection.

2007/104/EC: Commission Decision of 15 February 2007 amending Decision 2002/300/EC on areas excluded from the list of approved zones for *Bonamia ostreae* (notified under document number C(2007) 419).

2006/559/EC: Commission Decision of 8 August 2006 amending Decision 2002/300/EC on areas excluded from the list of approved zones for *Bonamia ostreae* and/or *Marteilia refringens* (notified under document number C(2006) 3518).

2.0 Deliberate introductions and planned releases

None reported

3.0 Accidental introductions and transfers

3.1 Invertebrates

In 2006 two veined whelk adults *Rapana venosa,* were recorded in the Bay of Quiberon, successively in June and August. No additional information is available regarding weight and length.

Hemigrapsus sanguineus was reported in summer 2006 near Luc sur mer (Normandie) and in the North of France (Pas de Calais) in 2006. Ballast water is suspected to be the vector.

3.2 Parasites, Pathogens, and Other Disease Agents

Bonamia *ostreae* was identified for the first time in the Granville area (Normandie- 48°50.80N lat-0°37.98W long WGS 84 system) in September 2005 and confirmed in November 2005 and July 2006. The prevalence of the disease remained very low (apparent prevalence 2.7%). This area was initially free of *Bonamia ostreae*. The origin of this infection is unknown.

Bonamia *ostreae* was also detected for the first time in Lough Swilly (North of Ireland near the border between Ireland and Ulster in 2006 – see Report 2007 from Ireland) and in UK in May 2006 in a wild oyster stock situated in Cleddau River (Wales). It was also confirmed for the first time in Loch Sunart (Scotland, UK) in April 2006. The area is now fallow and undergoing eradication programme. For both areas in UK, it is suspected that the disease was spread into this previously uninfected area by the illegal introduction of oysters from an infected area.

4.0 Live imports

No data available.

5.0 Live exports

No data available.

6.0 Meetings, conferences, symposia, projects or workshops on introductions and transfers

6.1 Past meetings for year being reported

Invasions biologiques Colloque de Restitution, 17 – 19 octobre 2006 Moliets, Actes du Colloque, 229 pages.

Biodiversité et changement global – Réponses adaptatives au changement global : résultats et prospectives IFB – GICC, Colloque de Restitution 18 – 20 septembre 2006, Paris, Actes de Colloque, 227 pages.

http://publications.ecologie.gouv.fr/IMG/pdf/ActesBiodiv_et_CG.pdf

6.2 2007 Conferences

Deuxièmes rencontres francophones Invasions biologiques et traits d'histoire de vie, ***Variabilité, plasticité et adaptation***. Rennes, du 14 au 16 novembre 2007.

http://www.inra.fr/colloque_invasions

6.3 Projects

A. PROGIG – A French programme on causes and consequences of the pacific oyster (*Crassostrea gigas*) proliferation in France (program 2006–2008)

Since the nineties more and more sites have been colonised by wild populations of the exploited exotic species *Crassostrea gigas* around the world. In Western Europe the invasion is occurring in numerous sites, especially along the French coasts where wild populations reached thousands of tons in many sheltered bays (Bay of Brest, Golfe of Morbihan, Arcachon basin, Marennes Oleron basin, Bourgneuf bay, etc). The aims of the PROGIG program (C. Hily coordinator christian.hily@univ-brest.fr) are (1) to understand the causes (phenotypic and/or genetic adaptation, global warming) of the proliferation, (2) to describe the status of the

invasion and its dynamics, (3) to analyse the ecological and socio-economical consequences, (4) to propose management tools which could help in the sustainable development of the coastal zone and the preservation of the biodiversity. It is a multidisciplinary program which includes many scientists from university, CNRS and Ifremer.

We identified the sites colonised by the species on the Atlantic and Channel coasts of France (GIS) and identified the set of habitats already affected by the colonisation and the proliferation of *C. gigas*. A monitoring of the invasion dynamics was started in 25 permanent stations along the shoreline to survey the spat settlement and the individual growth. We identified the ecological capacities of the species by analysing the larger diversity of field situations in term of substrata, salinity, emersion and hydrodynamism. The results showed that *C. gigas* has broader capacities than all others indigenous and exotic species of the shores. Its behaviour (larvae and adults), its phenotypic plasticity and its tolerance to the hydroclimatic factors, explain the observed dynamics of the invasion. The species can became a key species in a wide set of habitats. The biodiversity in the oyster reef habitat is often higher than in the original one due to the provision of many microhabitats. On the other hand, at a large spatial scale, this mechanism can induce a decrease of biodiversity by the banalization and the homogenization of the habitats. First results show that emersion is a factor of genetic selection for spat. We have shown that global warming is a facilitation process to the proliferation and the geographical spreading of the invasion, and because the propagation of propagules by the oyster farms will remain, only local management seems conceivable to mitigate the ecological consequences of the invasion. The consequences for the oyster aquaculture are dramatic because spat settles on the farms structures and on the farmed oysters which induces heavy costs (time and money) to clean up. Also, because the wild stock is a trophic competitor of the exploited stock, it can induce a growth decrease of the oysters which can last up to one year. The hand-fishing for wild oyster became a new well-developed leisure activity at low tides for the coastal users, but it can induce health problems because there is no control of the bacteriological contamination of the wild oysters.

B. The European project DIPNET, a two-year project started on October 2004, was finalized in 2006. It aimed to integrate current knowledge on the transfer of pathogens between wild and cultured aquatic animal populations. It addressed key issues needed to ensure sustainability and responsible exploitation of aquatic environments.

The project's specific tasks focused on a review of (i) disease interactions and pathogen exchanges, (ii) risk assessment and modeling of pathogen exchanges, (iii) epidemiology and surveillance of infectious diseases in wild fish and shellfish, and (iv) network building and knowledge dissemination (http://www.dipnet.info/). Findings and recommendations have been disseminated to all stakeholders via the web site and have also been collated into reports to the European Commission. The following reports were provided:

- Review of disease interactions and pathogen exchange between farm and wild finfish and shellfish in Europe, Ed by R Raynard, Th Whali, I Vatsos and S Mortensen, 444 pages.
- Review of risk assessment and disease modelling in Aquatic animal health with bibliography. E J Peeler, A G Murray, A Thébault, E Brun, MA Trush, A Giovaninni, 67 pages.
- Position paper on consequence assessment – measuring the impact of pathogen exchange and disease interaction between wild and farmed aquatic animal populations. E J Peeler, A G Murray, A Thébault, A Giovaninni, E Brun, MA Trush, 28 pages
- Position paper on research priorities for risk assessment and disease modeling in aquatic animal health. E J Peeler, A G Murray, A Thébault, A Giovaninni, E Brun, MA Trush, 13 pages.

- Review of current fish disease monitoring and surveillance activities in Europe. I De Blas, A Cameron, C Dopazo, A Vallejo, I Dalsgard, L Miossec, 120 pages.
- Considerations on epidemiological surveillance in wild aquatic populations (position paper on priorities in epidemiological research and surveillance). I De Blas, C Dopazo, A Cameron, L Miossec, A Vallejo, I Dalsgard, 18 pages.
- Transfer of pathogens between farmed and wild aquatic animals' epidemiological basis for demonstrating causality. Cameron AR, de Blas I, Miossec L, Dopazo C, Vallejo A, Dalsgaard I., 42 pages

All these reports are public and will be soon available on-line or after publication in journals.

A seminar in epidemiology was organised to provide advanced skills in the design and implementation of practical and effective aquatic animal disease surveillance systems. Moreover an introductory risk assessment seminar specifically targeted at potential users was run to share knowledge accumulated in the risk assessment review and the consequence assessment task.

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NATIONAL REPORT Germany, 2006

Prepared by: S. Gollasch and H. Rosenthal

HIGHLIGHTS

- *Pachygrapsus marmoratus* was found in the German Wadden Sea in Lüttmoorsiel, Nordstrand on Sept. 29, 2006 on a blue mussel bed. This range expansion may have been enabled by unusually warm water temperatures.
- In October 2006 the invasive ctenophore *Mnemiopsis leidyi* was first recorded in the Kiel Bight (western Baltic Sea). Its abundance increased from less than 30 individuals per meter cubic in mid-October to more than 90 in late November 2006. Its occurrence in the Baltic Sea is of great concern as this invader is assumed to have contributed to the decline in fishing harvest in the Black Sea.
- A guidance document for new alien species imports was prepared as an IUCN contract to provide a brief review of existing structures that might be useful in aiding an evaluation, and to provide a simplified list of considerations for undertaking an assessment of new aquatic species imports.
- A new EU-funded project was launched in December 2006 entitled "Environmental impacts of alien species in aquaculture" (IMPASSE). Two German partners are involved. The key objectives include to review and assess the impact of alien species in aquaculture.

1.0 Laws and Regulations

Nothing new recorded.

2.0 Deliberate Releases and Planned Introductions

None known.

3.0 Accidental Introductions and Transfers

As already pointed out in last year's report, several non-native aquatic species are reported from neighbouring countries which have not (yet) been found along the German coast, including the Asian shore crab *Hemigrapsus penicillatus* the Ponto-Caspian fish *Neogobius melanostomus* in the North Sea (*N. Melanostomus* was already found along the Baltic shores as a range expansion) and *Rapana venosa*.

The recently found macroalga *Gracilaria vermiculophylla* continues to occur in local populations along the German coasts (North and Baltic Seas).

Pachygrapsus marmoratus was found in the German Wadden Sea in Lüttmoorsiel, Nordstrand (approx. 54°33 N, 8°52 E) on Sept. 29, 2006 on a blue mussel bed. This is not considered as a species introduction, but a range extension which may have been supported by the unusual warm water temperatures. The species may also have reached the area with an unusual water inflow from the Atlantic (B. Krentz, Multimar Wattforum pers. comm).

In October 2006 the invasive ctenophore *Mnemiopsis leidyi* was first recorded in the Kiel Bight (western Baltic Sea, sampling station located at (54°19.7' N, 10°09.5' E). Its abundance increased from less than 30 individuals per meter cubic in mid-October to more than 90 in late November 2006 (Javidpour et al. 2006)1. Its occurrence in the Baltic Sea is of great concern as this invader is assumed to have contributed to the decline in fishing harvest in the Black Sea. *M. leidyi* may also have invaded the North Sea already in the 1990s with records from The Netherlands. However, this invasion may have been overlooked as the species was mis-identified as a native comb jelly (Faasse & Bayha 2006)[2].

[1] Javidpour J, Sommer U and Shiganova T (2006) First record of *Mnemiopsis leidyi* A. Agassiz 1865 in the Baltic Sea! Aquatic Invasions 1(4): 299-302

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4.0 Live Imports

4.1 Fish

Aquaculture

(no major changes to last years National Report)

Sturgeons are still imported for stocking and in the aquarium trade for petfish garden ponds. Imports of salmonid species continued at a comparable level as in previous years. As already reported in last years national Report it is extremely difficult to trace the routings and quantities of life fish trade as there is no mechanism to collect these data. As in previous years, rainbow trouts were imported from various European countries. Carps are also regularly imported alive.

4.2 Invertebrates

Crassostrea gigas was imported from France and *Mytilus* sp. from Sweden and Denmark.

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

4.3 Plants

Macroalgae for human consumption become an increasing business and test cultures continue with the brown-alga *Saccharina latissima* (=*Laminaria saccharina*) and red-alga *Palmaria palmata.*

5.0 Live exports to ICES Member Countries

Blue mussels (Mytilus *edulis*) were exported to Belgium and The Netherlands.

Rainbow trouts were exported to Finland and Carp to Sweden.

7.0 Meetings, Conferences, Symposia or Workshops on Introductions and Transfers

7.1 Meetings

NEOBIOTA. The last meeting was held in Vienna, Austria in September 2006. This 4th European Conference of the working group NEOBIOTA was attended by more than 350 international experts from 45 countries. For more details visit http://www.umweltbundesamt.at/en/umweltschutz/naturschutz/nat_veranstaltungen/neobiota/

Delivering Alien Invasive Species Inventories for Europe (**DAISIE**). Two objectives of this programme may be of particular interest to ITMO: (a) a European-wide database of biological invasions (including terrestrial habitats). A draft version of the database is ready. The final version will be made available via the Internet in the end of the programme duration (February 2008), and (b) the European Alien Species Expertise Registry. The expertise registry was set up in 2005 and includes already details of nearly 1500 experts from 89 countries (see also www.daisie.se).

7.2 New journal Aquatic Invasions

This new and free European journal of applied research on biological invasions in aquatic ecosystems develops very well. In 2006 four issues were released and the journal became recognised by leading libraries, such as the library of the British Natural History Museum. See http://www.aquaticinvasions.ru/ for more information. Contributions to the journal from WGITMO members are more than welcome. Manuscripts related to inland waters may be submitted to Vadim Panov at rbic@zin.ru and accounts on coastal invaders to Stephan Gollasch SGollasch@aol.com.

7.3 Ballast Water Treatment

As reported last year Germany continues to be active in the relevant working group of the International Maritime Organization (IMO). Onboard tests of two ballast water treatment systems developed by German vendors are ongoing. The tests are carried out according to IMO guidelines. A new project is underway to design and test a ballast water treatment system. The consortium includes experts from France, Germany, Israel, Norway, Portugal, Spain, Turkey and the United Kingdom. The key objectives include the development and construction of a treatment plant which will be tested on board of seagoing vessels according to IMO guidelines. More details at http://www.bawapla.com.

7.4 Impacts of alien species in aquaculture

A new EU-funded project was launched in December 2006 entitled "Environmental impacts of alien species in aquaculture" (IMPASSE). Two German partners are involved. The key objectives include:

- review of introductions and translocations in aquaculture and for aquaculture-based restocking and assess the economic importance of introductions and translocations resulting from aquaculture and aquaculture-based restocking in the community;
- audit the state of knowledge of the results of operations concerning introductions and translocations of aquatic organisms for aquaculture purposes, particularly concerning environmental and economic impacts and genetic interactions with wild populations; to analyse the economic importance of restocking, particularly for community aquaculture enterprises;
- develop risk assessment protocols for future aquatic species introductions and aquaculture, with specific models and sub-routine assessments to consider economic issues, the potential environmental and economic impacts of diseases in wild aquatic organisms and ecosystems, genetic interactions with wild populations, and the disruption of ecosystem structure and function;
- provide guidelines for quarantine procedures to account for phylum-specific peculiarities, developmental stages and risk levels, including procedures for containment and control where invasive species are identified as a problem; and
- provide guidelines for environmentally sound practices for introductions and translocations in aquaculture and stock enhancement operations.

The project duration is two years and it is coordinated by Ian Cowx, University of Hull, UK.

7.5 Other EU activities related to biological invaisons

The EU Project "**Scope Options for EU Action in Invasive Alien Species**". The project ended in the end of 2006 and summarizes options and recommendations how to halt biodiversity loss.

The EU Strategy on Invasive Alien Species. The final version of this strategy was delivered in December 2003. The EU Strategy promotes the development and implementation of coordinated measures and cooperative efforts throughout Europe to prevent or minimise

adverse impacts of invasive alien species (IAS) on Europe's biodiversity, as well as their consequences for the economy and human health and well-being. The Strategy provides guidance to help Bern Convention Parties in their efforts to:

- rapidly increase awareness and information on IAS issues and ways to tackle them,
- strengthen national and regional capacity and cooperation to deal with IAS issues,
- prevent the introduction of new invasive alien species into and within Europe and support rapid response to detected incursions,
- reduce the adverse impact of existing invasive alien species,
- recover species and restore natural habitats and ecosystems that have been adversely affected by biological invasions, where feasible and desirable, and
- identify and prioritise key actions to be implemented at the national and regional level.

The Strategy covers:

- terrestrial, freshwater and marine environments under the sovereignty or jurisdiction of Bern Convention Parties. It also provides guidance for activities carried out in areas beyond national jurisdiction (e.g. shipping),
- alien species (as defined by the Conference of the Parties to the Convention on Biological Diversity1) in all taxonomic groups, including viruses, prions, bacteria mycorrhiza and feral animals of domestic species (cats, dogs, goats, etc.).

It does not apply to genetically modified organisms.

The proposal for an EU Council Regulation Concerning the Use of Alien and Locally Absent Species2 in Aquaculture was delivered in April 2006. This instrument deals "only" with species imports from outside Europe. The main objective of this proposal is summarized as follows:

"In the past, aquaculture has benefited economically from the introduction of alien species (e.g. rainbow trout, Pacific oyster) and from the farming of species which do not occur in an area owing to biogeographical barriers. It is therefore likely that the aquaculture industry will continue to use new species in order to satisfy the needs of the market. It would thus be prudent to decouple this economic growth from the potential threats to ecosystems posed by alien species by anticipating and preventing negative biological interaction with indigenous populations, including genetic change, and by restricting the spread of non-target species and other detrimental impacts."

7.6 IUCN Guidance Document for New Alien Species Imports

This document provides a brief review of existing structures at international, regional and national levels that might prove useful in aiding an evaluation, and to provide a simplified list of considerations for undertaking an assessment of new imports. It is hoped that the risks of new aquaculture importations can be sufficiently decreased as to prevent the accidental introduction of invasive alien species (Hewitt et al. 2006). The report may be downloaded from the IUCN homepage (www.iucn.org).

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1 alien species = a species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.

2 locally absent species = species being absent from a zone within its natural range

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NATIONAL REPORT Ireland, 2006

Prepared by Dan Minchin

In a rapid assessment survey of twenty-nine sites with floating pontoons from all Irish coasts in 2006, twenty species were targeted. Ten were known to occur in Ireland and ten were known only from Europe or Britain. Twenty-seven new range distributions of species expanding their range in Ireland were found including *Caprella mutica* from Cork the south coast and in the northern Irish Sea. Four species not previously found in Ireland included (1) amphipod *Corophium insidiosum* from Belfast Lough, (2) the southern hemisphere tunicate *Corella eumyota* from the Irish Sea and the south coast, (3) the colonial tunicate *Botrylloides violaceus* from the Irish Sea and (4) the colonial tunicate *Didemnum* sp. from the Irish Sea. Samples of *Didemnum* has been sent to Plymouth and to New Zealand respectively for genetic and biochemical investigations.

At least five specimens of the Chinese mitten-crab have been captured over a ca 20 km stretch of the Waterford Estuary on the south Irish coast during 2006.

Bonamia ostreae is now confirmed from Lough Swilly on the Northern Irish coast.

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NATIONAL REPORT Italy, 2006

Prepared by: Anna Occhipinti-Ambrogi

SUMMARY: New findings of alien species in Italian marine waters are reported for the year 2006. No new species is known to have been deliberately introduced. Comments on the spread and ecology of established alien species are listed and discussed, and information on ongoing research activities is provided.

HIGHLIGHTS

- One specimen of the lessepsian clupeid *Etrumeus teres* was caught for the first time in Italy in 2005, off the island of Lampedusa, in the Sicily strait.
- The first record of the dwarf flathead *Elates ransonnetii* in the Mediterranean Sea was reported in 2005 along the southern coast of the Gulf of Taranto (North-western Ionian Sea).
- The specific digenean trematode parasite *Allolepidapedon fistulariae* was reported for the first time in the Mediterranean Sea, from the bluespotted cornetfish Fistularia *commersonii*, caught in Sardinia in 2005.
- A new polychaete species, *Novafabricia posidoniae*, has been described. The genus was not represented in Italy and its origin is probably from the Atlantic.
- Several individuals of the bivalve *Mercenaria mercenaria* were caught from 2002 to 2005 in two lagoons of the Po River Delta where the manila clam is harvested.
- A new alien decapod pilumnid, *Actumnus globulus*, was reported from the Mediterranean Sea. It was collected in 1978 off Punta Ala, Tuscany (Tyrrhenian Sea) but only recently identified. From the same sample another alien crustacean *Menaethius monoceros*, known from the Indopacific, was described in 2003.
- The red alga *Heterosiphonia japonica* has been present in the Lagoon of Venice since the 1990s, but was misclassified until recently due to taxonomic complexity, which is not yet completely clarified.
- Ecological studies on the most important invasive species established along the coasts of Italy have progressed, in particular with respect to the mechanisms underlying the success of the algae *Caulerpa racemosa* var. *cylindracea* and *Codium fragile* ssp. *tomentosoides*.

2.0 DELIBERATE RELEASES

2.1 Finfish

None recorded.

2.2 Invertebrates

A heated debate is under way regarding the management of the culture and fisheries of the imported clams, *Venerupis philippinarum* (= *Ruditapes philippinarum*), which is a considerable resource especially in the northern Adriatic (Boatto and Pellizzato, 2005). Fishermen's organizations are pressing the government in order to obtain full unrestricted permits to translocate stocks and seeds on the ground where the species was introduced into European waters more than 30 years ago, and must be labeled as "naturalized".

Pranovi *et al.* (2006) have assessed changes in macrobenthic community, in particular bivalve molluscs, of the Lagoon of Venice induced by *V. philippinarum* introduction and subsequent clam exploiting activity. They compared historical data (1968, 1985, 1990) with 1999 data and found a sharp reduction, both in terms of distribution area and density, of all other filter feeder bivalves. Moreover, by using the clearance rate of the most abundant bivalve species in 1990 and 1999 (*Cerastoderma glaucum* and *V. philippinarum*, respectively), they estimated a

doubling of the overall filtration capacity. This may have altered the functioning of the ecosystem, resulting in stronger benthic–pelagic coupling.

3.0 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Finfish

One specimen of the lessepsian clupeid *Etrumeus teres* was caught off the island of Lampedusa, in the Sicily strait, in 2005 (Falautano et al., 2006). The species is well known in the Eastern Mediterranean, as far as Rhodes and Cyprus.

The first record of the dwarf flathead, *Elates ransonnetii,* in the Mediterranean Sea was reported. The specimen was collected in October 2005 on a sandy bottom at 20 m depth along the southern coast of the Gulf of Taranto (North-western Ionian Sea). This species is commonly recorded from the Timor Sea off Australia to Papua New Guinea, and along the coast of Indonesia, Singapore, Thailand, South China and the Philippines. It is also known to be spread from the coast of Burma to the Red Sea and it may have entered the Mediterranean Sea through the Suez Canal (Mastrototaro et al., in press).

New information was made available for the following species which were already reported in previous years:

- The blue spotted cornet fish, *Fistularia commersonii,* was found for the first time outside Sicily, near Arbatax, in Sardinia (Pais et al., 2007). The specimen caught hosted 58 species of parasites in its mouth and digestive tract. With the exception of the specific trematode *Allolepidapedon fistulariae*, all the other parasites found were already reported in other hosts from the Mediterranean Sea.
- An additional Mediterranean record of the smooth puffer, *Sphoeroides pachygaster,* was reported for the Central Tyrrhenian Sea (Psomadakis *et al.*, 2006).

A study by Azzurro *et al.* (in press a) investigated some aspects of gonad morphology, fecundity, and oocyte dynamics of the newly settled *Siganus luridus* at Linosa island (Sicily). Ovarian development was consistent with the group-synchronous type and testicular organization was of unrestricted spermatogonial testis type, with cystic spermatogenesis. Both males and females had reached final stages of gonad maturation. The rates of follicular atresia were moderate and fecundity estimates did not diverge from what was observed in a reference population along the Lebanese coasts. These observations indicated that the population is reproductively active at Linosa and suggested the forthcoming of self-maintaining populations across the central Mediterranean area.

The resource partitioning between *Siganus luridus* and two ecological native analogs, *Sarpa salpa* and *Sparisoma cretense* was studied (Azzurro et al., in press b). Gut-content analyses provided a snapshot of the feeding habits of the three species: *S. luridus* fed on 34 taxa of benthic algae (mostly represented by *Dictyota dichotoma*) while a total of 27 taxa were identified in the stomach of *S. salpa,* with the predominance of *Sargassum vulgare*. *Sparisoma cretense* diet comprised 22 taxa of identified algae, albeit, due to the high percentage of digested food, this species was excluded from gut-content comparisons. A partial resource partitioning between *Siganus luridus* and *Sarpa salpa* was found, but a more dispersed diet was found for *S. luridus* with respect to *S. salpa.*

3.2 Invertebrates

The following species have been added to the list of NIS for Italian coasts:

- The specific digenean trematode parasite *Allolepidapedon fistulariae* was reported for the first time from the Mediterranean Sea, from the bluespotted

cornetfish *Fistularia commersonii* caught in Sardinia (Pais et al., 2007). This genus had been reported previously only from the Indo-Pacific area.

- The sabellid polychaete genus *Novafabricia*, represented up to now in the Mediterranean only by *N. infratorquata*, was recorded for the first time along the Italian coast. A new species, *Novafabricia posidoniae* was described by Licciano and Giangrande, 2006), the type locality being Ponza Island, (Tyrrhenian Sea). *Novafabricia* sp. cf. *N. infratorquata* was also reported by the same paper from Otranto (Southern Adriatic Sea).
- A specimen of the recently described muricid mollusc *Coralliophila trigoi*, an Atlantic species known to occur in the Mediterranean Sea in the Alboran area, was labelled under a different name since its finding south of Leghorn in 1982, and subsequently correctly identified after examination of *Coralliophila* species in a private collection (Margelli and Campani, 2006).
- *Mercenaria mercenaria* was added to the Italian list of alien species. Several individuals were caught from 2002 to 2005 in two lagoons of the Po River Delta among harvested Manila clams. It's likely that the introduction of *Mercenaria* specimens took place while *Venerupis philippinarum* seed from Atlantic hatcheries was placed in the lagoons. A few individuals of *M. mercenaria* had been recorded in a small lagoon of Caprolace in Central Italy by Bini (1983)
- A new alien decapod pilumnid, *Actumnus globulus*, was reported from the Mediterranean Sea. It was collected in 1978 off Punta Ala, Tuscany (Tyrrhenian Sea) and only recently identified. The species, although rarely cited, is known from the Red Sea and the East African coast. The adult morphology has been redescribed and illustrated (Galil et al, 2006). From the same sampling another single male specimen was attributed by Falciai (2003) to the alien crustacean *Menaethius monoceros* known from the Indopacific region. Both species may have been ship-borne since they were found near a port that is frequented by coastal vessels from many places.

New information was made available for the following species which were already reported in previous years:

- *Acartia tonsa* was reported in a southern Adriatic Sea lagoon (Lesina lagoon) during two sampling campaigns carried out in May and July 2004. The arrival of *A. tonsa* may have caused the disappearance of the formerly abundant *A. margalefi* (Sei and Ferrari, 2006).
- As reported in previous years, the planktonic copepod *Acartia clausi* has been the most widespread Acartiidae species in the Mediterranean Sea for many years, while *Acartia tonsa*, a species only recently introduced, is less common and occurs in brackish waters and confined environments. The latter became the dominant species of the planktonic copepod component in the lagoons of the North Adriatic Sea, leading to a gradual decrease of congeneric autochthonous species. Temperature and salinity do not appear to play a decisive role in the spatial distribution of these two species. Two studies by Invidia et al (2004) and Sei et al. (2006), compared the tolerance of *A. tonsa* and *A. clausi* eggs to anoxia and anoxia/sulphide. Hatching and viability of the eggs of the two species exposed to near anoxia and sulphide for different time periods were analysed to evaluate if these stress factors can play a role in the distribution of these species. Since egg production and viability are food quality and quantity dependent, feeding experiments were also conducted to select the most appropriate feeding regimen to obtain a large amount of viable eggs for the experiments. The results indicate that the eggs of the two *Acartia* species have similar tolerance to these stress conditions and that the occurrence of anoxic conditions cannot be a factor explaining the spatial distribution of these copepod species in coastal and brackish environments. Other factors, such as food quality may be implied. The results indicate that the two *Acartia* species have different feeding preferences, which might depend on the nutritional quality of the supplied algal species. Different diet preferences could favour species coexistence; however, differing flexibilities in food selection could give a competitive advantage.

- The hydroid *Clytia hummelincki* was recorded for the first time in Calabria in 1996. It has been found also in the Adriatic Sea (Tremiti islands, Croatia), in Sardinia and in the islands of the Pontine archipelago. At present, it is widespread along the Apulian coast. Two surveys carried out in 2003 and 2004 along the coast of Salento peninsula showed that this species inhabits a belt between 0.5 and 1 m depth in sea urchin barrens and in areas damaged by date mussel fisheries. The comparison between the two surveys estimated the diffusion rate of the alien species (Gravili *et al.*, 2006).

3.3 Algae and Higher Plants

The following algal species have been added to the list of NIS for Italian coasts:

- The red alga *Heterosiphonia japonica*, native to the Pacific Ocean (Korea) and introduced to North Europe, has been present in the Lagoon of Venice since the 1990s according to Sfriso (2006) but has been misclassified until recently due to taxonomic complexity, which is not yet completely clarified. It is common in the infralittoral range in the marine side of the outer islands and lagoon mouths. Overall, 20 alien algal species have been reported so far in the Lagoon of Venice (Curiel et al., in press)

New information was made available for the following species which were already reported in the previous years:

- *Caulerpa taxifolia* further expanded its distribution in Sicilian waters (Gianguzza *et al.*, 2006 a, b).
- A study aimed at obtaining deeper knowledge of the potential re-establishment of Mediterranean assemblages when invaded by alien species and thus acquiring useful information to address the management of pest control was carried out by Piazzi and Ceccherelli (2006). The capability of recovery of macroalgal rocky assemblages south of Leghorn, colonized by *Caulerpa racemosa* was evaluated after eradication. A manipulative experiment was performed over one year to compare the structure of native assemblages invaded by the alga and others where the alga was removed, with those that have never been invaded. The site was invaded by *Caulerpa racemosa* in 1996 and, at the start of the experiment (2003), populations of the alga consisted of a wide layer of stolons on the bottom. A one year period was considered enough to make predictions on the recovery of cleared surfaces by Mediterranean algal assemblages. In invaded plots, the total percentage cover and species richness were lower. The encrusting layer was not developed and in the turf layer, the most common species were the same as in the control locations, but fewer species were observed. In removed plots, the total percentage cover and the richness increased. Moreover, the encrusting layer, completely absent before removal, showed a small abundance one year after *C. racemosa* eradication. Results indicate that macroalgal assemblages in locations invaded by *C. racemosa* differed significantly from the control locations. One year after removal of the invader, the recovery of the community was still minimal. Recovery was related to a significant increase in species richness and cover of macroalgae, thus showing a pattern similar to that described after removal of other kinds of impact, such as sewage outfall. However, the abundance of each vegetation layer did not change significantly through time suggesting that only slight changes in the complexity of assemblage occurred, in contrast with other examples of recovery. In fact, most algae that recolonise removed plots were constituted by turf species and, although several encrusting and erect species recolonised the removed plots, their cover was very low. This work is consistent with other studies, showing that *C. racemosa* is able to substantially modify Mediterranean macroalgal communities. The results indicate that the effects of the colonization persist even one year after the removal of the invader and the recovery process of the assemblages is quite slow. This finding is important in evaluating invasion costs and in supporting effective control strategies.

- In Liguria, the heavy urban and industrial coastal development in the 1960s led to a massive decline of the *Posidonia oceanica* meadows, which formerly used to develop as a wide and continuous belt along the coast. This decline has been especially obvious adjacent to major coastal cities such as Genoa. The recolonisation of regressed meadows by the seagrass *Cymodocea nodosa* and/or the invasive alga *Caulerpa racemosa* has often been observed. After regression of *P. oceanica*, the meadow can become a dead "matte" or be replaced by stands of other species, thus undergoing a phase shift in the community. Using three environmental indices: conservation index (CI), substitution index (SI) and phase-shift index (PSI), Montefalcone et al. (2007) studied a system of five adjacent *P. oceanica* meadows facing the waterfront of Genoa over different spatial scales (metres–kilometres), investigating the influence of local factors on the status and the potential recovery of the original *Posidonia* meadows. Mapping of PSI showed that the meadows closest to Genoa centre and the harbour have undergone an almost total phase shift and have no real potential for recovery: attempts to re-establish *P. oceanica* in that location may therefore be a waste of time and money. On the contrary, the meadows farthest from Genoa centre and harbour showed a comparatively low level of phase shift and could still fully recover, given specific management actions.
- Factors involved in the colonization success of *Caulerpa* species were studied. While the other two varieties of *C. racemosa* present in the Mediterranean Sea are predominantly recorded as forming shallow stands, *C. racemosa* var. *cylindracea* features a wide bathymetric range, from the intertidal zone, down to 60 m depth. Hence, the physiological response to the irradiance regime was investigated by Raniello *et al.* (2004, 2006), along gradients of depth and daylight. In fact, light is the major factor affecting photosynthetic performance and growth response and a marked acclimatisation capacity of photosynthetic traits might be related to invasive behaviour. The data indicate that efficient acclimatisation of photosynthesis and pigments to different microhabitat conditions and seasonal changes is also evident during the circadian cycle and along the depth irradiance gradient. The results point to a well-defined function of siponaxanthin, not only in the acclimatisation to deep light regimes, but also in photoprotection of shallow stands through its regulated conversion into lutein, with this dual role contributing to the alga diffusion in a wide bathymetric range.
- Allelopathy has been postulated as a factor in the colonisation success of *Caulerpa racemosa* var. *cylindracea.* In order to reveal their possible phytotoxic activity, secondary metabolites (terpenoids, among which caulerpenyne) were isolated from a population growing in the Gulf of Naples and tested on leaf tissue of the native seagrass *Cymodocea nodosa*, which often co-occurs with *Caulerpa* in nature (Raniello et al., in press). The approach followed included the extraction, purification and identification of putative allelochemicals from tissues of *C. racemosa* var. *cylindracea*. Their toxicity was then tested on leaf fragments of *C. nodosa*, assessed through the effect on the photosynthetic performance of the seagrass, represented by variations in chlorophyll fluorescence. The aim was to provide preliminary evidence for the occurrence of allelopathic interactions between the two plants. It is the first evidence of a toxic effect of caulerpenyne on marine macrophytes, even though the high toxicity of this compound for sea urchin eggs, mice and mammalian cells had already been well documented by classical toxicity assays.
- The large populations of the introduced green alga, *Codium fragile* ssp. *tomentosoides* on artificial reefs in the shallow sandy bottoms of the northern Adriatic was studied extensively by Bulleri *et al.* (2006 a & b; in press). In general, the landward side of breakwaters supported greater numbers of thalli of *C. fragile* ssp. *tomentosoides* than seaward sides. Thalli grew longer and more branched in sheltered habitats, leading to an overall larger biomass of the alga on the landward side of breakwaters. The presence of sheltered man-made hard substrata in the vicinity of major trading ports and sources of eutrophication could enhance the dispersal of invasive species across regional and geographic scales. Thus, the effects of artificial structures and introduced species on coastal

assemblages cannot be evaluated separately, but their synergistic nature should be considered in planning strategies for conservation of biodiversity in coastal habitats. The other main space occupier of the breakwaters at low-intertidal and shallow subtidal levels is the native mussel, *Mytilus galloprovincialis*. Previous experiments had demonstrated complex effects of mussels on *Codium fragile*, ultimately affecting the success of the invasive alga. Specifically, pre-emption of space by mussels is effective in reducing rates of recruitment of *C. fragile*. In their study, Bulleri *et al.* (2006b) experimentally analysed the effects of *C. fragile* on mussels. Such effects could differ depending on the stage of development of *C. fragile*. On the one hand, juvenile thalli of *C. fragile*, also referred to as primordia, form complex three-dimensional clumps which enhance settlement and recruitment of mussels in comparison to the smooth bare surface of the quarried blocks used to build the breakwaters. On the other hand, adult canopies of *C. fragile* could affect the recruitment, survival and growth of under-story mussels, the direction of such effects potentially varying from positive to negative. The removal of the canopy of *C. fragile* negatively affected the density of mussels after 2 and 4 months from the start of the experiment, but there were no effects on the mean size of individuals, or on the size–frequency distribution. These results show that recolonisation of space by mussels is enhanced by *C. fragile*. Given that mussels, in turn, have the potential to reduce recruitment rates of *C. fragile*, quick recovery of mussel beds after disturbances could be crucial for controlling the abundance of this alga on breakwaters.

6.0 OTHERS ON INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

The national project V.E.C.T.O.R. (Vulnerability of shores and Italian marine ecosystem to climatic changes and their role in the Mediterranean carbon cycles) was launched at the end of 2006. The project, including 10 research lines, will supply information concerning the climatic changes that have an impact on the marine environment and the role of the Mediterranean in the planetary CO_2 cycle. The project will also evaluate the effects of climatic change on biodiversity of coastal areas, also taking into account socio-economic aspects such as tourism, fisheries and fish-farming.

In the Mediterranean Sea the probable cases of introduction via ship are numerous (Flagella and Abdulla, 2005), yet comparatively few direct port studies have been carried out. Two estimates (in Naples and Salerno) on ballast water transport of organisms were financed by the European Community in the framework of the project ''Algal Introduction to European Shores'' (ALIENS). The results (Flagella et al., 2006) show a total of 55,738 and 118,339 tons of ballast water released annually in Naples and Salerno, respectively, which theoretically corresponds to the discharge of 4,977,403 (Naples) and 10,366,496 (Salerno) phytoplankton organisms. The importance of small crafts in the distribution and spread of non-indigenous species in Italy has been discussed in the frame of a paper by Minchin et al. (2006) in comparison with other well known examples from e.g. New Zealand and Ireland. In particular, information on marinas and small ports abundance along Italian coasts, world trip traffics, hull fouling composition, secondary spread of well known invaders and the importance of new man-made structures as "incubators" for alien species has been provided in this paper.

As an outcome of the European projects under the Sixth Framework Programme, ALARM (Assessing Large-scale environmental Risks for biodiversity with tested Methods) and DAISIE (Delivering Alien Invasive Species Inventories for Europe), Zenetos et al. (2006) published a list of the 745 alien species of the Mediterranean, which also incorporates the work undertaken with funds of the Italian Ministry for the Environment during the past years.

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NATIONAL REPORT Norway, 2006

Prepared by: Anders Jelmert

HIGHLIGHTS

- The alien comb-jelly *Mnemiopsis leidyi* continued its spread into Norwegian Waters after its discovery in The Netherlands, Germany and Sweden (likely also Denmark). Fairly high numbers of adults (>6 cm) were found in the "Coastal current "from the Oslofjord area, outside Skagerrak, and outside Bergen.
- Except a number of singular (likely human-translocated specimen, no apparent southwest-ward expansion of the red king crab, *Paralithodes camtschatica* have been observed.
- The snow crab *Chionocetes opilio* are sporadically found outside the Coast of Finnmark County, but the main population is still concentrated in the eastern part of the Barents Sea. Of a total of 11 suspects, 3 specimen of American lobster, *Homarus americanus* were found in Norwegian waters in 2006, 2 outside Alesund, and 1 outside Kristiansand.
- A Norwegian web-based Alien Species Database has been established. A thorough revision of the "Red list" have been finished and published, and an "Alien List is being finalized. The alien list includes risk assessment and a web-based map application for national distribution. It is complete for terrestrial, limnic and marine species, but does not include protists, bacterial and viral species other than known pathogens. The revised Norwegiana alien list now contains 47 marine/brackish water species.

1.0 Laws and regulations

Norway ratified the ballast water convention in December 2006. This increased the ratifying tonnage to >3% of world's tonnage.

A report on ballast water management (including exchange zones) commissioned by the Directorate for Nature Management, (lead: DNV, Norway) is finalized, and is now sent on hearing.

A revised list of introduced species with risk assessments has been finalized. The risk assessments will later be implemented in management plans for non-indigenous species. A report on mapping and management of introduced marine species has been commissioned and will be finalized before summer 2007.

2.0 Deliberate releases

Nothing to report

3.0 Accidental introductions and transfers

3.1 Invertebrates

Specimens suspected to be the comb-jellyfish *Mnemiopsis leidyi* were spotted in the Oslofjord in December 2006. The identity was later confirmed by US taxonomists. The combjelly have also been found in the "Coastal Current" as far north as outside Bergen (N:60 22, E 05 04). Refer to Figure 1 (below). The specimen will be targeted by the zooplankton surveys at IMR. A North European initiative to monitor *Mnemiopsis* was established (Uli Sommer, Germany) and will meet in March 2007.

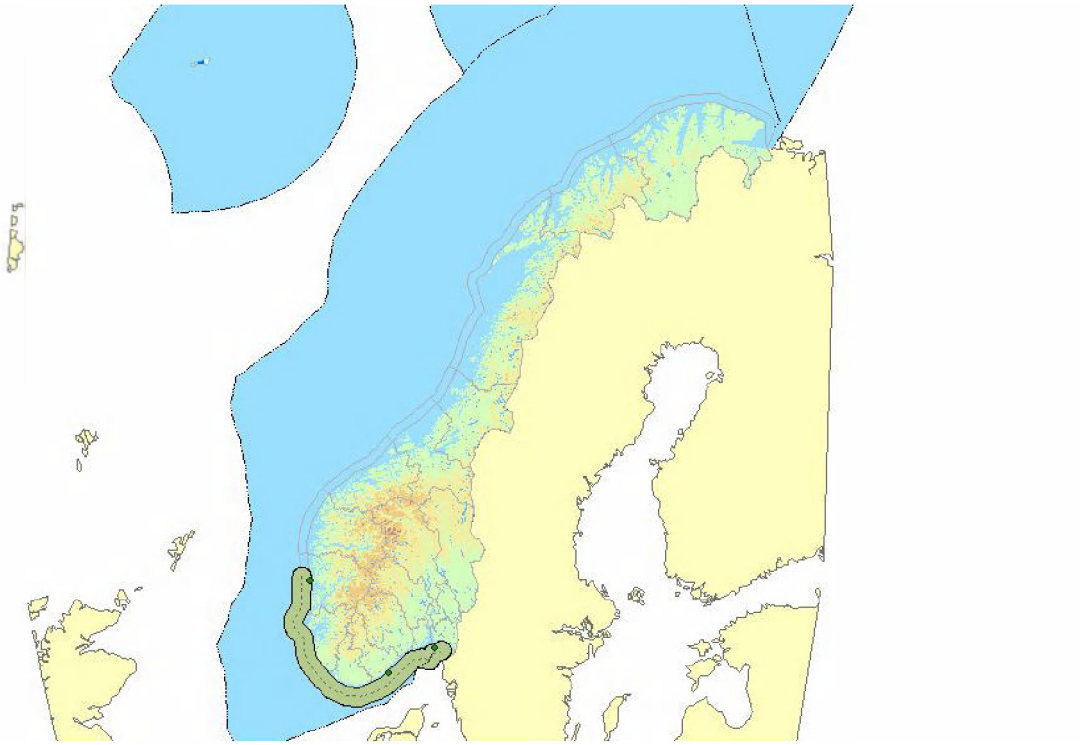

Figure 1. Distribution of *Mnemiopsis leidyi* by the end of 2006. Dots: point sightings. Field: Likely distribution in the "Coastal current"

The Pacific oyster, *Crassostrea gigas*, was previously cultured in enclosed ponds in Norway - but is now illegal. In 2006 scientists from IMR did a survey in the vicinity of one facility and reported a young specimen at Espevik (N: 59 54, E 05 40). Two additional specimens were found (and collected) outside Kragero (N: 58 52, E 09.). Hopefully more fieldwork aiming to eradicate other eventual specimens will be carried out in 2007.

The red king crab *Paralithodes camtschatica* was monitored, and the south and westward migration seems to have halted. The most southwesterly distributed population (N: 70 27, E 21 38) seems mainly to have stayed along the coast and at depths above 200m. Refer to Figure 2. A specimen found north in the Barents Sea seems to be a northward expansion of the stock outside Eastern Finnmark (Jan Sundet, IMR, Pers. Comm).

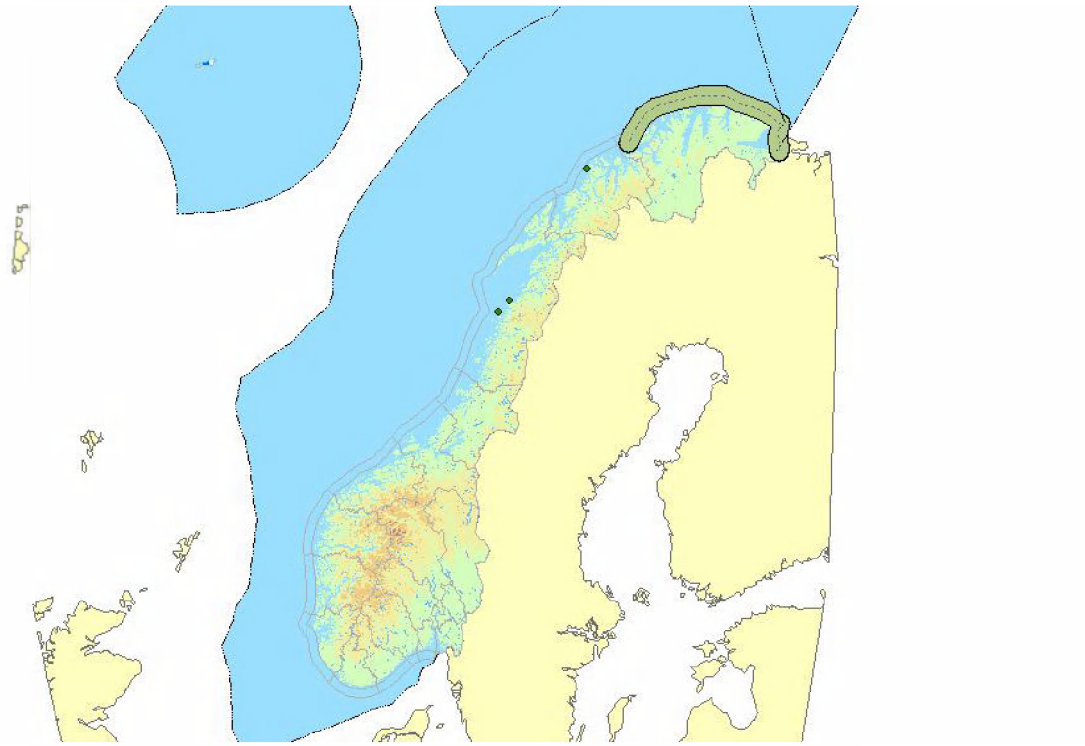

Figure 2. The distribution of red king Crab in Norwegian waters. Continuous field: approximate area of abundant stock. Dots: individual sightings (likely transported by humans).

The Snow Crab, *Chionocetes opilio,* was found outside Finnmark, at relatively low, but increasing numbers. The stronghold of the stock is still in the eastern (Russian) part of the Barents Sea (Goose Bank). Russian Scientists have estimated the population to be around 1 million adult crabs.

A low number of individuals of American lobster (*Homarus americanus*) appeared in Norway again in 2006. A total of 11 specimens with suspect characteristics were collected and DNA analyzed. Three individuals were confirmed to be *H. americanus.* Two individuals caught outside Ålesund (N: 62 27, E: 06 13), and one caught outside Krisitansand (N: 58 07, E: 08 01) One individual confirmed to be *H. americanus* was caught in Danish waters but analysed in Norway - details of this location was not specified. Since 2000 a total of 66 lobsters with atypical morphology have been collected and tested by microsatellite DNA analysis. Of these, 16 have been confirmed to be *H. americanus.*

3.3 Algae and Higher Plants

There was anecdotal information about an expansion north of the "Sognefjorden" area (N:61 10 E: 04 58), but no scientifically confirmed sightings, of the Japanese drift kelp *Sargassum muticum.* Where established, the species seems to expand in density.

The rhodophycean *Gracillaria vermiculophylla* has apparently not managed to cross the border from Swedish water.

Heterosiphonia japonica (Ceramiales, Rhodophyta) continues to spread north and south, and continues to grow aggressively in the sub-tidal habitats. It is now established in the Oslofjorden area (N: 59 05, E: 10 37), and grows north to outside Trondheim (N: 63 40, E 09 34).

4.0 Live imports

A request has been made to the "Dyrehelsetilsynet" who is in the process of collecting and summarising the data from the National "Matilda VAM" –database and the EU- TRACES database. The functionality for the latter is unfortunately still sub-optimal. The data should be available directly after the meeting and will be communicated by correspondence.

5.0 Live exports

A request has been made to the "Dyrehelsetilsynet" who is in the process of collecting and summarising the data from the National "Matilda VAM" –database and the EU- TRACES database. The functionality for the latter is unfortunately still sub-optimal.

6.0 Meeting conferences, symposia, workshops etc.

A workshop on introduced species with ballast water was hosted by the Norwegian branch of WWF in Oslo, Nov 30, 2006. Jose Matheical contributed on behalf of the IMO.

A one-day seminar on "Ecological impact on the Red King Crab on Benthos and demersal fish eggs" was held Feb.15, 2006 in Oslo.

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NATIONAL REPORT Poland, 2006

Prepared by: A. Szaniawska and J. Hegele-Drywa

HIGHLIGHTS

- Deliberate releases of salmon (*Salmo salar),* sea trout (*Salmo trutta morpha trutta*), and whitefish were consistent with previous years.
- In May 2005 24 specimens of *Platorchestia* were found beneath stones and debris wedges within a stone coastal defense structure on the southern shore of the Hel Peninsula at Kuźnica (Puck Bay) (Spicer & Janas, 2006).
- In 2002 *Hemimysis anomala* was found in the Odra Estuary (Gruszka *et al.*, 2003), where it had probably arrived via canals and rivers.
- The first recording of *Neogobius gymnotrachelus* in Poland was during 1995 in the River Bug. Then this species was founded in Włocławski reservoir where it has formed a vivid, abundant self-sustaining population (Kostrzewa and Grabowski, 2003). At present the species had spread to the middle and lower section of the Vistula River, down to the vicinity of Toruń (53°02'N, 18°37'E) (Grabowska and Grabowski, 2005).

1.0 LAWS AND REGULATIONS

Polish regulations include:

- CBD Convention (05 June 1992) - protection of native biodiversity on all levels: genetics, ecosystems, landscapes.
- Nature Conservation Act (16 April 2004) - regulations for the introduction of alien fungi, plants and animals and on the import of alien species that pose a threat to native biodiversity.

2.0 DELIBERATE INTRODUCTIONS AND TRANSFERS

2.1 Fish

In 2004, 273 831 smolts and 170 000 juveniles of salmon *Salmo salar* (Linnaeus, 1758) were released into the natural environment. 755 118 smolts, 251 540 juvenile, and 1 160 000 fry of sea trout *Salmo trutta morpha trutta* (Linnaeus, 1758) were released as an enhancement of wild stock. 70 000 fry of whitefish *Coregonus lavaretus* (Linnaeus, 1758), origin of Pomeranian Bay stock, were released in Szczecin Lagoon as a part of program of reintroduction of whitefish, which has been carried out since 1991. As well, 212 190 juveniles of whitefish were released into Puck Bay and Reda River.

In 2005, 146 579 salmon *S. salar* smolts were released into the natural environment. 764 919 smolts, 400 000 juveniles and 1 700 000 fry of sea trout *S. trutta morpha trutta* were released into natural environment. 1 000 000 fry of whitefish *C. lavaretus* were released in Puck Bay. Also 160 483 juveniles of whitefish were released into Reda River. (Ministry of Agriculture and Rural Development Bulletin).

In 2006, 32 400 smolts and 50 000 juveniles of salmon *S. salar* were released into the natural environment. 855 409 smolts, 19 700 juveniles and 2 150 000 fry of sea trout *S. trutta morpha trutta* were released into natural environment. 47 000 fry and 1800 juveniles of whitefish were released into natural environment as a part of program of reintroduction of whitefish. (Bartel, personal communication).

3.0 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Invertebrates

Platorchestia platensis (Krøyer, 1845) (Amphipoda) - In May 2005 24 specimens of the semiterrestial beach flea were found beneath stones and debris wedges within a stone coastal defence structure on the southern shore of the Hel Peninsula at Kuźnica (Puck Bay) (Spicer and Janas, 2006). It has a cosmopolitan distribution, occurring world-wide in supralittoral environments.

Hemimysis anomala (G.O. Sars, 1907) (Mysidacea) - in 2002 it was found in the Odra Estuary (Gruszka *et al.*, 2003), where it had probably arrived via canals and rivers. This species was first identified in the coastal zone of the Gulf of Gdańsk in 2004. Analysis of archival films indicates that this species was already present there in the spring of 2002. In 2003–2004 *H. anomala* was sighted in shoals of several hundred individuals at four localities at depths from 2 to 7 m (Janas and Wysocki, 2005). It is a Ponto-Caspian species which is endemic to the Sea of Azov - Black Sea basin. Mature individuals range from 6 to 13 mm length (Borcherding *et al.*, 2006).

3.2 Fish

Neogobius gymnotrachelus (Kessler, 1857) - The first recording of the Ponto-Caspian racer goby in Poland was during 1995 in the River Bug. Then this species was founded in Włocławski reservoir where it has formed a vivid, abundant self-sustaining population (Kostrzewa and Grabowski, 2003). At present the species had spread to the middle and lower section of the Vistula River, down to the vicinity of Toruń (53°02'N, 18°37'E) (Grabowska and Grabowski, 2005).

Table of all non-native marine species in Polish Baltic coastal environment

	ALIEN SPECIES NAME	TAXON
1	*Acartia tonsa*	Crustacea
2	*Atyaephyra desmarestii*	Crustacea
3	*Balanus imrovisus*	Crustacea
4	*Cercopagis pengoi*	Crustacea
5	*Chaetogammarus ischnus*	Crustacea
6	*Chelicorophium curvispinum*	Crustacea
7	*Dikerogammarus haemobaphes*	Crustacea
8	*Dikerogammarus villosus*	Crustacea
9	*Eriocheir sinensis*	Crustacea
10	*Gammarus tigrinus*	Crustacea
11	*Hemimysis anomala*	Crustacea
12	*Obesogammarus crassus*	Crustacea
13	*Orconectes limosus*	Crustacea
14	*Palaemon elegans*	Crustacea
15	*Platorchestia platensis*	Crustacea
16	*Pontogammarus robustoides*	Crustacea
17	*Rhithropanopeus harrisii tridentatus*	Crustacea
18	*Cordylophora caspia*	Hydrozoa
19	*Dreissena polymorpha*	Mollusca
20	*Mya arenaria*	Mollusca
21	*Potamopyrgus antipodarum*	Mollusca
22	*Branchiura sowerbyi*	Oligochaeta
23	*Anguillicola crassus*	Nematoda
24	*Acipenser baerii*	Pisces
25	*Acipenser gueldenstaedti*	Pisces
26	*Acipenser ruthenus*	Pisces
27	*Aristichthys nobilis*	Pisces
28	*Coregonus peled*	Pisces
29	*Ctenopharyngodon idella*	Pisces
30	*Cyprinus carpio*	Pisces
31	*Hypophtalmichthys molitrix*	Pisces
32	*Lepomis gibbosus*	Pisces
33	*Neogobius gymnotrachelus*	Pisces
34	*Neogobius melanostomus*	Pisces
35	*Oncorhynchus mykiss*	Pisces
36	*Percottus glehni*	Pisces
37	*Marenzelleria viridis*	Polychaeta

4.0 LIVE IMPORTS AND TRANSFERS

Eggs of sturgeon *Acipenser baerii* were imported from Russia; and eggs of rainbow trout *Oncorhynchus mykiss* were imported from France, Spain, and Denmark.

5.0 LIVE EXPORTS TO ICES MEMBER COUNTRIES

Rainbow trout were exported to Germany.

6.0 PLANNED INTRODUCTIONS AND TRANSFERS

In 2007 Poland will continue restocking of salmon and sea trout, as in previous years. As well, the program of reintroduction of white fish in Puck Bay and Reda River will be continued.

7.0 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS

None

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NATIONAL REPORT Spain, 2006

Prepared by: Jesús Cabal

The Environmental Ministry, Regional Administration and local authorities have established several programmes to eradicate non-native species in freshwater and terrestrial ecosystems, especially in areas catalogued as protected areas. Eradication programmes of marine invasive species were carried out by local, regional or central authorities and focused on species such as *Eriocheir sinensis*, *Sargassum muticum*, *Carpobrotus aciniformis*, etc. (Fig.1).

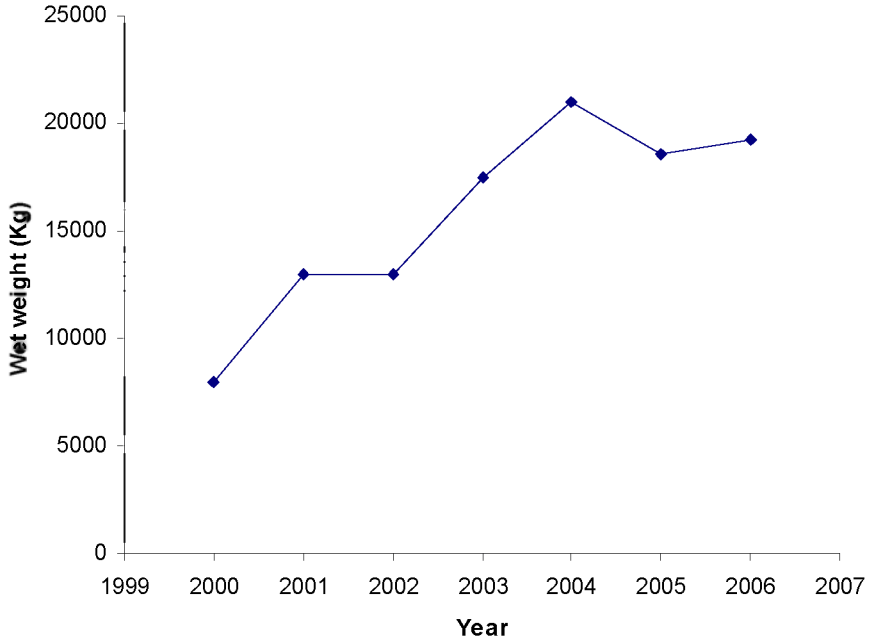

Figure 1. Eradication program of *Sargassum muticum* in the swimming area of Fomento Beach in the municipality of Gijón from 2000–2006. Data are wet weight (Kg) of seaweed.

In Andalucía a programme exists to control invasive species since 2001. This programme has collected 571 *Eriocheir sinensis* crabs in the Guadalquivir River at Seville Port.

The study reported here was undertaken to collect records and review information about the introduction of marine fauna and flora to Spain. In order to obtain a list of non native marine species, a questionnaire was distributed to marine biologists including targeted marine specialists with knowledge of particular taxonomic groups. In addition, information was drawn from an extensive literature search on alien species in the Spanish coast. Several studies have focused on non-native species in coastal areas in the last years (Moro *et al.*, 2003, Barbara *et al.*, 2005, Martinez and Adarraga, 2005, 2006). For this reason, the total number of non-native species has been increasing during these years. However, information of some taxonomic groups (sponges, cnidarians, bryozoans, etc.), is still very scarce. A few studies have focused on the ecological impact of the alien species (Castillo *et al.*, 2005, Nieva *et al.*, 2005).

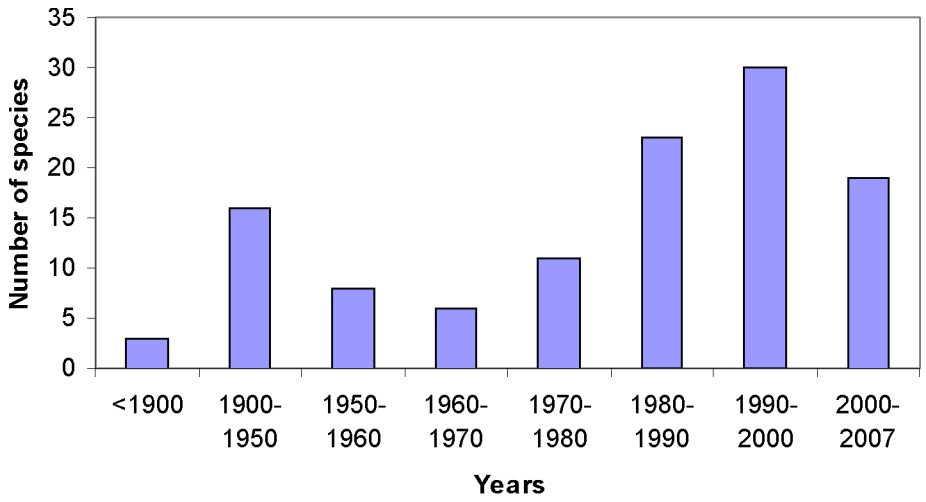

Figure 2. New records of non native species in Spanish coast from 1900.

At the moment, 131 species of marine organisms have been identified as non-native. The majority of these species are crustacean (27 species), molluscs (18) and seaweeds (52). The Spanish coast is distributed along the Mediterranean, Atlantic and Macaronesian biogeographical regions. In this report, only data from the Atlantic and Mediterranean coasts were considered (Figure 3), and fish from the Atlantic Ocean that were found in the Mediterranean Sea via Gibraltar Strait were also not considered.

In the 2005–2006 six new records from mollusca, crustacean and tunicate were recognized in the Atlantic coast of Spain (Table I).

Table I. First records from Spain (2005-2006)

Genus	Species	Common na	Locality	Latitude	longtitude	comments	date
Xenostrobus	*securis*	mollusca	Ria de Vigo	42°13´34"	8°48´29"	established	2005
Callinectes	*sapidus*	crustaceans	Gijón (Port of Musel	43°33´42"	´5°45´40"	individual	2005
Calllinectes	*sapidus*	crustaceans	Sevilla (Guadalquivi	37°23´07"	6°00´03"	established	2005
Hemigrapsus	*takanoi*	crustaceans	Guipuzcoa	43°19´40"	2°04´24"	present	2006
Hexapleomer	*robusta*	crustacean	Guipuzcoa	43°19´40"	2°04´24"	present	2006
Hyale	*spinidactila*	crustacean	Guipuzcoa	43°19´40"	2°04´24"	present	2006
Corella	*eumyota*	tunicate	Guipuzcoa	43°19´40"	2°04´24"	present	2006

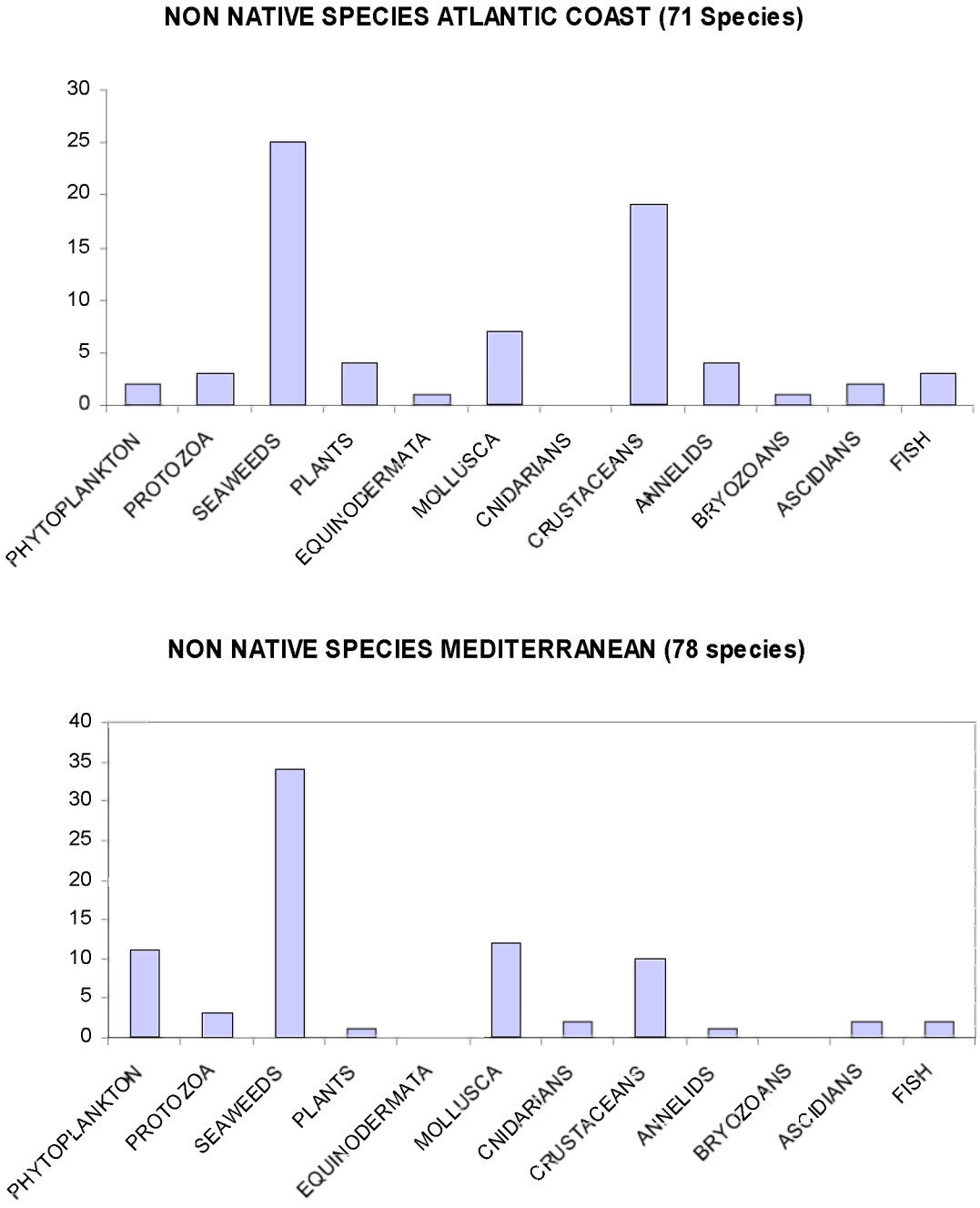

Figure 3. Number of non-native species from different taxonomical groups in the Atlantic and Mediterranean coast (Spain).

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NATIONAL REPORT Sweden, 2006

Prepared by: Inger Wallentinus and Susanna Pakkasmaa

HIGHLIGHTS

- The comb jelly *Mnemiopsis leidyi* was recorded at the northern part of the Swedish Skagerrak coast from mid-September to November 2006; the large population size indicates that the species had arrived before 2006.
- In 2006, many more individuals of the Chinese mitten crab, *Eriocheir sinensis* were recorded in Lake Vänern than previously.
- In 2006, the Japanese red alga *Heterosiphonia japonica* was recorded much further south (ca. 140 km) on the Swedish west coast in the NE Kattegat (Göteborg), previously only seen in the northernmost part of the Skagerrak.

1.0 LAWS AND REGULATIONS

There are no new laws or regulations, but the Swedish EPA is considering the need for changes.

2.0 DELIBERATE RELEASES

2.1 Finfish

In 2005, 1.95 million Atlantic salmon (*Salmo salar*) smolts were released in rivers and coastal areas of the Baltic Sea, and 200 000 smolts on the Swedish west coast. The number of stocked sea-trout (*Salmo trutta*) smolts in the Baltic Sea was 628 000, and on the west coast 7000. Stocking of salmon and trout is also performed in some of the largest inland lakes and rivers (191 000 salmon and 74 000 trout). The objective is to use native stocks in compensatory stocking.

In 2006, about 580 000 glass eels (*Anguilla anguilla*) were imported from England and released in the coastal areas of the Baltic Sea.

3.0 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Finfish

There are still NO reports of the round goby *Neogobius melanostomus* from Swedish coastal waters, despite its common occurrence in Gdansk Bay, Poland, at some sites in northern Germany, Estonia, Lithuania, and most recently, a record from the Turku archipelago, Finland, in February 2005. There are ongoing studies, in cooperation with Polish scientists, on the behaviour, life history traits and ecology of the invasive *N. melanostomus*, in Gdansk Bay, in relation to habitat variations, structure as well as size and age at sexual maturity (Almqvist 2005, Karlson *et al.* in press). During 2006, fecundity studies were performed in the Gdansk Bay. It is believed that the lack of spawning areas may hamper the dispersal of the species in the southern and south-eastern Baltic Sea (Almqvist et al. submitted manuscript).

3.2 Invertebrates

The comb jelly *Mnemiopsis leidyi* was recorded outside Tjärnö (58°52'N, 11°06'E) at the northern part of the Swedish Skagerrak coast from mid-September to November 2006 (Hansson, 2006). The large population size indicates that the species had arrived before 2006. They might have benefited from the unusually warm water, perhaps in combination with less competition from other scyphomedusae, which occurred deeper down. Large amounts of lobed ctenophores were also seen during last autumn further south, in the Gullmar fjord area, but identification to species has not been verified (Peter Tiselius, Göteborg Univ. pers. comm.).

According to Hansson (2007 pp. 71–72) *Mnemiopsis leidyi* occurred in the Oslofjord already during autumn in 2005, as could be identified from photos on the Internet.

A new DNA-based method and new species-specific primers, amplifying a 154-bp fragment of mitochondrial 16S rDNA gene, have been developed to quantify the importance of the cladoceran *Cercopagis pengoi* as a prey for native fish and macroinvertebrates (Gorokhova 2006). The contribution of *C. pengoi* to the diets of other zooplanktivores has not been addressed earlier, mostly because of the inadequacy of microscopic methods for diet analyses. By this technique it was possible to identify *C. pengoi* in stomachs of *Neomysis integer*, a common Baltic mysid. The technique will probably also be useful for diet analysis of other predators, both invertebrates and vertebrates, in a variety of trophic studies. This could contribute to a growing body of evidence that *C. pengoi* successfully integrates into food webs in the invaded ecosystems and that it represents novel prey not only for fish but also for invertebrate zooplanktivores. Trophic interactions between *Cercopagis pengoi* and the native mysids, *Mysis mixta* and *M. relicta*, were studied in the Gulf of Finland, using feeding experiments, molecular markers, and stable isotopes (Gorokhova and Lehtiniemi 2007).

Both mysid species ingested *C. pengoi* with a maximum of 16 prey mysid^{-1} d^{-1}, similar to for other prey species. All methods indicated higher contribution of *C. pengoi* to nutrition of juveniles and of *M. mixta*, which likely reflect differences related to the different migratory behaviour of the mysids. Thus, despite the low relative abundance, *C. pengoi* is readily consumed by mysids, which may impact lower food web interactions and the nutrition of mysids.

Competition between two co-occurring copepods *Acartia tonsa* (an introduced species) and *A. clausi* over a wide salinity range (2–33 psu and 16–33 psu, respectively) has been studied experimentally (Calliari *et al.* 2006). For *A. tonsa*, the energy partitioning between ingestion, production and respiration was relatively constant with small differences in gross growth efficiency and cost of growth. In contrast, *A. clausi* exhibited significantly reduced ingestion and gross growth efficiency, and highly elevated cost of growth at salinities ≤20. These results contribute to the understanding of distribution patterns of the two species along salinity gradients, which would allow the dominance of *A. tonsa* at low salinities, although its higher energetic requirement and feeding activity, it is subjected to stronger predation pressure than competing *A. clausi*.

The polychaete *Marenzelleria* is still referred to as cf. *viridis* in the monitoring programmes. Strömberg and Persson (2006) studied available samples in the northern Sound around Helsingborg and concluded that those most likely really belonged to this species, while it is less certain for other programmes. Only a few individuals were seen, the highest density north of the Sound in Skälderviken. In 2005, *Marenzelleria* had become very common also at the reference stations to the nuclear power plant at Forsmark, the S Bothnian Sea, and comprised up to 81 % of all individuals, while previously only single specimens had been found (Adill *et al.* 2006). In the species-poor Gulf of Bothnia, Leonardsson and Karlsson (2006) have related the densities of *Marenzelleria* to the quality assessment (BQI) used for benthic macrofauna. They showed that at low densities (50 ind m^{-2}) *Marenzelleria* would in fact increase the quality index slightly (number of species is included in the index), as would the low quality indices for higher densites (550 or 1000 ind m^{-2} – already experienced at many stations). On the other hand, at high densities the indices showing higher qualities would decrease slighly, They recommended that the class values rendered by this index should be adjusted.

Every year single specimens of the Chinese mitten crab, *Eriocheir sinensis,* are reported. In 2006, a fisherman in Lake Vänern (Kinneviken) had caught around 300 crabs, and also from other parts of this lake (the largest in Sweden) many catches have been reported as far in as Glafsfjorden. Some crabs have been caught in this lake previously, but not as many as last

year. There is a proposal for a project, trying to solve why the crabs have increased so much (Marcus Drotz, Vänermuseet, Lidköping pers. comm.) He has been informed of the record of egg-carrying females south of Göteborg (connected to Vänern by the river Göta Älv) some years ago (see WGITMO, 2005), and perhaps some spawning population exists on the Swedish west coast (salinity around 20–25 psu). The Chinese mitten crab was also was very common on the Swedish east coast of the Baltic proper (in Bråviken one fisherman caught 10 individuals last summer and another up to 30 individuals each time), and single specimens were caught on the coast of the island Gotland and southeast of Sundsvall, in the northern Bothnian Sea, as well as in some inland lakes. There are NO reports of mass migrations.

Despite the records of American lobster in Norway and a confirmed recent (December 2006) record from the Öresund (Øresundsvandsamarbejdet, 2007), there are still NO reports of the species from Swedish waters (Mats Ulmestrand, Swedish Board of Fisheries, pers. comm.).

3.3 Algae and Higher Plants

Macroalgae

In 2006, the Japanese red alga *Heterosiphonia japonica* (i.e. "*Dasysiphonia* sp." in WGITMO reports until 2003) was also very common on both sides of the Kosterfjord, N Bohuslän, the NE Skagerrak coast, (Jan Karlsson and Annelie Lindgren, Göteborg Univ., pers. comm.). In the summer it was recorded for the first time much further south (ca. 140 km), south of the small island Vinga, west of Göteborg city, the NE Kattegat, (Bo Gustafsson, Göteborg Univ. and county administration of Halland, pers. comm.). It is not known if this is a secondary dispersal by fishing or leisure boats from the northern part of the Swedish west coast, for example - no reports of the species in between the two areas and the surface currents are going north – or an introduction from Denmark, where it has been found in the northern Kattegat and the Limfjorden since 2005 (Thomsen et al. in press). It might also be a new introduction by a ship from elsewhere, since the location is just outside the harbour of Göteborg.

There are no reports of further dispersal in Sweden of the large Asiatic red alga *Gracilaria vermiculophylla,* first recorded during August-September 2003 in the Göteborg archipelago, (see WGITMO-reports, 2004, 2005, 2006), nor of the small red alga *Aglaothamnion halliae* (see WGITMO, 2004, 2006).

3.4 Parasites, pathogens and other disease agents

The fish health status in Swedish farms is still good, and in total 6 infections, half of which were new infections (1 BKD, 1 *Gyrodactylus*, 1 yersiniosis), were recorded in Swedish fish farms during 2006.

A new bacterial infection, caused by *Francisella* sp., has been recorded in wild cod on the Swedish west coast. There is little information about the health status of wild fish stocks (and no regular monitoring program), and therefore it is also unknown how long cods have been carrying this infection or how frequent it is among wild fish.

Sixty percent of the eels caught in 2005 at the Oskarshamn nuclear power plant water intake (SE Sweden) were found to be infected by the nematode *Anguillicola crassus* (first seen in the area in 1988), which is slightly less than the mean during the previous five-year period. The majority of eels had less than ten parasites, however one had 30. The percentages of infested eels caught by fishermen in two bays in the surroundings was 50 and 64 % (Franzen, 2006).

4.0 LIVE IMPORTS during 2006 (for EU countries amounts may be underestimated)

4.1 Fish

For consumption/processing

Glass eel (*A. anguilla*)	Import permissions	Quantity
Country of origin		
England	1	600 kg

Ornamental fish

Koi (*Cyprinys carpio*)	Import permissions	Quantity
Country of origin		
Israel	1	2500 inds
Japan	1	500 inds
Thailand	1	500 inds
Denmark	1	15 inds

4.2 Live invertebrates for consumption/processing

Crustaceans	Import permissions	Quantity
	6	non-specified

5.0 LIVE EXPORTS during 2006

5.1 Fish

For consumption/processing (Metric tonnes)

Eel 532

Carp 1

Ornamental fish (aquarium fish)

Freshwater spp. 121

Marine spp. 1

5.2 Live invertebrates for consumption/processing

Mytilus edulis 746

6.0 Meetings, Conferences, Symposia, Workshops, Projects on Introductions and Transfers

Recently, there have been many studies from different aspects related to the fouling barnacle *Balanus improvisus* (Larsson, 2006; Marine Paint, 2006; Brock *et al.* in press).

The interdisciplinary research programme Marine Paint, with scientists from Göteborg University and the Chalmers University of Technology in Göteborg has been financed since 2003 by MISTRA – The Foundation for Strategic Environmental Research. It is aimed at tackling the problem of marine biofouling of boats and ships hulls by developing effective and environmently-friendly paints. Among other things, they have developed a substance which, when added in very small amounts to a paint, can keep a surface entirely free from barnacles. A continuation, known as New Marine Paint, was awarded in 2007 with extended funding of SEK 44 million until 2010. Work is now continuing to develop a paint system for this substance, and to develop agents that will prevent all types of hull fouling.

The plankton group at Stockholm University continues to participate in the development of the ballast water treatment system conducted by the Swedish companies Wallenius Water

(previously Benrad Marine) and Alfa Laval. Methods were developed for evaluating viability in phyto- and zooplankton organisms and apply them in the laboratory and field tests to assess the efficiency of the equipment (Elena Gorokhova, Stockholm Univ., pers. comm.).

A topical session "Non-indigenous Aquatic Species – An Integrated Approach" was arranged at the ASLO Summer Meeting, June 4–9, 2006, Victoria, British Columbia, Canada. Besides Ph.D. students and senior scientists from the Swedish research programme AquAliens (who initiated the session), scientists from several other countries also contributed to this session with oral presentations and posters. During autumn 2007, the research programme AquAliens will summarize and report on the results of the programme.

The web site "Främmande arter i svenska hav" (Alien species in Swedish seas and archipelago areas) (http://www.frammandearter.se) is now partly available in English, covering parts of the text as well as the descriptions of the alien species (for more information see WGITMO 2006).

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NATIONAL REPORT United Kingdom, 2006

Compiled by: Gordon Copp, Ian Laing & Tracy Edwards

HIGHLIGHTS

- Deliberate releases of Pacific oysters for cultivation continue at a similar level to that in previous years.
- A survey of the distribution of *Styela clava* (leathery sea squirt) in Europe has been completed. In all, 260 harbours and marinas in Europe (excluding Denmark); from Scotland in the North to Portugal in the South, and from Ireland in the West to Italy in the Mediterranean Sea, Finland in the Baltic Sea and Romania in the Black Sea in the East were visited. Populations were found in only 64 of the sites.
- Of the seven species most closely monitored by the Marine Aliens Project (www.marlin.ac.uk/marine_aliens): (1) *Caprella mutica* has still only been found on artificial structures to date. The global status of *Caprella* is highlighted by a publication (in press); (2) *Styela clava* and *Perophora japonica* ranges do not appear to have extended over the last year; (3) Chinese Mitten Crab has been reported as now reaching the River Dee (Wales), which suggests a clockwise extension around the UK; (4) *Corella eumyota* (tunicate) has been reported along the south coast of England; and (5) Slipper limpets *(Crepidula fornicata)* have recently been found in the Menai Strait (Wales), most likely introduced with mussel seed (Countryside Commission for Wales, personal communication).
- The zebra mussel has been found at Monks Pool in Johnstown. This is the first confirmed sighting in North Wales.
- There were five records of non-native signal crayfish (*Pacifastacus leniusculus*) extending their range into new areas of Great Britain in 2006. These are likely to have been the result of transfers by people in ignorance of the laws designed to prevent such movements. There were also three incidences non-native crayfish turning up in the ornamental fish trade.
- *Sargassum muticum* range appears to have remained stable in Wales, though increased abundances (in North Wales) have been anecdotally recorded. However, in Scotland, it has now appeared in Loch Fyne (Summer of 2006). This is the fourth report of this alien species in Scotland since it was first recorded in Loch Ryan in 2004.
- A draft document for the Global Biodiversity Sub-Working group of the UK Global Environmental Change Working group has suggested research priorities for invasive alien species. Although priorities have not yet been assigned, trade patterns, projections, island endemism, research into impacts and control are all being considered.
- The GB Strategy Working Group has recently published the draft 'GB Invasive Nonnative Species Framework Strategy' for consultation (closes 23rd May 2007). This consultation document suggests ways by which the actions of government departments, their related bodies and key stakeholders can be better coordinated. Its overall aim is to minimize the risks posed, and reduce the negative impacts caused, by invasive non-native species in Great Britain.

1.0 LAWS AND REGULATIONS

In 2006, legislation relevant to non-native species introductions and transfers that came into force was the Natural Environment & Rural Communities Act (i.e. NERC, 2006), which includes restrictions on the sale of specified species. After much debate, fish were not included amongst the organisms banned from sale because this would duplicate controls already in place, specifically the Import of Live Fish Act 1980, and subsequent, related legislative orders.

2.0 DELIBERATE INTRODUCTIONS AND TRANSFERS

2.1 Fish

The UK Database and Atlas of Freshwater Fishes (DAFF, 2002), which contains records of fish surveys and occurrences in the wild for the period prior to 2001, has been subjected to analysis with specific regard to the incidence of non-native fishes in rivers and streams of the UK for the years 1961 to 2000 inclusive (Copp *et al.*, 2006a). The proportion of records pertaining to non-native fishes was found to have remained more or less constant, but the mean number of non-native species was significantly higher in 1991–2000 than in earlier decades, and the proportion of records pertaining to certain species have increased whilst others have decreased.

Dead specimens of the marine species porcupinefish *Diondon hystrix* and the tropical freshwater species (piranha *Pygocentrus* sp.) documented in the 2005 report have come out in published form (Ellis, 2006).

Other records of non-native fishes include the first report in the wild of the white catfish *Ameiurus catus*, which was found in Epson Stew Pond, Epsom Common, Surrey, southern England (Britton and Davies, 2006). Initially identified as an albino channel catfish *Ictalurus punctatus*, the specimen was later identified to white catfish.

Five specimens of bighead carp *Hypophthalmichthys nobilis* were found in Windmill Lake, Denver, Downham Market (Cambridgeshire) in December 2005/January 2006 (Britton and Davies, 2007). Although imported legally into the country for keeping in a secure aquaculture facility, no licenses to release the species had been granted, so the specimens are considered to have been intentional, illegal introductions to the wild.

2.2 Invertebrates

Deliberate releases of Pacific oysters for cultivation continue at a similar level to that in previous years. A survey in Devon found substantial wild populations at sites along the River Yealm, where aquaculture of the species has taken place since its introduction in 1965. The greatest abundance of individuals was observed at the closest site to the local oyster farm. There was a noticeable decrease in abundance from estuarine sites to the open coast suggesting that local aquaculture has been a source of recruitment. Individuals were also observed in areas around Plymouth even though commercial production of the species has never occurred in the surrounding estuaries. The site found to support the highest number of individuals is a marina where the only space available was the structure holding the visitor's pontoon and *C. gigas* appeared to have optimized this space (Couzens, 2006). The Pacific oyster is also reported to be recruiting naturally in the estuary of the River Thames and specimens have been recorded as far as Folkestone, Kent, where a single individual was seen attached to a boulder at mid-tide level.

The managed Manila clam fishery in Poole Harbour continues to flourish; 350 tonnes were harvested in 2005. There are occasional reports of individuals of this species elsewhere, mainly in the Thames area near the hatchery, but no evidence of other self-sustaining populations.

3.0 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Fish

The North American white sucker *Catostomus commersoni* has only once been reported in open waters of Europe (Copp *et al.*, 1993), and this was a single specimen found in the River Gade at Hemel Hempstead (Hertfordshire, England) in 1992. The species was not found again until 2004, when an additional seven specimens were found during routine and follow-up

surveys (Copp *et al.,* 2006b). During these surveys, specimens of other non-native ornamental fish species were also captured (golden orfe *Leuciscus idus*, goldfish *Carassius auratus*, mirror carp *Cyprinus carpio*). It remains unknown whether these occurrences derive from intentional or accidental introductions.

The role of accidentally-introduced fish species in hosting and transmitting diseases has been examined for sunbleak *Leucaspius delineatus* (Beyer *et al.* 2005), and reviewed in general with regard to the impacts on biodiversity of fish movements for the ornamental and pet trades (Gozlan *et al.*, 2006).

3.2 Invertebrates

Marine

A full-grown (15–17 cm) live specimen of tiger prawn (Penaeid, possibly *Penaeus japonicus*) was caught in 35 fathoms of water off Start Point (Western English Channel at 50 deg 08.066 N 03 deg 48.335 W) on 25 January 2007 (report provided by J. Ellis, Cefas-Lowestoft). There is anecdotal evidence of previous records, probably of the same species. This prawn is farmed in France.

A survey of the distribution of *Styela clava* (leathery sea squirt) in Europe has been completed. In all, 260 harbours and marinas in Europe (excluding Denmark); from Scotland in the North to Portugal in the South, and from Ireland in the West to Italy in the Mediterranean Sea, Finland in the Baltic Sea and Romania in the Black Sea in the East were visited. Populations were found in only 64 of the sites. No specimens were found in water with salinity <20 psu or >35 psu. No specimens were found in 50 surveyed harbours in the Mediterranean Sea. No specimens have been found in sites where water temperatures do not exceed 16°C during the summer months. Finally, no specimens were found in shallow exposed sites; supporting the observation that *S .clava* is apparently intolerant of wave exposure.

Natural England (previously 'English Nature') have claimed that the mitten crab is burrowing extensively into the river banks around the Humber and the estuary area and gradually destroying the flood defenses, bringing a serious threat of flooding. They also claim that the crab is attacking marine life, including the Humber fishery.

This report follows a study by scientists from the University of Newcastle upon Tyne (Herborg *et al.*, 2005). This details how the UK colonisation of mitten crabs has increased on a large scale in recent years. The pattern of the crabs' ongoing invasion of the UK is similar to the population expansion in Europe earlier in the last century. Chinese mitten crabs are already present in the Thames, Humber and Tyne rivers and parts of the North Sea and Channel coasts. Recently, it has been spreading at a very fast rate. From 1997–1999 the spread along the coast was 448 km per year - nearly six times the average spread of 78 km per year from 1976–1999. In rivers, the increased spread from 1995–1998 was 49 km per year, around three times the average spread of 16 km per year from 1973–1998. The authors predict that the mitten crab has the potential to establish itself in all major UK estuaries in several years time.

A survey of mitten crabs from the River Thames found no evidence of infection with the human lung fluke (*Pseudamphistomum truncatum*), which is sometimes carried by crabs in their native range. This finding is important, as it is possible that a fishery for these crabs will develop in the UK, to supply ethnic markets.

Of the seven species most closely monitored by the Marine Aliens Project

(www.marlin.ac.uk/marine_aliens): (1) *Caprella mutica* has still only been found on artificial structures to date. The global status of *Caprella* is highlighted by a publication (in press); (2) *Styela clava* and *Perophora japonica* ranges do not appear to have extended over the last year;

(3) Chinese mitten crab has been reported as now reaching the River Dee (Wales), which suggests a clockwise extension around the UK; 4) *Corella eumyota* (tunicate) has been reported along the south coast of England; and 5) slipper limpets *(Crepidula fornicata)* have recently been found in the Menai Strait (Wales), most likely introduced with mussel seed (Countryside Commission for Wales, personal communication).

Freshwater:

The zebra mussel has been found at Monks Pool in Johnstown. This is the first confirmed sighting in North Wales. Anglers are being encouraged to wash all equipment, including nets, with disinfectant to help prevent the further spread of this invasive organism.

There was one confirmed crayfish plague outbreak in 2006, in a river catchment where the disease has been seen before. There were five records of non-native signal crayfish (*Pacifastacus leniusculus*) extending their range into new areas of Great Britain in 2006. These are likely to have been the result of transfers by people in ignorance of the laws designed to prevent such movements. There were also three incidences non-native crayfish turning up in the ornamental fish trade. As the keeping of non-native crayfish as ornamental animals is prohibited in GB, these animals were destroyed, two at the point of import, the other post-import. It appears that there remains a small volume of trade in crayfish from other EU member states, where they are more widespread in the ornamental trade.

3.3 Algae and Higher Plants

Sargassum muticum range appears to have remained stable in Wales, though increased abundances (in North Wales) have been anecdotally recorded. However, in Scotland, it has now appeared in Loch Fyne (Summer of 2006). This is the fourth report of this alien species in Scotland since it was first recorded in Loch Ryan in 2004. Since then, populations have also been found at Great Cumbrae Island and on the North Ayrshire coast, which indicates a movement north along the west coast of Scotland. It may also be present, but as yet unidentified, in other locations in the Firth of Clyde. *Heterpsiphonia japonica* has recently been reported in the Moray Firth in Scotland, although data are currently unavailable to qualify current status in Scotland or explain spread from the south coast of England.

Undaria pinnatifida range does not appear to have extended over the last year.

4.0 LIVE IMPORTS AND TRANSFERS

4.1 Fish

Imports of rainbow trout eggs into the UK were 41.3 million in 2005 (21.4 million into England and Wales, 19.9 million into Scotland). This represents a decrease of 23% on the total number of eggs imported in 2004 (53.7 million). These eggs came mainly from Denmark (36%), the USA (35%) and the Isle of Man (21%), with the remainder from disease-free sources including Northern Ireland, Australia and France.

Over 131 tonnes of live eels were imported from Holland (125 tonnes), France (6.6 tonnes, mostly juveniles) and Spain (34 kg) in 2006. The total represents a reduction of about 26% from that in 2005. In Scotland, small numbers of eggs (< 10 000) of arctic charr, cod and brown trout were imported for aquaculture of these species. Imports of Atlantic salmon eggs into Scotland were 16.8 million. This represents a small decrease from the previous year (17 million in 2004). These eggs came mainly from Norway and other EU member states, with small quantities from the USA. Scotland also received 150 000 salmon parr and smolts from other EU member states. This is a smaller quantity than imported in 2004 and a considerable reduction from the 2–3 million imported in years previous to 2003.

4.2 Invertebrates

The hatchery on Guernsey sent 350 000 (0.6 tonnes) Pacific oyster seed of hatchery origin to shellfish farm sites in England. In addition, and for the first time in 2006, part grown Pacific oysters were imported from France and Jersey for on-growing. One consignment was rejected as not fulfilling shellfish health requirements, as there were other mollusc species present. It is considered that even the washed consignments that meet inspection standards, represent a risk of transfer of alien nontarget species.

Imports of non-native species of live bivalve molluscs and crustaceans for human consumption continue. There are strict controls to prevent them being deposited into the wild, through both disease control and wildlife legislation. About two thousand tonnes of live molluscs were imported in 2005, with two thirds of this total from other EU Member States. In addition, about 800 tonnes of live Canadian/American lobsters were bought in to the UK.

There were no reports of American lobsters being caught in the wild in 2006.

5.0 LIVE EXPORTS TO ICES MEMBER COUNTRIES

5.1 Fish

In 2005, a total of 13.2 million Atlantic salmon ova were exported from Scotland.

This is over double the number exported in 2004 and returns the trade to a level similar to that in 2001. Most of the other ova exported went to Chile or to other EU member states, with 1.6 million being sent to the Faroe Islands for the first time.

5.2 Invertebrates

Specific information on seed shellfish for relaying is only available where exports are to EU Approved Zones. Pacific oyster seed produced in UK hatcheries were exported to Eire, Guernsey and Northern Ireland (56 consignments). There was a significant change in the pattern of trade in seed mussels, *Mytilus edulis*, in 2006 with over 100 consignments being sent to Ireland (North and South). Some of these seed mussels were collected in areas affected by slipper limpets and there is concern that this species may become introduced to Ireland through these seed mussel movements.

Significant quantities of live mussels are exported to The Netherlands, where they may be re-immersed and so there is also concern here about the risks of introduction of alien non-target species. The Dutch authorities have sponsored a report that concluded that the risk that the transfer of mussels from the Irish and Celtic Sea to the Oosterschelde will lead to substantial ecological impact as a result of importing exotic non-indigenous species is small, but not totally absent (Wijsman and Smaal, 2006).

The UK is a net exporter of live shellfish for human consumption and almost all of the trade (22 000 tonnes of bivalve molluscs and 1,400 tonnes of lobsters) goes elsewhere in Europe.

6.0 MEETINGS ETC.

6.1 Research initiatives

6.1.1. Eradications of topmouth gudgeon *Pseudorasbora parva*, an Asiatic cyprinid that now occurs in most European countries, have begun in the UK using rotenone (Allen *et al.*, 2006). The first such eradication was undertaken in a small lake of northwest England near Kendall, Cumbria (Britton and Brazier, 2006). The species was discovered in 2002 and because the lake drains into a river system that passes through a site of high conservation interest (and connects further on the English Lake District), the eradication was considered essential. The work was carried out in the Spring of 2005 and to date it appears to have been a success.

6.1.2. A rapid assessment survey for non-native species was conducted at 12 harbours along the south coast of England from East Sussex to Cornwall, focusing on communities of algae and invertebrates colonizing floating pontoons in marinas (Pederson *et al.*, 2006). Over 80 taxa each of algae and invertebrates were recorded, including 20 recognized non-native species. The southern hemisphere solitary ascidian *Corella eumyota* was recorded in the UK for the first time and was present at three sites. The colonial ascidian *Botrylloides violaceus* was also recorded as new to the UK, but was very widespread and has probably been present for a number of years but misidentified as the native congener *B. leachi*, which was infrequent. Other ascidians included *Styela clava*, introduced at Plymouth in the early 1950s, which was recorded at all locations visited, and *Perophora japonica*, which was found only at the Plymouth locality where it first occurred in the UK in 1999. The diverse algal flora included nine alien species previously recorded in the British Isles. Range extensions and population increases were noted for the kelp *Undaria pinnatifida* and the bryozoan *Tricellaria inopinata*, both first recorded in UK waters during the 1990s. The widespread occurrence of another non-native bryozoan, *Bugula neritina*, appears significant, since in earlier times this was known in UK waters predominantly from artificially heated docks. The results of this survey indicate that dock pontoon systems in southern England are significant reservoirs of non-native species dispersed by vessels and other means. The proliferation of these structures is therefore of conservation importance. The new UK records highlight the need for periodic monitoring of ports for non-native species.

6.1.3. In August 2006, the ten largest marinas in Scotland were surveyed for the presence of seven non-native species, known to occur at other locations within the UK (Ashton *et al.*, 2006). As part of the Marine Aliens Project, species surveyed were: the crustaceans *Caprella mutica* and *Eriocheir sinensis*, ascidians *Perophora japonica* and *Styela clava*, the green alga *Codium fragile* subsp. *tomentosoides*, and brown algae *Sargassum muticum* and *Undaria pinnatifida*. The status of these species are reported elsewhere in this report. A variety of structures, including pontoon floats, chains and harbour walls were inspected to a depth of 0.5 m for the presence of these non-native species. Seven of the marinas had one or more of the target species. *C. mutica* was found at seven marinas; *C. fragile* subsp. *tomentosoides* at two marinas; *S. muticum* and *S. clava* were each found at a single marina; *E. sinensis*, *P. japonica* and *U. pinnatifida* were not found. The survey suggests that recreational boating is an important vector for the dispersal of marine non-native species, and that marinas may act as a refuge for such species. Further and regular port surveys throughout the UK are recommended to provide an effective early warning system for invasive nonnative species. Further port surveys are planned (see below)

Liz Cook (Scottish Association for Marine Science; SAMS) is currently progressing work on: 1) community resilience to invasives (particularly *Sargassum*; 2) effects of changes in seawater temperature (climate change) on marine non-natives (especially Pacific oyster *Crassostrea gigas*); and 3) port monitoring surveys (continued series of 6.1.3 above). Chinese Mitten crab research is ongoing concerning possible control through fishing (SAMS pers comms.).

Two MSc students from Herriot-Watt University are working on the invasion of *Sargassum muticum* on the West Coast of Scotland although there research is not yet published. Scottish National Heritage (SNH) are supporting these students a casepartner. The Countryside Commission for Wales (CCW) are also funding a PhD student to look at the genetics of *Sargassum* in Wales to try and ascertain the most likely route of introduction and whether the records are all from one introduction or several. As part of this, a GIS layer of current invasion status will be produced. The Scottish Environmental Protection Agency (SEPA) is beginning to collect *S. muticum* as part of routine monitoring, which probably relates to alien species issues raised by the Water Framework Directive (WFD). Research in Plymouth (south coast of England) suggests that *S. muticum* in rock pools was not problematic by shading out other

species. However, other work in the sub-tidal suggests this is not the case (Liz Cook (Scottish Association for Marine Science), personal communication).

6.1.4. The Centre for the Economics and Management of Marine Resources (CEMARE) at Portsmouth University (UK) collaborated with the Scottish Association for Marine Science (SAMS- UK), to assign economic value for environmental impact and ecosystem function. This was reported in the Non-Natives Species Research Strategy, published by the Biodiversity Research Action Group (BRAG) Non-Native Species Sub-Group (www.ukbrag.org.uk).

6.1.5. Technology now allows one to produce tetraploids oysters, which are fertile. Without any regulation and recommendation, transferring those animals may interact directly with local reproductive populations, resulting in 3N (sterile) natural population, resulting in a significant risk. Therefore, the use of tetraploids is strictly restricted to quarantine stations in France. (No reference available).

6.2 Policy initiatives

6.2.1. An EC-funded Coordinated Action on the '*Environmental impacts of alien species in aquaculture* (IMPASSE)' was initiated in December 2006, led by Prof. Ian G. Cowx (Hull International Fisheries Institute, University of Hull). This project is designed to support the draft EC regulation '*Rules governing the introduction of exotic species and on containment of stock in aquaculture*' (FISH A3/RB/2004025-

A3). IMPASSE responds directly to Task 12, priority area 8.1. B.1.3 and will develop '*Guidelines for environmentally sound practices for introductions and translocations in' aquaculture, guidelines on quarantine procedures, and risk assessment protocols and procedures for assessing the potential impacts of invasive alien species in aquaculture*'.

6.2.2. A draft document for the Global Biodiversity Sub-Working group of the UK Global Environmental Change Working group has suggested research priorities for invasive alien species. Although priorities have not yet been assigned, trade patterns, projections, island endemism, research into impacts and control are all being considered.

The Biodiversity Research Action Group (BRAG) is to be re-launched imminently at: www.ukbrag.org.uk and can be found through the Joint Nature Conservation Council (JNCC) website. It is anticipated that a reunion meeting of the non-natives species sub-group will be held soon to stimulate further interest in research opportunities.

6.2.3. Defra (UK Department of Environment, Food and Rural Affairs) has established the GB Non-native Species Programme Board (PB), which coordinates through the Non-native Species Secretariat (based at the Central Sciences Laboratory, York). One of the panels that reports to the PB through the Secretariat is the Non-Native Risk Analysis Panel (NNRAP), which meets quarterly to assist in the development of risk analysis protocols and the review of risk assessments. Further working groups support the PB.

The GB Strategy Working Group has recently published the draft 'GB Invasive Nonnative Species Framework Strategy' for consultation (closes 23rd May 2007). This consultation document suggests ways by which the actions of government departments, their related bodies and key stakeholders can be better coordinated. Its overall aim is to minimize the risks posed, and reduce the negative impacts caused, by invasive non-native species in Great Britain.

The Defra Programme Board issued two main contracts for work this year, which were: (1) An audit of non-native species research in GB; and (2) A review of existing surveillance and monitoring mechanisms (with a view to recommendations for appropriate recording on non-natives in GB). Argyll & Bute (area in Scotland) have recently formed a non-natives species forum.

Sargassum muticum is also included within the Scottish Natural Heritage (SNH) Species Framework as the marine non-native choice which sets out the Scottish conservation agency's aims for action and resources to be deployed in future years.

6.3 Meetings

6.3.1. In the UK, The Water Framework Directive Alien Species Group (WFD ASG) meets on an ad hoc basis to support the work of the TAG (Technical Advisory Group), to address issues surrounding the inclusion of non-native species in the implementation of the WFD. Updates have recently been provided to TAG regarding '*Guidance on the assessment of alien species pressures*'. Changes refer to the list of aquatic non-native species, both by adding or deleting some species, and by moving others from one impact category to another for the purposes of the WFD.

A European workshop was held in spring 2006 to discuss how other European countries were taking account of non-native species within the WFD.

The Eurostat (European Status) group for the Water Framework Directive met in July 2006 and agreed that alien species should be included within the 2007–2010 work program.

6.3.2. The next Defra Non-native Species Forum is scheduled to meet on 3 May in Edinburgh.

6.3.3. A number of conferences and symposia held in 2006 focused on, or had special sessions addressing, non-native species:

- The International Workshop on '*Biological Invasions in Inland Waters*', 5–6 May 2005, Florence, Italy.
- '*Change in Aquatic Ecosystems: Natural and Human Influences*' 2007. July 4–6, 2007. Planned themes include mechanisms of invasion and impacts of nonnative species. University of Plymouth, UK.
- 4th European Conference on '*Biological Invasions (Neobiota) — from Ecology to Control'*, Vienna, Austria, 27–29 September 2006.

Amongst the most notable of forthcoming symposia are:

- The Annual Conference of the Fisheries Society of the British Isles '*Integrated Biology of the Establishment Success and Dispersal of Non-Native Fishes*', which will be held 23–27 July 2007 in Exeter, England.
- The 15th International Conference '*Aquatic Invasive Species*', which will be held in Nijmegen, Netherlands, on 23 to 27 September 2007.

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NATIONAL REPORT United States, 2006

Prepared by Gregory Ruiz, Paul Fofonoff and Judith Pederson

HIGHLIGHTS

- The range and abundance of *Pterois miles/volitans complex* (Red Lionfish) continues to expand in the Northwest Atlantic. In 2006, specimens have been captured as far north as Jamestown, Rhode Island, on Narragansett Bay, and the first records were reported from the Gulf of Mexico, and Treasure Island, Florida.
- *Rhinogobius brunneus* is now established and reproducing in drainages of the Columbia River in Washington State.
- *Phyllorhiza punctata* (Australian Spotted Jellyfish) appeared for the first time in Galveston Bay, Texas. and in July it extended its range about 200 km north to Guana Lake, a lagoon near Augustine Inlet, Florida
- *Mytella charruana* (Charru Mussel), was found "growing heavily on floating docks" on the Medway River, flowing into St. Catherines Sound, Georgia.
- *Perna viridis* (Green Mussel) continues to expand its range northward along the Atlantic Coast. In October, 2006, it was collected for the first time in South Carolina waters, in Charleston Harbor and surrounding waters.
- A single specimen of *Cancer magister* (Dungeness Crab) was caught in the Atlantic Ocean off Gloucester, Massachusetts. This specimen was apparently discarded or escaped from a live-seafood market. There are no other reports of this crab from the Atlantic.
- Specimens of *Eriocheir sinensis* (Chinese Mitten Crab) were caught in the Patapsco River, near Baltimore, on the upper Chesapeake Bay. This was the first known collection of this invasive crab on the US Atlantic Coast, although this crab had been collected several times in the Great Lakes and tidal St. Lawrence River, and once in Louisiana.
- *Didemnum* sp. is expanding its range on Georges Bank. At some of the surveyed sites, *Didemnum* covered 50-75% of the gravel bottoms, approximately doubling the amount of coverage seen in 2005 and earlier in 2006. It was also found in Mission Bay, San Diego.
- *Clymenella torquata* was found to be abundant in Samish Bay, Washington, where it is interfering with culture of the Pacific Oyster (*Crassostrea gigas)*

1.0 LAWS AND REGULATIONS

Federal legislation was proposed by the 109th Congress (2005–2006) to address several aspects of biological invasions by marine organisms, with multiple bills introduced to the U.S. House of Representatives (H.R.) and the U.S. Senate (S.). These bills included:

- National Aquatic Invasions Species Act of 2005 (H.R. 1591)
- Aquatic Invasive Species Research Act (H.R. 1592)
- National Invasive Species Council Act (H.R. 1593; S. 770)
- Ballast Water Management Act of 2005 (S. 363)

Although these bills remained under consideration through 2006, none of them were approved and implemented by Congress, and none of them can be considered further by the new 110th Congress (2007–2008). Instead, all proposed legislation that was not enacted by the end of 2006 must be reintroduced as a new bill for consideration.

In early 2007, the 110th Congress introduced several new bills, including the (a) Aquatic Invasive Species Research Act (H.R. 260), (b) Prevention of Aquatic Invasive Species Act of 2007 (H.R. 889), and (c) National Aquatic Invasive Species Act of 2007 (S. 725).

As with the proposed legislation in 2006, these new bills seek to implement various regulations and research activities to reduce species transfers by ships' ballast water (and other vectors), to evaluate patterns and underlying mechanisms of invasion by non-native species, and to assess impacts and risks of invasions. Action on these bills is still pending, and additional information can be obtained at http://www.invasivespeciesinfo.gov/laws/bills.shtml.

In 2006, the U.S. Federal Court ruled that the U.S. Environmental Protection Agency (EPA) is required to regulate ballast water discharge. Although the EPA may appeal this ruling, it has not done so at this point, and further decisions and actions are still pending. Thus, at the present time, Federal Regulations for ships' ballast water management remain in place and effectively unchanged sine 2004:

- All ships arriving to U.S. ports are required to submit ballast water reports to the National Ballast Information Clearinghouse, except for a very small percentage of ships restricted to local trade.
- All ships arriving to U.S. ports from outside of the 200-mile Exclusive Economic Zone and Canadian waters are required to conduct ballast water exchange or an alternative approved treatment, under penalty.
- U.S. Coast Guard boards and inspects vessels for compliance of ballast water management regulations, conducting an estimated 7,000 ballast water inspections in 2006.

Independent of existing Federal Regulations, three western U.S. states (California, Oregon, and Washington) have separate State Regulations for ballast water management. Although the State and Federal Regulations are the same for ships arriving from outside the 200 mile Exclusive Economic Zone, requiring mandatory ballast water exchange or alternative treatment, the State Regulations also include mandatory treatment for some coastwise traffic among these states. In general, ships moving among states must conduct ballast water exchange at least 50 miles from shore prior to discharge, or utilize an approved alternative treatment. The Federal Regulations do not currently require such practice, and so it is unique to the three western states. A summary of these State Regulations can be found at: http://groups.ucanr.org/Ballast_Outreach/Laws_and_Regulations.

In addition to the requirement of when to treat ships' ballast water, several states have adopted laws to specify standards and/or the type of treatment required. California will prohibit the release of organisms larger than 50 microns by 2020. Michigan law which was passed in 2005 will require permits for ballast discharge in 2007. The specific strategy for implementation of these regulations is still under review.

Finally, alternative ballast water exchange areas or zones have been recommended for both the East and West Coasts, but no official actions have been taken by the federal government to implement alternative ballast water exchange zones.

2.0 DELIBERATE RELEASES AND PLANNED INTRODUCTIONS

3.0 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Fish

Atlantic/Gulf Coasts

Pterois miles/volitans complex (Red Lionfish) - The range and abundance of this introduced fish continues to expand in the Northwest Atlantic. In 2006, specimens have been captured as far north as Jamestown, Rhode Island, on Narragansett Bay, and the first records were reported from the Gulf of Mexico, at Treasure Island, Florida, just outside the mouth of Tampa Bay (USGS Center for Aquatic Resource Studies 2007). Diver, sportsfisher surveys, and ROV surveys off North Carolina indicate that lionfish were now the second most

abundant finfish in offshore waters at 35-100 m depth (Whitfield et al. 2006). Newspaper reports indicated large numbers of juveniles occurring in bays on the south side of Long Island. Those fish, north of Cape Hatteras are mostly juveniles, carried north by currents, and are probably unable to survive the winter.

Pacific Coast

Rhinogobius brunneus (species complex), an amphidromous goby native to East Asia (Russia and Japan to the Philippines), is established and reproducing in drainages of the Columbia River in Washington State. Spawning in this species group occurs in freshwater, but larvae drift downstream to develop in estuaries. This goby was probably introduced to North America in ballast water, although websites indicate that it is sometimes kept as an aquarium fish. The name "*R. brunneus*" is applied to a number of populations, probably cryptic species, differing in habitat preferences and life history. DNA samples have been sent to Japanese researchers to clarify the identity and origins of the Columbia River fish (USGS Center for Aquatic Resource Studies 2007). This introduction brings the total of Asian/Northwest Pacific gobies established on the US West Coast to five. *Rhinogobius brunneus* is the first of these species to occur outside California.

3.2 Invertebrates

Atlantic/Gulf Coasts

Phyllorhiza punctata (Australian Spotted Jellyfish)- This Indo-Pacific scyphomedusan first appeared in the Gulf of Mexico in 2000 in massive blooms off Alabama and Mississippi, and has recurred sporadically since then. In June, 2006, they appeared for the first time in Galveston Bay, Texas. In 2001, *P. punctata* was seen on the Atlantic coast of Florida in the Indian River Lagoon, Brevard County, and in July 2006, this medusa extended its range about 200 km north to Guana Lake, a lagoon near Augustine Inlet, Florida (USGS Center for Aquatic Resource Studies 2007).

Mytella charruana (Charru Mussel)- This mussel is native to the Atlantic coast of South America, from Uruguay to Venezuela. In 1986, this mussel suddenly appeared at the mouth of the St. Johns River in Jacksonville, Florida, where it fouled a powerplant, but then apparently died out. In 2004, *M. charruana* was discovered fouling docks of the University of Central Florida's research facility, on Mosquito Lagoon, a branch of the Indian River Lagoon, Volusia County, Florida (Boudreaux and Walters, 2006). In August 2006, it was found "growing heavily on floating docks" on the Medway River, flowing into St. Catherines Sound, Georgia" at 33 PSU salinity (USGS Center for Aquatic Resource Studies 2007).

Perna viridis (Green Mussel) - This Indo-Pacific mussel, first collected in the Caribbean in 1990 in Trinidad, and in the Gulf of Mexico, at Tampa, Florida, in 1999, was first found on the Atlantic Coast near St. Augustine in 2003. It continues to expand its range northward along the Atlantic Coast. In October, 2006, it was collected for the first time in South Carolina waters, in Charleston Harbor and surrounding waters. Hundreds of mussels clogged the supply line of a mariculture facility in Charleston (USGS Center for Aquatic Resource Studies 2007).

Megabalanus coccopoma (Titan Acorn Barnacle)- This Eastern Pacific barnacle, native from the Gulf of California to Peru, had colonized Brazil by 1961, and has been collected from 2001 through 2004, at several locations in the Gulf of Mexico (Florida, Texas, and Louisiana), although established populations were not found (Perrault *et al.*, 2004). In 2005 into 2007, it was collected at numerous Atlantic Coast records from Fort Pierce, in the Indian River Lagoon, Florida, north to Wrightsville Beach, North Carolina (USGS Center for Aquatic Resource Studies 2007; Ruiz *et al.*, unpublished data). It is apparently now established on the Atlantic Coast south of Cape Hatteras.

Cancer magister (Dungeness Crab) - In July, 2006, a single specimen of this Northeast Pacific (California to Alaska) crab was caught in the Atlantic Ocean off Gloucester, Massachusetts, at a depth of 82 meters. This specimen was apparently discarded or escaped from a live-seafood market (USGS Center for Aquatic Resource Studies, 2007). There are no other reports of this crab from the Atlantic.

Eriocheir sinensis (Chinese Mitten Crab) - In June 2006, a fisherman found a specimen of *E. sinensis* in his blue crab pots at the mouth of the Patapsco River, near Baltimore, on the upper Chesapeake Bay. This was the first known collection of this invasive crab on the US Atlantic Coast, although this crab had been collected several times in the Great Lakes and tidal St. Lawrence River, and once in Louisiana. When this report was publicized, another crab specimen was found, also in the Patapsco, in May 2005. Two additional reports of mitten crabs from fishermen, further south in Maryland waters, seem reliable, though these crabs had been released. These specimens could represent ballast water introductions, or releases of illegally imported live food animals. The Smithsonian Environmental Research Center Marine Invasions Laboratory and the Maryland Department of Natural Resources have started a sampling program to determine whether a reproducing population exists in the Chesapeake Bay (Ruiz *et al.*, 2006).

Celleporaria pilaefera, Electra bengalensis, Hippoporina indica, Sinoflustra annae (bryozoans)- Fouling plate studies and taxonomic studies, starting in 2001, conducted by the SERC Marine Invasions Group, and Judith Winston (Virginia Museum of Natural History) have identified four Indo-Pacific bryozoans introduced to estuaries of the southeastern United States (McCann *et al.*, 2007, in press). *Hippoporina indica* (Pillai, 1978) was the most widespread, occurring in eight of the sampled estuaries, from Norfolk, Virginia, in Chesapeake Bay, to Corpus Christi, Texas. This species has not previously been reported from the Atlantic. *Electra bengalensis* (Stoliczka, 1869), was found in the St. Johns River estuary, Jacksonville, and the Indian River Lagoon, both in Florida, and is previously known from Hawaii, the Pacific entrance to Panama Canal and West Africa. *Sinoflustra annae* (Osburn, 1953) and *Celleporaria pilaefera* (Canu and Bassler, 1929) were found only in the St. Johns estuary. Two of these species, *E. bengalensis* and *S. annae*, are characteristic of brackish water, and possibly could survive transport through the Panama Canal as adults, but also belong to families with long-lived planktrophic larvae, and so have a potential for ballast water transport. The other two species seem to be confined to more saline locations, and their mode of development is unknown (McCann *et al.*, 2007, in press)

Didemnum sp. - (previously called *D. vexillum*, *D. vestum*, *D. lahillei*). This invasive colonial tunicate - which forms large sheets, covering the substrate and other benthic fauna - is expanding its range on Georges Bank, according to an October 2006 survey on Georges Bank. At some of the surveyed sites, *Didemnum* covered 50–75% of the gravel bottoms, approximately doubling the amount of coverage seen in 2005 and earlier in 2006 (Valentine *et al.*, 2006).

Pacific Coast

Clymenella torquata (bamboo-worm, a maldanid polychaete)- *C. torquata,* an infaunal polychaete native to the East Coast of North America, has been present in waters of southernmost British Columbia since the 1970s. In 2006, it was found to be abundant in Samish Bay, Washington, where it is interfering with culture of the Pacific Oyster (*Crassostrea gigas*). The worm had been present in the Bay for several years, but was not identified until 2006 (USGS Center for Aquatic Resource Studies 2007). This worm was probably introduced decades ago, with Atlantic Oysters, and has also been introduced to England with oyster plantings.

Potamopyrgus antipodarum (New Zealand Mud Snail)- This freshwater snail was first reported from North America in the Snake River, Idaho, a tributary of the Columbia River in 1997. It has spread to many river systems in the Western US, and was collected in the Columbia River estuary in 1997. In 2004, it was found in the tidal Sacramento-San Joaquin Delta, flowing into San Francisco Bay. In 2002, *P. antipodarum* was collected in the Rogue River estuary at Gold beach, Oregon, and in 2006, in the lower intertidal at Coos Bay, Oregon (USGS Center for Aquatic Resource Studies 2007). Since this snail is tolerant of brackish waters and is easily transported on boats and fishing gear, it can be expected to colonize many other West Coast estuaries.

Crassostrea gigas (Pacific Oyster)- In August, 2006, 256 specimens of an unidentified exotic oyster were found in San Francisco Bay, on the eastern shore of South Bay from Dumbarton Point to Coyote Slough. The oysters were collected in an eradication attempt, as they are considered a threat to restoration of the native *Ostrea conchaphila* (Olympic Oyster). The exotic oysters did not look like typical *C. gigas*; genetic studies are underway to determine their identity. One empty shell of a large *Crassostrea* was found on a fouling plate in the Bay in 2004 (San Francisco Chronicle 2006; USGS Center for Aquatic Resource Studies 2007). Since 2000, settlement of unidentified *Crassostrea* oysters has also been observed in Southern California embayments, from Tijuana Estuary to Los Angeles-Long Beach Harbor. These oysters are probably established in some embayments, and efforts at genetic identification are in progress (Jeffrey Crooks, personal communication).

Didemnum sp. - (previously called *D. vexillum*, *D. vestum*, *D. lahillei*). This invasive, colonial tunicate had previously been reported to occur as far north as Pendrell Sound, British Columbia, and as far south as Morro Bay, California. In 2006, the tunicate was found in Mission Bay, San Diego. Gretchen Lambert re-examined samples of *Didemnum* previously identified as *D. carnulentum,* and found that the invasive form was present in Mission Bay as early as 1994 (Lambert, personal communication).

Molgula ficus- A solitary tunicate, found in Southern California harbors had been previously identified as the native *M. verrucifera* (Ritter & Forsyth 1917) by Gretchen Lambert, but was found to be different from open-coast forms which more clearly fit the original description. The harbor form has been identified as *M. ficus* MacDonald 1859), an Indo-Pacific species. It was first collected in San Diego Bay in 1994, and now ranges north to Port Hueneme, and a single location in San Francisco Bay This tunicate has also been reported from Chile (Lambert 2007, in press).

3.3 Algae and Higher Plants

Pacific Coast

Sargassum filicinum, Sargassum horneri- These two species of Western Pacific brown algae, native from northern Japan to the Philippines, were discovered in southern California in 2004 (Miller *et al.*, 2007). *Sargassum filicinum* was found in Long Beach Harbor in 2003, growing either on the substrate, or attached to another introduced *Sargassum*, *S. muticum.* In 2006, several population of *S. filicinum* were found growing in on Santa Catalina Island., *Sargassum horneri* a very similar species, was also discovered in 2003 in Long Beach Harbor, and a single specimen of *S. horneri* was found in a kelp bed on Santa Catalina Island (Miller *et al.*, 2007).

3.4 Parasites, Pathogens, and Other Disease Agents

Atlantic/Gulf Coasts

Bonamia sp.(Protozoan oyster parasite)- The occurrence of a *Bonamia* parasite, infecting transplanted triploid Suminoe Oysters (*Crassostrea ariakensis*) was discovered in Bogue

Sound, North Carolina in 2003. This parasite was apparently found only in locations near the port of Morehead City, North Carolina. In 2004, a more comprehensive spatial survey was made, by planting *C. ariakensis* at different locations in North Carolina Sounds, but again *Bonamia* infections were found only close to Morehead City, and only high-salinity regions. The same parasite was found in the native oyster *Ostreola equestris* (Crested Oyster) on the Intracoastal Canal (Bishop *et al.*, 2006). The authors suggest that *Bonamia* is a recent introduction to North Carolina waters, possibly in ballast water, and has just started to spread outside the port region. DNA analyses suggest that the Bogue Sound parasite as an affinity with southern hemisphere species of *Bonamia* (Bishop *et al.*, 2006).

Cambarincola mesochoreus, C. pamelae (crayfish leeches) - In 2003, unusual ectosymbiont worms were found on Blue Crabs (*Callinectes sapidus*) in low salinity waters (0-3 PSU) in upper Chesapeake Bay. These were identified as two species of branchiobdellan annelids (crayfish leeches) which otherwise normally occur on the Red Swamp Crayfish (*Procambarus clarkii*), native to Gulf of Mexico drainages of the southern United States. The host crayfish, presumably bearing its symbionts, has been introduced to Chesapeake Bay and other Atlantic and Pacific drainages for aquaculture, bait, and research. The impact of *Cambarincola sp.* on Blue Crabs is not known, but would be confined to crabs in low-salinity waters (Gelder and Messick, 2006).

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Annex 6: Rapid Response Guidelines

Rapid Response Guidelines

Working Group on Introductions and Transfers of Marine Organisms

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Introduction

In marine ecosystems, once species become established it is virtually impossible to eradicate them. Management actions have focused on prevention; however, new introductions continue to occur. One strategy is to develop a rapid response to an early detection to eradicate a species completely or contain it to prevent further spread. This document is a review of the elements that should be considered and used when developing a Rapid Response Plan.

The purpose is to develop a generic approach to rapid response that can be modified for international, national, regional and local levels of authority. The Rapid Response Approach Guidelines presuppose that there is a process whereby early detection of unwanted species can be communicated to authorities. There is no standardized monitoring approach to early detection of invasions. In the U.S. often school age (elementary school to high school), undergraduate, and graduate students, naturalists, scientists with long-term monitoring stations, rapid assessment surveys, and recreational divers have found new species and sent them to experts for identification.

Taxonomy

The accurate identification of the species is verified by taxonomists and forms the basis for considering a Rapid Response. Two other components are essential for conducting a response, i.e., a responsible party that can respond that receives information on new reports of new invasions. These may be:

- a government agency,
- non-government organization,
- private party or
- anyone with authority to respond)

In addition to the reports of new invasions, the responsible parties should be aware of a list of unwanted species that may be regulated or policy and have the flexibility to consider species not on the list (i.e. be able to respond to new threats). There also needs to be an authority (government agency, ad hoc working group, etc.) that has the ***authority*** to respond and determine if action is needed and what level of response is appropriate. Such authorization should be decided upon in advance.

Guidelines

The Rapid Response Plan Guidelines provided in this document are for estuarine and marine waters, but with minor modification, it could apply to other ecosystems. The following assumptions were used in preparing this document:

- The primary goal is eradication of unwanted species, although this decision is a part of the decision process.
- A secondary goal may be to contain the species or manage it in the short- or long-term.

- The approach is suitable for the species and consistent with regulations of the political body or bodies that have oversight of treatment options.
- The rapid response protocol should be flexible in both specific approaches adopted and the timing of implementation of the protocols. Often what appears to be the optimal approach does not work in the field and other methods need to be employed.
- The underlying approach is based on sound science.
- The plan can be modified for plants or animals (including fish, parasites, etc.) or microbes and other diseases.
- A public outreach and education effort is established early and throughout the process, including how individuals can prevent invasions.

The Rapid Response Guidelines highlight the need to identify species of high risk a priori, with the caveat that any species may become invasive. There may be lag times of a few years to decades before some species disperse (Crooks and Soule, 1999). Examples include the compound sea squirt *Didemnum* sp. found in the northeast U.S., which was identified as early as 1993 or possibly earlier, but not reported until 2000. By this time it had spread from the Damariscotta River to Connecticut. Dispersal of some species is much more rapid, e.g. *Hemigrapsus sanguineus* which spread from the Delaware Bay and Cape May, New Jersey with a sighting of one gravid female to south of Boston within 12 years (McDermott, 2000). Furthermore, many macroalgae (e.g. *Caulerpa* spp., *Gracilaria vermiculophylla* and several other red algal species) can spread immediately by regrowth of moved (e.g. in fishing nets, on ropes, in bilge water) vegetative fragments (even < 1 cm). Also planktonic organisms may easily disperse further by currents.

Types of Responses

Type of responses (mechanical, chemical, biological) as controls and vector management is discussed for different taxonomic groups. Because this guidance would apply to all levels of government, specific regulations and permits are not identified as these vary from governing body to governing body. Nonetheless, there is a need for cooperation at all levels and across borders to fully eradicate and control invasive species. Throughout the process the public, politicians, and stakeholders should be involved and outreach efforts should provide accurate information on the understanding of the threat, uncertainty in the knowledge of the species or its potential to cause harm, the potential for success (or failure), and the costs and benefits of the actions. The first section reviews seven steps involved in a Rapid Response Protocol, the next section highlights general options for treatment of marine biota, the third section reviews some eradication efforts as case studies. In addition to the seven steps other elements are also important in successful planning and implementation. These include leadership, co-ordination, adequate available funding, and other support resources (such as forming a scientific advisory group) (Dechoretz 2003). Although not explicitly stated throughout the steps, public education on preventing introductions is assumed and is an especially important component of the vector management options.

Section I

Rapid Response Protocol

The following seven steps identify the major decision points or information needed for developing a Rapid Response plan (Figure 1). These include (1) confirmed species identification, (2) risk potential for species in questions, (3) detailed characterization of area of impact, (4) selection of treatment, (5) treatment plan and implementation, (6) monitoring for effectiveness, and (7) evaluation to determine what future actions may be needed.

Step 1: Identification and confirmation of introduced species

Species identification is key component of the development of a Rapid Response Plan. Misidentification may lead to actions that were unnecessary and costly. One option is to have a list of taxonomists who are willing to assist with rapid identifications. In some cases, verification may involve molecular studies, thus, reaching agreement with a lab that can conduct these analyses ahead of time reduces the length of time before accurate species identification can occur. Once the species of concern are verified, public outreach efforts should be initiated. These would include information on the species; impacts from the species or related taxa reported in other locations (if known); scenarios with and without eradication actions; and the physical, chemical, biological, and vector management options. In some cases the impact may not be known at an early stage of invasions, especially for species not having an impact in the area of origin, but with a large impact in the areas of introduction.

Box 1.

One recent example of species identified by molecular analysis was the reclassification and identification of *Porphyra* sp. in New England (Bray *et al.*, 2005, West *et al.*, 2005). Using both morphological evaluations and molecular studies, two new introduces species of *Porphyra* were found from Massachusetts to Maine. The two introduced species were *Porphyra yezoensis*, strain NA4 and the Asian species, *P. katadae*.

Step 2: Risk assessment

Presenting information on potential risk benefits from pre-determining what species might invade and estimating risk associated with each species. Risk assessment approaches range from very detailed data-intensive analysis to less data intensive assignments of high, moderate and low priority. Risk assessments may take into account, human health, biodiversity, potential to invade other areas, and impacts to valued resources (e.g. aquaculture).

An overview of risk assessments will provide decision makers with background information. The decision to attempt eradication, to quarantine, or to not take any action is, in part, based on public perception, regulations, costs, potential impacts with and without action, and a commitment by agencies on policy makers.

The risk assessment should include a review of the vector or vectors involved. The risk assessment should identify the likelihood of the event happening (as in once or many times) and include the probability of introduction events from each source in the overall risk assessment.

Step 3: Characterization of area impacted

In developing a plan for response, the area currently impacted by the introduced species should be delineated and defined. Predicted areas of impact should also be identified to provide additional information for evaluating risk, for consideration in choosing treatment options, and to keep public (shareholders) informed. Consideration should be given to the size of a buffer zone around the impacted area. The buffer zone should be related to the potential for spread of the organism and be included in monitoring plan to ensure it is not spreading into

new areas. Organisms that have life history characteristics favoring dispersion, e.g. crab larvae that have prolonged pelagic existence, are unlikely candidates for eradication.

The types of data to be included in the characterization report include physical habitat, (e.g., bathymetry, bottom type, currents, temperature, and salinity), presence of threatened and endangered species, impacts to human health, and other species and valued resources. The evaluation process should also include the potential for the species to continue its spread.

Because it is likely that an agency or government department head will make the final decision to proceed with developing a rapid response implementation plan, they should be kept informed throughout evaluation process. If the area is too large, there may be a decision to not proceed. However, even for highly dispersive organisms, the option to contain organisms may well delay spread until other long-term eradication approaches are employed and has been favored by some agencies. Nonetheless, the area and potential to spread to buffer areas should be assessed at this stage and may result in a no action decision.

Step 4: Selecting treatment options

Eradication options fall into four general categories - physical, chemical and biological and vector management (Table 1). Physical and chemical options are more likely to be used in rapid responses, but each has disadvantages. For example, physical and chemical actions may extirpate valued native or threatened or endangered species. Mechanical disruptions may also create more propagules that can disperse, for species that can reproduce asexually. Some chemical options, e.g. applications of pesticides are often controversial and may leave long-lived residues. Biological control may be used as a long-term approach, but its use in marine and estuarine ecosystems is rare, if it is used at all. When populations have spread covering large areas physical or chemical options may not be feasible. If a biological agent has been previously determined to be specific to the species (i.e. not affecting any native relatives) and will not itself cause further harm, it may be used to control or manage populations. However, such risks must be evaluated in advance.

Vector management includes understanding the source and the secondary vectors that facilitate spread once a population is established. Ballast water management is one of the significant vectors with international and national efforts to regulate, establish management practices that minimize or prevent introductions, and support development of treatment technologies to prevent new introductions. However, hull fouling of all types of vessels (e.g. recreational and commercial fishing boats, recreational ships, and commercial vessels) is a vector that is not being adequately addressed. Other major vectors include bait, aquaculture, trade of living organisms (e.g. for aquaria, consumption, ornamental purposes) and canals.

Step 5: Choosing a treatment approach and developing an implementation plan

Once a treatment approach has been identified, a Rapid Response Plan should be designed. Treatment choices will take into account the species, the extent of impact, the habitat, costs, benefits, likelihood of success, and the options available for the locality. Because permitting chemicals, pesticides, and physical activities in some habitats (e.g. salt marshes or submerged aquatic vegetation beds) may be a lengthy process. To facilitate implementation, it is recommended that options be pre-approved or a shortened permitting process be established to ensure timely action.

In addition to the regulations, public opinion and political will may be the determining factor in the implementation. Realistic expectations of taking actions or doing nothing should be part of the ongoing updates and information for the public and decision-makers.

Step 6: Monitoring for effectiveness

In order to evaluate the effectiveness of the rapid response actions, a monitoring plan should be part of the implementation plan. If done correctly, this is not an insignificant cost and may

last for several years. For example, monitoring for *Caulerpa taxifolia* continues five years after the eradication effort (Anderson, 2005). In addition, the monitoring program involved placing plastic plants to test the effectiveness of the monitoring program. In other instances, monitoring may include testing for residues from toxic materials used as the extirpation agent. For example, organic chemicals such as pesticides, petroleum hydrocarbons, etc. are often perceived as more dangerous than metals or chemicals that break down *in situ*.

Step 7: Evaluation of treatment to determine if additional steps are needed

The monitoring activities should indicate the level of success. The first options may not be as effective as anticipated and additional measures may be added to the protocol. For example, hand picking may not remove all plants, chemicals and/or covering areas may need to be included in the efforts to fully eliminate any remaining species. Attempts to eradicate the sea star *Asterias amurensis* in Port Philip Bay, Australia, from 1995–1998, were abandoned after monitoring indicated the population was established (McEnnulty *et al.*, 2001) and further removal efforts would not be successful. Thus, there may be a decision to take no further action.

Step 8: Implications for legislation

Efforts to respond to new invasions are costly and may not be successful. The awareness of impacts to the ecosystem and implications for the community may stimulate efforts to improve prevention of new introductions. The outcome may be to consider legislation that prevents new invasions. For example, the *Caulerpa taxifolia* eradication efforts lead to a ban on importation of *Caulerpa* to California and other states. Similarly, ballast water legislation resulted from zebra mussel invasions in the Great Lakes.

Summary

Rapid Response efforts require cooperation and coordination at all levels of government and often involves several political entities. Making the decision to eradicate is as much a political decision as a scientific one. The scientific information should be the basis for the decision and provided to policy makers, politicians and the public. To be most effective, preliminary information on potential invaders should be documented along with basic physiological and ecological information that includes impacts of the invaders in other countries. The risk assessment will include information on the likelihood of reintroduction risk, related taxa, and the ability to quarantine the area during eradication.

The generic approach described above does not include the regulatory and permitting requirements that vary considerably. Thus, each country or region should consider pre-approval for actions that require lengthy approval processes. Keeping both the public and policy-makers informed throughout the process is considered a key component in the decision-making process.

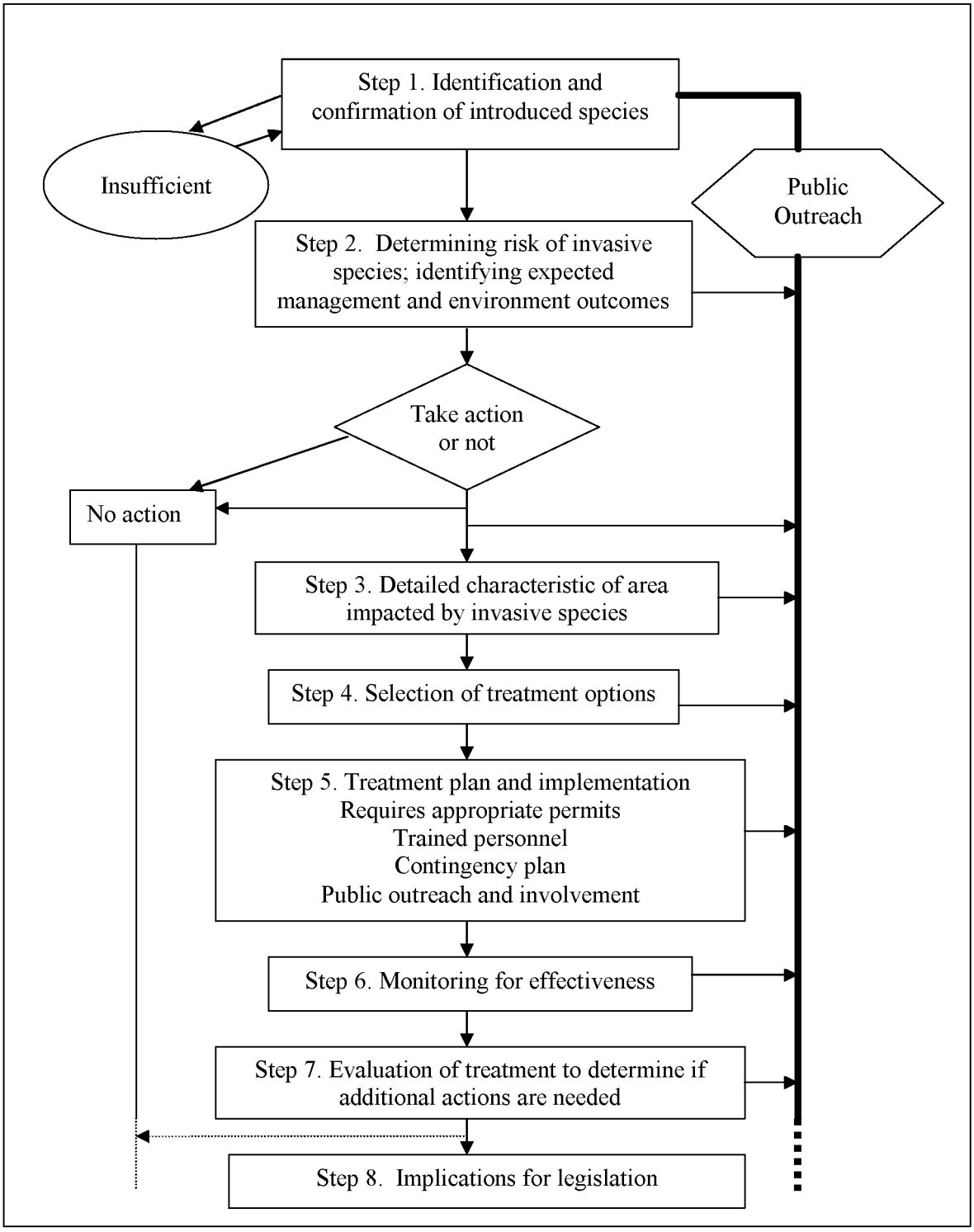

Figure 1. Rapid Response Guidance for marine and estuarine biota.

Table 1. Overview of control options for several taxonomic groups modified from McEnnulty *et al.*, 2001 and other references.

TAXONOMIC GROUP	CONTROL OPTIONS	EXAMPLES	REFERENCES
Phytoplankton, HABs	Physical	Improved circulation, decreased eutrophication, sonication, clays and flocculants	McEnnulty *et al.*, 2001; Raloff 2002
	Chemical	Hydrogen peroxide, chlorination, rarely used but could work in small lakes	McEnnulty *et al.*, 2001
	Vector Management: Ballast water treatment	Exchange, pH, salinity, chlorine, oxygen deprivation, UV, hydrogen peroxide, electric-shock, heat, copper sulfate	
	Biological	Fungi, predators, parasites, viruses to limit phytoplankton blooms, etc., rarely used	
Macroalgae	Physical	Diver removal, suction, cover, harvesting, heat, cold; concern for pieces settling	Anderson 2005; McEnnulty *et al.*, 2001
	Chemical	Copper sulfate, herbicides, antifoulants, chlorine, lime	Anderson 2005; McEnnulty *et al.*, 2001.
	Vector Management	Fisheries, aquaculture, ballast water & hull fouling, recreational boats, aquarium trade, package material for transports of live shellfish or baits	Trowbridge 1998; McEnnulty *et al.*, 2001
	Biological	Herbivores but questionable if they are truly species-specific, no known host specific parasites	Meinesz *et al.*, 1999; Harris and Jones, 2005; McEnnulty *et al.*, 2001
Ctenophores and Cnidarians	Physical/ Chemical Vector Management	None are effective	Graham *et al.*, 2003; McEnnulty *et al.*, 2001
	Biological	Predators considered high risk, fish, *Beroe* in Black Sea was unintentional	McEnnulty *et al.*, 2001
Molluscs	Physical	Handpicking, harvesting, filters (larvae), thermal shock, salinity, UV (larvae), electricity, ultrasonic, flow, bounty programs, selective fishing effort	McEnnulty *et al.*, 2001
	Chemical	Antifoulants, chlorine, copper sulfate, mollusicides, pesticides	McEnnulty *et al.*, 2001
	Vector Management	Ballast water, hulls, canals, aquaculture, recreational boats, food trade	Moy, 1999; McEnnulty *et al.*, 2001
	Biological	Polyploids, parasites, predation, pathogens, sterility	

TAXONOMIC GROUP	CONTROL OPTIONS	EXAMPLES	REFERENCES
Crustaceans	Physical	Trapping, fishery, sound pulses, screens, etc.	McEnnulty *et al.*, 2001; W. Walton, pers. comm.
	Chemical	Poisoned bait, pesticides (insecticides), metals, organic chemicals, salinity, hormonal interruptive molecules, etc.	McEnnulty *et al.*, 2001
	Vector Management	Ballast, hulls, aquaculture, recreational boats and fishing, food and aquarium trade	Ruiz *et al.*, 1998; McEnnulty *et al.*, 2001
	Biological	Castrating parasites (but not species specific), predatory fish, crabs, birds, genetic control – not yet effective	Thresher, 1996; Goddard *et al.*, 2005, Torchin *et al.*, 2005; McEnnulty *et al.*, 2001
Wood borers and other borers	Management	Plastic etc. wraps, vacuum/ pressure, turpentine, insecticides, plastic replacements, wood selectivity	McEnnulty *et al.*, 2001
Polychaetes	Physical	Divers, hot water, wax on prey shells, heat, ultrasound, freshwater	Culver and Kuris, 1999, 2000; McEnnulty *et al.*, 2001
	Chemical	Metals, petroleum hydrocarbons, detergents, pesticides, radiation, microencapsulated toxins	McEnnulty *et al.*, 2001
	Vector Management	Hulls, ballast, aquaculture, fisheries, bait	McEnnulty *et al.*, 2001
	Biological	No known specialized parasites, copepods, bacteria, viruses, fungi, etc.,	McEnnulty *et al.*, 2001
Echinoderms	Physical	Bounty, fisheries, manual removal, specialized dredges, trapping, reduced density lowers reproduction, food and fertilizer	McEnnulty *et al.*, 2001
	Chemical	Metals, lime, toxin filled pole spears	Thresher et al. 1998; McEnnulty et al. 2001
	Vector Management	Ballast, hulls, moorings, aquaculture management, live and fresh food trade, ornamentals,	Thresher *et al.*, 1998; McEnnulty *et al.*, 2001
	Biological	Natural chemicals, genetic manipulation, parasites (ciliate, etc.),	Thresher *et al.*, 1998; McEnnulty *et al.*, 2001
Bacteria	Vector management	Heat (cooking), sanitation, education, food safety etc., ballast water treatments (not currently effective), aquaculture, UV, bacteriophages	McEnnulty *et al.*, 2001; Morrison and Rainnie, 2004

TAXONOMIC GROUP	CONTROL OPTIONS	EXAMPLES	REFERENCES
Phanerogams (saltmarsh and seagrasses)	Physical	Hand pulling, steam, harvesting (N.B. seedbanks might be left),	Daehler and Strong, 1996, 1997; McEnnulty *et al.*, 2001
	Chemical	Herbicides	
	Biological	Specific herbivores but questionable if they are truly species-specific	
	Vector Management	Intentional plantations against erosion, package material for transports of live shellfish or baits (e.g. *Zostera japonica)*	
Fish	Physical	Removal, drawdowns, electro-fishing (in fresh water systems)	McEnnulty *et al.*, 2001
	Chemical	Piscicide (e.g., rotenone), lime, etc., contaminated diets, pheromones, trap and kill	McEnnulty *et al.*, 2001
	Biological	Virus, predator stocking, gender manipulation (etc.)	McEnnulty *et al.*, 2001
	Vector Management	Aquaculture, ballast water, trade with live organisms (food, aquaria, ornamental purposes (lakes))	
Parasites	Vector Management	Aquaculture, ballast water, ornamentals, bait	

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Annex 7: Risk Assessment Protocols: Identifying risk of Nonindigenous Species

UK Non-native Species Risk Assessment Scheme

Protocols for identifying and assessing risk

Talk outline

- Summary of UK NN risk assessment scheme
- Summary of pending EU legislation on 'Alien species in aquaculture'
- Summary of aims of EC project IMPASSE to advise this piece of legislation, with comments on risk assessment protocol development

UK non-native risk scheme (consortium):

CABI Bioscience, Central Science Laboratory, Centre for Ecology & Hydrology, CEFAS, Imperial College (London), University of Greenwich

Consortium research funded by Defra European Wildlife Division, January 2004 – February 2005

Approach - UK consortium

Developing a Pest Risk Assessment Scheme for all Non-Native Species

- *Adapt* the EPPO plant health pest risk assessment scheme for:
  - Intentional introductions
  - Plants, herbivores, carnivores, parasites
  - Terrestrial, freshwater, marine habitats
- *Test* with a wide variety of species and taxon-habitat combinations:
  - 33 non-native species
  - 12 taxon-habitat combinations

UK Risk Assessment scheme

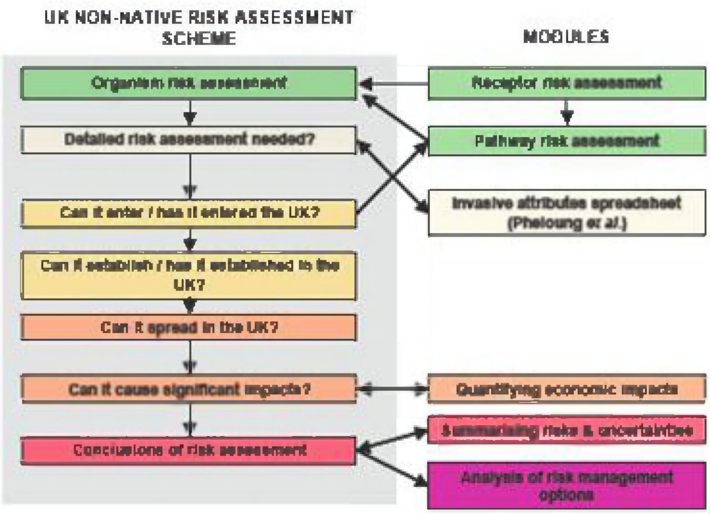
Developing a Risk Assessment Scheme for all Non-Native Species

- *Adaptation* of the EPPO scheme:
  - Use of plug-in sub-routines: e.g.
    - Invasiveness
    - Parasites and pathogens
    - Economic Impact Assessment
  - Improved scoring system (based on Bayesian statistics): 0—4

Indian House Crow
Corvus splendens

Topmouth gudgeon
Pseudorasbora parva

UK Non-Native Risk Assessment Scheme Structure



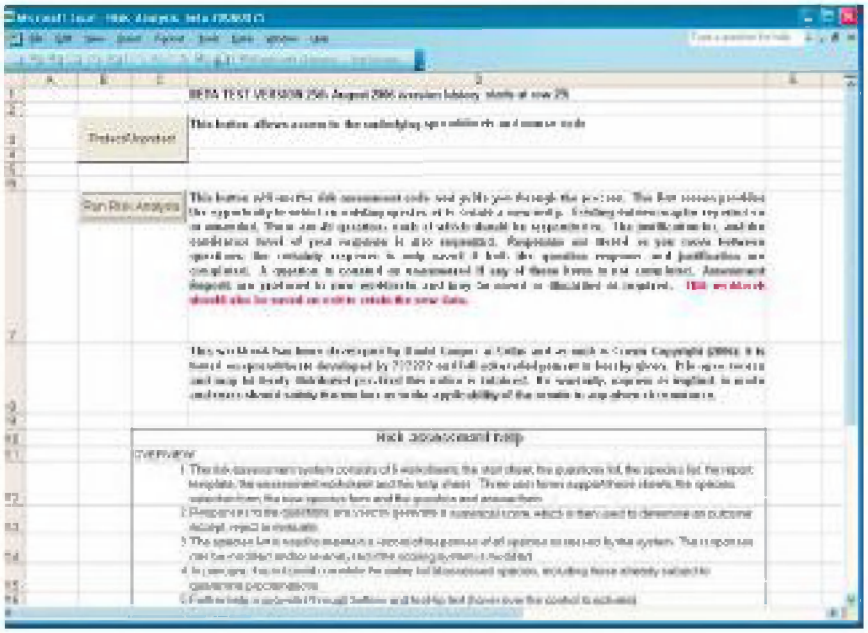
UK Non-Native Risk Assessment Scheme Structure

UK NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

	Name of Organism, Pathway, Receptor or Policy:	**Topmouth gudgeon (or stone moroko, or false rasbora, or clicker barb)** *Pseudorasbora parva*	
	Objectives:	An established infestation or an outbreak has been discovered in the Risk Assessment area	
	Authors, Date:	G.H. Copp, 3 November 2004	
N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the Risk Assessment?	An established infestation or an outbreak has been discovered in the Risk Assessment area	To assess status of species as regards ILFA
2	What is the Risk Assessment area?	England & Wales	
3	Does a relevant earlier Risk Assessment exist?	NO OR UNKNOWN (Go to 5)	
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?		
	Stage 2: Organism Risk Assessment SECTION A: Organism Screening		
5	Identify the Organism. Is the organism clearly a single taxonomic entity and can it be adequately distinguished	YES (Give the full name & Go to 7)	topmouth gudgeon (*Pseudorasbora parva*)
6	If not a single taxonomic entity, can it be redefined?		
7	Is the organism in its present range known to be invasive, i.e. to threaten species, habitats or ecosystems?	YES (Go to 8)	
8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?	YES or UNCERTAIN (Go to 9)	Scores highly (i.e. rejected as invasive) in the FIRA (Fish Invasiveness Risk Assessment), which is the freshwater fish version of Pheloung et al.'s WRA. pheloung spreadsheet
9	Does the organism occur outside effective containment in the Risk Assessment area?	YES (Go to 10)	

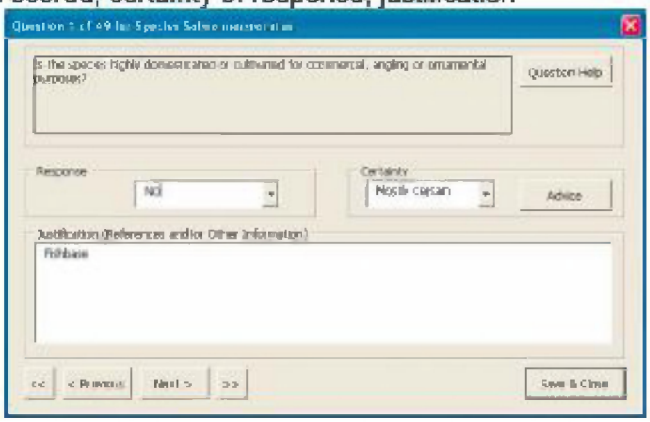
Module 1: Invasive Attributes Spreadsheet

- FISK (Copp et al. 2005) adapted from Pheloung *et al.* WRA



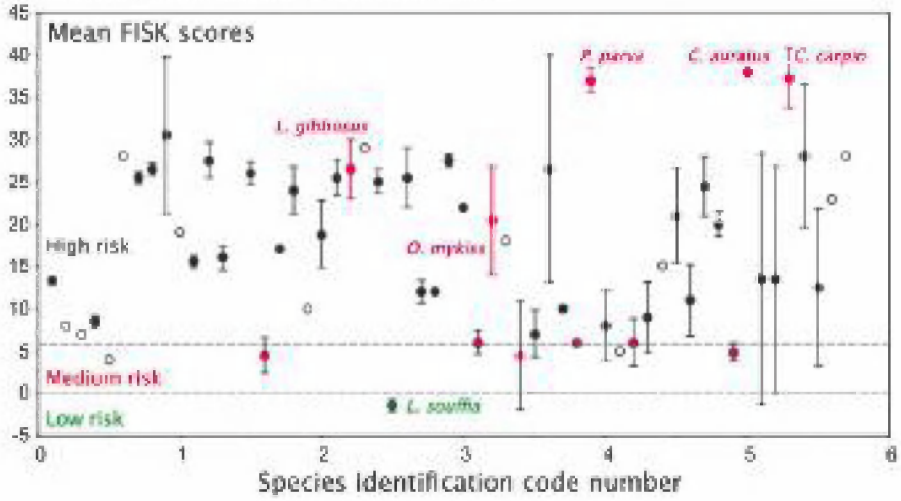
Module 1: Invasive Attributes Spreadsheet

- Based on adaptations of Pheloung *et al.*'s plant weed R.A. protocols: e.g. FISK (Copp *et al.* 2005)
- Attributes scored, certainty of response, justification



Module 1: Invasive Attributes Spreadsheet

- Based on adaptations of Pheloung *et al.*'s plant weed R.A. protocols: e.g. FISK (Copp *et al.* 2005)
- Attributes scored, certainty of response, justification
- **Initial FISK trials: summary of scores**



Module 1: Invasive Attributes Spreadsheet

- Based on adaptations of Pheloung *et al.'s* plant weed R.A. protocols: e.g. FISK (Copp *et al.* 2005)
- Attributes scored, certainty of response, justification
- Initial FISK trials: summary of scores
- Protocols also exists for marine fish, marine invertebrates, amphibia
- Linked to main scheme to enhance objectivity of invasiveness assessment

Module 2: Pathway (delivery) Risk Assessment

- Spreadsheet provides a rapid assessment of risks from a delivery system
- Summarises delivery pathway risk from many organism assessments

Module 3: Receptor (facility) Risk Assessment

- Spreadsheet to provide a rapid assessment of the vulnerability of a facility
- Will summarise receptor (facility) risk from many pathway & organism assessments
- Helps identify potential receptors
- Examples:
  - Coastal bays, fjords, etc.
  - On-line water courses
  - Connected ponds or lakes

Module 4: Economic Impact Assessment

- Spreadsheet provides means to quantify costs over time:
  - Eradication (possible, but requires careful implementation)

Mortalities under experimental conditions

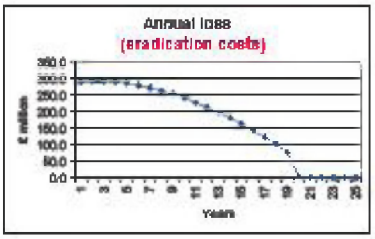
		C concentration: 0.125 mg·L^{-1} (5.0)				0.150 mg·L^{-1} (6.0)		
Exposure	Controls replicate:		1	2	3	1	2	3
2 h	0/0	0*/7	—	—	1*/10	10/10	10/10	
4 h	0/0	10/10	10/10	10/10	—	—	—	
7 h	0/0	10/10	10/10	10/10	—	—	—	

*remaining fish were alive but moribund

Module 4: Economic Impact Assessment

- Spreadsheet provides means to quantify costs over time:
  - Eradication (possible, but…)
  - Local & regional economies (more difficult)
- Gives examples of each level of risk: minimal, minor, moderate, major, massive
- Example: topmouth gudgeon

Response	Annual Economic Impact
Minimal	Up to £10k
Minor	£10k - £100k
Moderate	£100k - £1m
Major	£1m - £10m
Massive	£10m +



Module 5: Summarising Risks & Uncertainties

- Responses for each question are analysed to give an overall high, medium, low risk rating in three ways :
  - Author's Opinion
  - Score Averaging (Summation)
  - Conditional Probability
- Score averaging underestimate high and overestimates low risk
- Mapping of scores to conditional probabilities provides a powerful new tool
- The influence of uncertainty has also been investigated

Case study	Author	Score Averaging	Conditional probability
topmouth gudgeon	High	Medium	High

Module 5: Reviewing Risks

- Risk review — a dynamic process
- Example of topmouth gudgeon

Module 6: Risk Management Options

- Provides a method for identifying management options which are:
  - Efficient
  - Reliable
  - Cost effective
- Can be used on their own or in combination
- Based on the EPPO Risk Management Scheme adapted for intentional introductions, with quarantine measures an integral component

UK NonNative Risk Analysis Panel

- Reports to the '*GB Non-native Species Mechanism*' through the GB '*Non-native Species Secretariat*', which is based at the Central Sciences Laboratory (York)
  - www.nonnativespecies.org
- Includes 3 of 6 consortium members
- Chaired currently by Prof. John Mumford, specialist of economic risk assessment
- Purpose to:
  - Review risk assessments
  - Review proposed risk management plans (options, etc.)
  - Recommend improvements to the UK scheme

EU legislation: Alien species in aquaculture

- Article 1 — Objectives and Scope
  - Objective: establish a framework governing the use of alien species in European aquaculture, with a view to assessing and minimising the possible impact of alien species on the aquatic environment.

- Regulation applications
  - Applies to the introduction of alien species from outside the EC for use in aquaculture
  - Within the EC, it shall apply to the translocation of species beyond their natural range from one Member State to another.
  - Does not apply to movement of species within Member States except in the case of translocation of species to, from or between the non-European territories of Member States.
  - Covers all aquaculture facilities located within Member States irrespective of their size or characteristics or of the species of animal or algae farmed.
  - Extends to all types of waters, marine, brackish and freshwaters.
  - Does not apply retrospectively to species which have already been moved and are an established part of the Community aquaculture sector.

EU legislation: Alien species in aquaculture

- Article 2 — Definitions
- Article 4 — Risk analysis and decision making
  - Member States shall designate the competent authority or authorities responsible for complying with the requirements of this Regulation.
  - Each competent authority shall appoint and be assisted by an advisory committee which shall include appropriate biological expertise.
  - The advisory committee shall determine whether the proposed movement is routine or non-routine and advise the competent authority accordingly.
  - Routine: permitted at the discretion of the competent authority
  - Non-Routine: competent authority decides if RA needed (as per Annex B)
  - High or medium risk outcomes: examine mitigation procedures or technologies available to reduce the level of risk to low.
  - Decision on whether or not to grant a permit on basis of RA

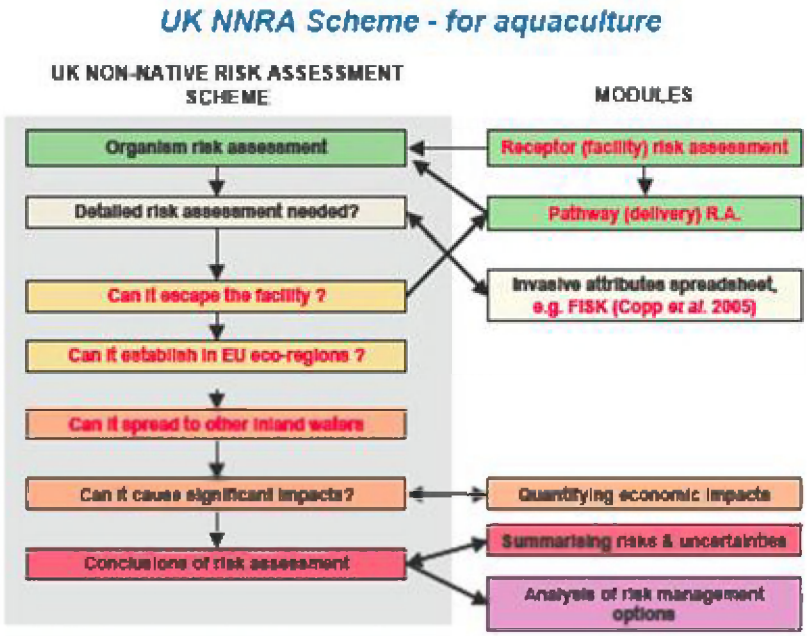
- Article 6 — Conditions for introductions once a permit has been issued
- Article 7 — Conditions for translocations once a permit has been issued

EU legislation: Alien species in aquaculture

- Article 8 — Keeping of a register
- Article 9 — Adaptation to technical progress
  - Amendments to Annexes A, B and C which are necessary in order to adapt them to technical and scientific progress shall be adopted in accordance with the procedure laid down in Article 30(3) of Regulation (EC) No 2371/2002.
- Article 10 — date regulation comes into force
- ANNEX B
  - Procedures and minimum elements to be addressed in a Risk Assessment (ICES guidelines, basically)

EC Project: IMPASSE objectives

- Review of introductions and translocations in aquaculture and for aquaculture-based restocking
  - Assess economic importance of introductions and translocations resulting from aquaculture and aquaculture-based restocking in the Community
- Audit the state of knowledge of the consequences (environmental, economic, genetic interactions) of operations concerning introductions and translocations of aquatic organisms for aquaculture purposes
- Develop risk assessment protocols for future aquatic species introductions and aquaculture
- Provide guidelines for quarantine procedures to account for phylum-specific peculiarities, etc., including procedures for containment and control where invasive species are identified as a problem
- Provide guidelines for environmentally sound practices


UK NNRA Scheme - for aquaculture
UK NON-NATIVE RISK ASSESSMENT SCHEME
MODULES
Organism risk assessment
Detailed risk assessment needed?
Can it escape the facility ?
Can it establish in EU eco-regions ?
Can it spread to other inland waters
Can it cause significant impacts?
Conclusions of risk assessment
Receptor (facility) risk assessment
Pathway (delivery) R.A.
Invasive attributes spreadsheet, e.g. FISK (Copp et al. 2005)
Quantifying economic impacts
Summarising risks & uncertainties
Analysis of risk management options

Annex 8: Alien Species Alert Report – *Crassostrea gigas*

Laurence Miossec
Ifremer – France

The pacific oyster, *Crassostrea gigas*, was introduced worldwide into a number of countries, including USA, Canada, UK, France, Netherlands, South Africa South America, Korea, China, New Zealand and Australia. In 2002, *C. gigas* aquaculture has reached a 4 216 300 metric tons record high, representing 97.7% of the total oyster culture production in the world (FAO, 2004). In Europe the pacific oyster was massively introduced in the seventies of the last century especially in France following mass mortality in *Crassostrea angulata*. Good environmental conditions in some French areas south of the Loire River on the Atlantic coast induced successful recruitments in the following years. The population became established in the mid 70's. Since de nineties successful recruitment, associated with the global warming, has been observed northward and consequently wild populations were established in many areas where *C. gigas* was introduced for aquaculture as in areas far from farms due to larvae colonisation. Now this species has become a permanent member of the coastal ecosystem. This phenomena is not limited to the French Atlantic coasts but is also observed in northern European countries (i.e. UK, Belgium, The Netherlands, Germany and Denmark and Scandinavian countries) but also in different countries worldwide where the species was introduced in the past. The status of this invasion, its dynamics and the ecological and socio-economical consequences of this phenomenon are under-investigation in these countries.

We propose to review the current status of knowledge concerning the *Crassostrea gigas* invasiveness. The following tentative table of contents provides additional information on the chapters which will be developed in the expected document.

Alien Species Alert: *Crassostrea gigas* (Pacific oyster)

Table of contents

- Diseases and parasites

5.2 Economical impact

Worldwide production

5.3 Social impact

Farming activity (lease development, shellfish areas development)

Recreational activity

Public health issue

6 – Mitigation and restoration

Technical solutions to limit the extension

7 – Prospective

- impact of the global change:
  - Problem associated with calcification process related to CO2 cycle
  - Further potential expansion of the species

Annex 9: Draft: Consideration of the oyster *Crassostrea ariakensis* for introduction to the Chesapeake Bay, USA and the utility of ICES Code of Practice guidelines

2007 International Council for Exploration of the Seas (ICES) Working Group meeting on Introductions and Transfer of Marine Organisms (WGITMO).

Dubrovnik, Croatia

March 18–24, 2007

WGITMO presentation: Consideration of the oyster *Crassostrea ariakensis* for introduction to the Chesapeake Bay, USA and the utility of ICES Code of Practice guidelines. **

Roger Mann,
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA 23062, USA

Summary

The ICES Code of Practice guidelines were develop over three decades ago to assist the process of consideration of marine species for intentional introductions beyond their native range. The guidelines have been updated and revised throughout their working life in response to both needs and the development of new technologies such as ploidy manipulation. A program is currently underway in the Mid Atlantic region of the United States wherein a non-native oyster, *Crassostrea ariakensis*, is being considered for introduction to the Chesapeake Bay for both ecological and fishery enhancement purposes. The oversight mechanism is through formal development of an Environmental Impact Statement (EIS) by the US federal government, represented by the Army Corps of Engineers (USACOE), in collaboration with the State of Maryland and the Commonwealth of Virginia. This is probably the most comprehensive evaluation of a potential introduction that this author is aware of in over three decades of working in this field, and provides an opportunity to critically evaluate the most recent revision of the ICES Code of Practice in a contentious and high stakes debate. Four questions are posed. These are (1) what similarities and dissimilarities exist between the process pursued in the current evaluation and the WGITMO the revised Code of Practice, (2) has the current process defined limitations or inadequacies that the ICES Code should incorporate, (3) has the current evaluation failed to address issues that are presented by the current Code of Practice, and (4) what is the time frame for completion of the current EIS and is any scientific consensus emerging at this time on the risks and benefits of the considered introduction.

**This presentation was invited by Judith Pederson, WGITMO Chair, ICES USA representative.

Introduction

Transfers and introductions of oysters for the enhancement and/or replacement of native species fisheries have been many. The native oyster, *Crassostrea virginica*, resource of the Chesapeake Bay on the Atlantic coastline of the United States has been severely depleted by harvest since colonial times, habitat destruction and the combined impact of two diseases, *Haplosporidium nelsoni* (commonly known as MSX for **M**ultinucleate **S**phere **X**-unknown) and *Perkinsus marinus* (commonly known as Dermo disease form a period when the genus was *Dermocystidium*). Both diseases show highest impact in higher salinities, and extant oyster populations in the Chesapeake Bay exist as modest, arguably isolated "subpopulations"

in lower salinity (typically <15ppt) regions of the subestuaries of the Bay (for reference the bay is 298 km long – the largest estuary in the United States). MSX has been shown to be non-native and probably of oriental origin in elegant molecular work by Nancy Stokes and Eugene Burreson at the Virginia Institute of Marine Science (VIMS). The life cycle of MSX has proven difficult to elucidate in that we still cannot transmit this species from host to host in the laboratory – all disease challenges for MSX occur in field trials. The life cycle of Dermo is better understood. The debate over possible alternate use of a non-native species in the Chesapeake Bay has been open at a very modest level for a number of years, but the subject gained momentum in the early 1990's when the combination of the development of triploidy for widespread application in oyster culture (initially and predominantly in the Pacific North West for *Crassostrea gigas*, work by Standish Allen Jr.) prompted the possibility of testing reproductively compromised *C. gigas in situ* for disease susceptibility. These proposals resulted in intense, sometimes heated debates, but they served the purpose of posing the question "how would we test a non-native oyster species for possible introduction to the Chesapeake Bay – especially when one of the challenging diseases cannot be transmitted in laboratory challenge?"

Limited studies were conducted with *C.gigas* in quarantine systems. While some positive results were obtained the tests were terminated before serious consideration was given to in water testing. None the less interest remained in non-native oyster species, and in particular attention was focused on *C. ariakensis* that, during the late 1990's was being cultured in the Pacific North West based on a limited stock identified in Oregon. *C. ariakensis* were considered to have been introduced as an accidental inclusion is seed shipments of *Crassoatrea sikamea* to that state in the 1970's. During the 1990's considerable progress had been made on methods to reliably produce triploid oysters in large numbers. Early methods of triploid induction involved disruption of the chromosome division following fertilization using cytochalasin B. This produced variable percentages of triploid animals in the final population, thus compromising an *in situ* deployment in that a small but measurable percentage of diploid, and therefore reproductively active, individuals would remain. Later work developed tetraploid oysters. When crossed with diploid oysters these produced triploid oysters with very low incidence of diploids and low reversion rates. A tool was now available to produce large number of reproductively compromised oysters for *in situ* testing.

As methods for providing triploid oysters improved the climate for consideration of non-native oysters was changing. The native oyster fishery continued to decline, especially in the state of Maryland where earlier consideration of *C. gigas* had been strongly opposed. Increasing emphasis had also been placed on the ecosystem services provided by oysters such as filtering phytoplankton, benthic-pelagic coupling, and the provision of complex habitat for benthic species by reef building. A more positive interest in a non –native was expressed, with specific focus on *C. ariakensis*.

A U.S. National Academy of Science (USNAS) working group was assembled and tasked with examining the question at hand. A comprehensive report was produced that, in addition to providing some cautionary statements on what could and could not be considered in the course of non-native evaluation testing, also suggested a revisiting of options for the native species. In due course the preparation of a federal Environmental Impact statement (EIS) was required. An EIS requirement is typically published in the Federal Register –the chronicle of activity of the U.S. Federal Government. The federal agency tasked with completing the EIS is the U.S. Army Corps of Engineers (USACOE). This is in part because of a jurisdictional issue relating to placement of structures and materials in navigable waterways – the jurisdictional issues would in themselves take many page to describe, and they are ultimately still open to some debate about the roles of federal versus states rights. The consensus is that federal law prevails, but this has not been challenged in a court of law. To return to the EIS process, the announcement was published is given below.

The environmental impact statement

The Federal Register, Vol. 69, No. 2, dated Monday, January 5, 2004 provides notice of "DEPARTMENT OF DEFENSE, Department of the Army; Corps of Engineers Intent [To Prepare a Programmatic Environmental Impact Statement] for a Proposed Introduction of the Oyster Species, *Crassostrea ariakensis*, Into the Tidal Waters of Maryland and Virginia To Establish a Naturalized, Reproducing, and Self-Sustaining Population of This Oyster Species." and describes seven alternatives to be evaluated in the EIS process. These are:

Alternative 1—No Action: Not taking the proposed action: Continue Maryland's present Oyster Restoration and Repletion Programs, and Virginia's Oyster Restoration Program under current program and resource management policies and available funding using the best available restoration strategies and stock assessment techniques.

Alternative 2—Expand native Oyster Restoration Program: Expand, improve, and accelerate Maryland's Oyster Restoration and Repletion Programs, and Virginia's Oyster Restoration Program in collaboration with Federal and private partners. This work would include, but not be limited to an assessment of clutch limitations and long-term solutions for this problem and the development, production, and deployment of large quantities of disease resistant strain(s) of C. Virginia (Eastern Oyster) for broodstock enhancement.

Alternative 3—Harvest Moratorium: Implement a temporary harvest moratorium on native oysters and an oyster industry compensation (buy-out) program in Maryland and Virginia or a program under which displaced oystermen are offered on-water work in a restoration program.

Alternative 4—Aquaculture: Establish and/or expand State-assisted, managed regulated aquaculture operations in Maryland and Virginia using the native oyster species.

Alternative 5—Aquaculture: Establish State-assisted, managed or regulated aquaculture operations in Maryland and Virginia using suitable triploid, non-native oyster species.

Alternative 6—Introduce and Propagate and Alternative Oyster Species: (Other than *C. ariakensis*) or an alternative strain of *C. ariakensis*: Introduce and propagate in the State-sponsored, managed or regulated oyster restoration programs in Maryland and Virginia, a disease resistant oyster species other than *C. ariakensis*, or an alternative strain of *C. ariakensis*, from waters outside the U.S. in accordance with the ICES 1994 Code of Practices on the Introductions and Transfers of Marine Organisms.

Alternative 7—Combination of Alternatives. The EIS is noteworthy for identifying "the Tidal Waters of Maryland and Virginia" because both states have within their own state laws sections that address introduction of non-native species to their tidal waters. In the end the three parties agreed to collaborate on the EIS with the federal agency as the lead agency. This should work very well until the final interpretation (which is still some time away) assuming that all parties agree on the final course of action. If they do not then legal debates may again arise. To illustrate the seriousness of this debate the General assembly of the Commonwealth of Virginia (the elected state representative body), in its FY 2006-07 State Budget document inserted the following language:

"Upon the effective date of this act, the Commissioner of Marine Resources shall, as soon as practicable, apply for a permit from the United States Army Corps of Engineers to introduce, on an extensive scale, the oyster *Crassostrea ariakensis* into the waters of the Chesapeake Bay. If necessary, the Commissioner shall expeditiously exhaust all administrative appeals and remedies to obtain such permit. If all such administrative appeals and remedies have been exhausted and the permit described herein has not been granted, the Commissioner shall, as soon as practicable, appeal such denial of the permit in the proper court".

The Commissioner of Marine Resources is the agency head for the Virginia Marine Resources Commission (VMRC), the regulatory agency tasked with custodianship of the marine resources of the Commonwealth of Virginia. The Virginia Institute of Marine Science (VIMS) is tasked by the Virginia General Assembly as an advisory agency to VMRC. A plan is being drafted by the VIMS at the request of the Commissioner to guide implementation of an introduction should the decision to introduce be positive (more on that later, my presentation for ICES WGITMO 2008 wherever we meet).

Scientific contributions to date in support of the EIS

The need for scientific investigation in support of this EIS was anticipated by the science community. A workshop sponsored by the Chesapeake Bay Scientific and Technical Advisory Working group (STAC) was convened in December of 2003 to discuss research needs. A report was produced entitled "Identifying and Prioritizing Research Required to Evaluate Ecological Risks and Benefits of Introducing Diploid *Crassostrea ariakensis* to Restore Oysters to Chesapeake Bay." This is lengthy and I have provided a complete digital copy for the WGITMO record. I present below a complete Executive Summary from the report as a quotation:

> "Heavy fishing pressure, habitat degradation and high disease mortality have driven native oyster (*Crassostrea virginica*) populations to historic low levels in Chesapeake Bay. In response, the states of Maryland and Virginia are considering introducing the Asian Suminoe oyster (*C. ariakensis*) with the goal of establishing a naturalized, self-sustaining population.
>
> Neither the potential risks nor the potential benefits of such an introduction are adequately known at this time. The scientific community agrees that an introduction of diploid *C. ariakensis* is likely to be irreversible (NRC 2004, copies are available on the web at http://www.nap.edu), and that the spread of *C. ariakensis* beyond the borders of Chesapeake Bay is inevitable if a self-sustaining population is established. Further, the potential for novel interactions between oyster pathogens— those resident in the Bay and others that may emerge—and *C. ariakensis* is uncertain and impacts may be unpredictable both for this oyster and for other species over time. Given the long-term implications of an introduction, sound scientific information must form the basis of the environmental impact statement (EIS) that will assess the proposed introduction as well as other alternatives.
>
> The Scientific and Technical Advisory Working group (STAC) of the Chesapeake Bay Program convened a workshop of research scientists in Annapolis on December 2–3, 2003 to discuss and prioritize research needed to fill critical gaps in our ability to predict risks and benefits that might result from an introduction of diploid *C. ariakensis* to Chesapeake Bay. *The outcome of this effort represents a disciplined approach to prioritize research needs—only those that were considered to be most important are reported here.* The specific research recommendations found in this report address issues of the genetics, biology and ecology of *C. ariakensis* that should be clarified prior to a final decision on the introduction of diploid individuals to Chesapeake Bay.
>
> Meeting organizers and attendees were specifically focused on research to inform the primary proposal put forward by Maryland and Virginia - i.e., the introduction of 'Oregon' C. *ariakensis*. – because of the urgency of this issue. Previous workshops have provided guidance on research needs for native oyster restoration and oyster disease—issues of critical importance to Chesapeake Bay. Because of the scarcity and limited genetic diversity of the 'Oregon strain', recommendations below that specifically target this organism should be considered to be more generally applicable

to whichever stocks of *C. ariakensis* are considered for introduction. In addition, wild-strain and disease-tolerant *C. virginica* will clearly need to be used as the benchmarks against which to assess the risks and benefits of *C. ariakensis*."

A reading of the STAC report shows that it follows many of the general principles outlined in the ICES Code of Practice, although it does not cite ICES until a later section on actual introduction where it states: "Diploid *C. ariakensis* will be propagated from the 3rd or later generation of the naturalized Oregon stock of this species, in accordance with the International Council for the Exploration of the Sea's (ICES) 1994 Code of Practices on the Introductions and Transfers of Marine Organisms." The possible alternatives section of the STAC report provides the framework for the EIS wording given earlier.

Approximately three years have elapsed since the STAC report and the EIS publication. There has been a massive research effort focusing on many aspects of the biology of *C. ariakensis* and both economic and sociological aspects of a possible fishery based on the species. In excess of $6 million (a conservative estimate) has been spent or committed to research, both completed and continuing, focusing on EIS supportive science. Much of this work follows the guidance given in the ICES Code of Practice. ACOE has stated that a first draft of the EIS will be available this coming spring. Much of the supporting research is still in progress and will not be completed until at least then end of calendar year 2007, so I expect this to be the first of several drafts.

Several interesting discoveries have been made as part of this work to date. A selection,of these follows:

1) In order to examine the ecology of *C. ariakensis* in its native environment it is necessary to unambiguously identify the species and its distribution. The taxonomy and distribution of *C. ariakensis* and other *Crassostrea* species in the Orient was far less well understood in 2004 than was desired, and a considerable effort has been invested in advancing that subject as part of the EIS. Molecular tools have proven extremely useful in this work.

2) *C. ariakensis* is generally considered an estuarine species in its native location, being displaced by other species, notably *C. gigas*, in higher salinity water. Interest in *C. ariakensis* culture in China is modest compared with other species. By contrast, the proposed region of introduction, and the region of current testing, includes sites with salinity in excess of 30 ppt.

3) A suite of biosecurity measures have been developed for holding *C. ariakensis* for experimental purposes both the in laboratory and in the field. These are typically site and study specific, but they provide a virtual encyclopedia for workers considering future non-native trials.

4) Very large scale production of triploid *C. ariakensis* for field trials is feasible. Using a benchmark standard of less than 1 diploid in 1000 triploid animals the VIMS oyster hatchery, under the direction of Standish Allen Jr., has routinely produced very large numbers for the past four years using a tetraploid – diploid cross as described earlier.

5) Using triploid oysters both scientific and industry pilot scale field studies have been undertaken, As an example of industry collaboration three field trials, with 1 000 000 animals in batches of 100 000 have been or are being completed in collaboration at this time without any evidence of loss of experimental animals.

6) A simple risk model has been developed to assist such field trial operations. This is an evolving model that improves with each trial and with continual addition of new knowledge, using both published scientific information and expert opinion. Despite its limitations it has proven to be a useful tool in support of the regulatory process.

7) *C. ariakensis* does not suffer the heavy disease related (MSX and Dermo) mortalities observed in native oysters in side by side growth trials in the Chesapeake Bay.

8) *C. ariakensis* triploids grown in the field in North Carolina are, when small, susceptible to a newly documented *Bonamia* species. This is very troubling in that *Bonamia* is generally considered to be a parasite of flat oysters of the genus *Ostrea*. The origin of this *Bonamia* in North Carolina waters is in itself a challenge, and work is continuing to elucidate the global phylogeny of this genus. Field deployments of *C. ariakensis* in Chesapeake Bay sites do not show evidence of *Bonamia*.

9) Growth of *C. ariakensis* in the field has been remarkable in many locations. Commercial harvest size oysters in Virginia and Maryland must exceed 3 inches (76mm) in the longest dimension. *C. ariakensis* grown in various culture containers (as dictated by biosecurity measures) can exceed this size in under one year, especially at higher salinity.

10) High growth rates make a one year culture crop a probable option for the industry. Meat yields in industry trials consistently exceed those of native oysters by a large amount. Even with the employment of extensive biosecurity measures current industry participants have recorded sales of final product that exceed investment in the trial by as much as 100%!

11) Despite the observed high growth rate and apparent tolerance of extant diseases *C. ariakensis* has limitations. The shells are typically thin, although this may in part be a product of off bottom culture in cages. Where careful experimental studies have minimized this possible artifact there still appears to be a preference for juvenile *C. ariakensis* over native oysters by local predators. Losses to predation may be unacceptably high.

12) Larval biology of *C. ariakensis* has been intensively examined, and there are strong suggestions that *C. ariakensis* larvae may be more "bottom seeking" than the native species with implications for dispersal and possible establishment and range expansion.

13) Growth in sites with any intertidal exposure may limit growth and survival of *C. ariakensis*. Studies in progress suggest that survival in these locations may be less than that of the native species. Conclusive statements must await completion of the studies.

14) Industry collaborators have noted a more limited shelf life of the species compared to the native species that affects opportunities to store and ship the harvested product.

Utility of ICES Code of Practice guidelines in the current process: a review of work to date

The purpose of this contribution is to examine the utility of ICES Code of Practice guidelines in studies completed so far in the *C. ariakensis* evaluation process. In offering this review it is important to understand that the science community still has a number of important studies in progress, so there will be an inevitable iteration between the science and the EIS. With that qualifying statement in hand I will examine the four questions posed earlier.

1. What similarities and dissimilarities exist between the process pursued in the current evaluation and the WGITMO the revised Code of Practice?

There has been strong parallel between the process as guided by the EIS, the STAC report and subsequent research contributions towards developing an understanding of the ecology of the species in its native environment. The taxonomic challenges aside, *C. ariakensis* has been found to have a limited natural distribution in regions that are disturbed by human activity. The baseline information on *C. ariakensis* is poor compared to other widely used species such as *C. gigas*. The proposal to use this species in receptor locations with salinities atypical of its native distribution have forced reliance on field testing in the proposed sites of introduction. Without the use of triploidy as a facilitating tool this would never have been considered.

2. Has the current process defined limitations or inadequacies that the ICES Code should incorporate?

A significant challenge in this, as in other prior evaluations for introduction, is the synthesis of collected data to a predictive tool. In past experience this has generally been limited to modestly complex comparisons of tolerance to one or two physical variables, such as temperature and salinity, or the susceptibility to a local parasite or disease. The STAC report independently acknowledges this challenge with statements thus:

> "Models of various types are needed to integrate the results of completed and future research, to provide a tool for prediction, and to inform economic and risk analyses. " and

> "Model development should be conducted in a phased/sequenced (iterative) approach between data collection and model development to insure that the models provide ecologically relevant outputs and that the proper types of data are being collected for input into the models."

These statements are of importance because they acknowledge a limitation in invasive species biology – the general inability to predict the outcome of an introduction. The work to date has included an effort to develop a population dynamics model for the native species that incorporate growth, mortality (notably that aspects related to salinity driven disease impacts), and recruitment. This model strives to link the spatial dynamics of the population using a second complex three dimensional circulation model to predict larval dispersal from known sources. Developing and linking these models has been a significant challenge but progress is being made and the final combined model tested by examining ability to hindcast known events. What has emerged from this study is a startling account of the poor knowledge of basic rate functions in the native species, notably natural growth and mortality rates! Given the challenges that have emerged for the native species, I predict that difficulty will be encountered in developing this model as a predictive tool for *C. ariakensis*, especially in the proposed time frame for the EIS. This is not to criticize the ecological work to date - it may well in summary provide a reasoned argument for or against the introduction in the absence of a complete *C. ariakenis* population dynamics model. The lesson to be learned from this exercise is that the population dynamics tools used in fishery rebuilding, well proven with finfish in terms of required understanding of rate processes for recruitment, growth and mortality, could prove very useful tools for invasion biology, but we need to measure **rate processes** in a manner atypical to most observational or experimental ecological studies in support of introductions. These fishery management tools provide a structure to guide research needs for both the native and the considered non-native species. When the data for the native species are inadequate, it is critical that it be collected in order to identify limitations in that species to guide rebuilding, rather than simply discard this option and move to an introduction. Evaluations of possible introductions need to move beyond complex **descriptions** of ecology in native and possible receptor locations to **quantitative models** of population biology in native and possible receptor locations, where rate functions can be manipulated to create scenarios that are not driven by mean values, but rather examine extreme events that correspond to failures to establish or invasions that displace native species and radically alter receptor environments. I argue that it is not the mean values of such rates that drive events, it is the end regions of the rate distribution that drive atypical events that will shape the outcome of an introduction. We should pay close attention to available models at the initiation of the study to guide relevant research, rather than fit the available data at the end of the process.

Recent revisions of the Code of Practice have included discussion of the use of ploidy manipulation to allow experimentation in receptor locations of reproductively compromised non-native species. Where the biology of the considered species is conducive, as with immobile oysters that can be cultured and contained in cage enclosures, this tool is of

immense value. It has allowed field studies, guided by sound risk assessment, and provided data that would have been unavailable if such a study were proposed a decade ago (see earlier comments on *C. gigas* as a option in the Chesapeake Bay). Ploidy manipulation, in combination with existing guidelines for limiting transmission of diseases (use of F1, F2 or some designated generation following the initial introduction to quarantine) provides a valuable tool that should be investigated. Better data allows better decisions.

Risk assessment as a quantitative tool to design supportive field studies is valuable for the regulatory process, but it also identifies limitations in general knowledge of the target species in a manner generally not acknowledged by the investigators. Again, risk assessment tools generally require knowledge of rates of processes that are poorly known by both fishery biologists and ecologists. There is no excuse not to attempt to quantify these and we need to do better.

3. Has the current evaluation failed to address issues that are presented by the current Code of Practice?

The current suite of studies generally cover the subjects included in the Code. But the Code may also, as described above, have limitations as described above. The diversity of contributions in the current study is to be complimented in that it is very broad. As mentioned earlier, this is probably the most comprehensive evaluation of a potential introduction that this authors is aware of in over three decades of working in this field, a statement supported by the level of investment in scientific study among a number of traditional disciplines.

4. What is the time frame for completion of the current EIS and is any scientific consensus emerging at this time on the risks and benefits of the considered introduction?

A first draft delivery date has been scheduled by ACOE for spring 2007. With continuing scientific investigations having completion schedules that vary until the end of calendar year 2007 I expect a series of revisions and updates to this EIS as more information becomes available. While it is presumptuous to suggest a final conclusion for the collected work unexpected opinions are beginning to emerge. A review of work to date with *C. ariakensis* is interesting in that the initial impetus for consideration of the species was for release as a diploid, self sustaining population for ecological and fishery support purposes. What is emerging is a greater interest in the use of *C. ariakensis* as a cultured species with a short generation time and a high meat yield. The scientific infrastructure to support a triploid based culture industry already exists. The industry is ready to expand to include this opportunity, and they are convinced this can be very profitable. Implementation is a matter of scale and permitting.

The EIS also called for greater effort to consider the native species. This has also had unexpected results. Many of the *C. ariakensis* field trials have used triploid native *C. virginica* as controls, and the performance of this species in culture conditions has gradually improved using selected strains from a long term breeding program under the direction of Standish Allen Jr. at VIMS. There is now an expanding culture industry focusing on the production of triploid native oysters for direct market. Cultured native oysters are reaching market size in less than 18 months, and in doing so avoiding significant losses to endemic diseases. So while the native oyster fishery may still be in a difficult situation, the culture industry may have a bright future. Again, the infrastructure exists. Implementation at large scale is again an issue of permitting for larger scale operations using cage or float structures.

Finally, a quantitative analysis may begin to emerge as data are assembled (where they cannot be connected and truly synthesized). Staring with a model that drives interlinked quantitative data collection is absolutely critical if we are t improve our abilities to predict the impacts of introductions – both accidental and intentional.