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

18–20 March 2015

Bergen, Norway

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

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Contents

Executive summary

The 2015 meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was held in Bergen, Norway on18–20 March with Anders Jelmert as host and Henn Ojaveer as chair. Fourteen countries participated in the meeting. Attendants were from Belgium, Canada, Estonia, Finland, France, Germany, Italy, Lithuania, Norway, Poland, Portugal, Sweden, United Kingdom and United States. Greece, Ireland, Spain and Denmark contributed by correspondence. The meeting was also attended by the JRC representative. It was the 41th meeting of this expert group.

The objectives of the meeting were to update information and discuss several aspects related to the introductions and transfers of non-indigenous species. Data and information management was a key component of the meeting with a special focus on the applicationof the ‘Information system on aquatic non-indigenous and cryptogenic species’ (AquaNIS) to support WGITMO mandate. These included issues such as: i) fouling of artificial structures by non-indigenous species, ii) how to better address emerging ICES strategic topics (climate impacts, Arctic research) and iii) internal cooperation in ICES (WGBOSV, WGAQUA, WGIMT). The group also dedicated time for addressing the MSFD D2 issues and discussed these in relation to data availability and management implications for NIS in marine ecosystems. Another alien species alert report was published in ICES CRR series (see: Gollasch, S. *et al.* 2015. Alien Species Alert: *Ensis directus*. Current status of invasions by the marine bivalve *Ensis directus.* ICES Cooperative Research Report No. 323. 32 pp.). The outline for the new report onthe sea squirt *Didemnum vexillum,* was developed during the meeting. The group also reviewed OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition and developed advice related to non-indigenous phytoplankton species. As usual, appropriate time was devoted to discuss national reports, exchange of information on the management of NIS and review of research activities.

The approach taken during the meeting facilitated presentations and discussions on the issues of relevance related to the Terms of References, but also a few generic and strategically important issues relevant to the theme of bioinvasions in general. The meeting started with a full-day joint meeting with the Working Group on Ballast and Other Ship Vectors (WGBOSV) to provide an opportunity to discuss and address issues of common interest. It was also agreed that this practice of conducting back to back meetings with one joint day will continue in 2016.

All Terms of References identified for 2015 were discussed. For some Terms of Reference, a more detailed presentation was given during the meeting and a short overview of the information and subsequent discussion is provided in the report at the end of each section. The report is structured so that each Term of Reference is dealt with in sequential order. The main body of the report contains summaries of the presentations and discussions with the more detailed documents being contained in the Annexes.

The group progressed in each of the Terms of Reference by either completing the task or clearly identifying and agreeing on the intersessional activities required to finalise the work. Intersessional work is inherently an integral component of future work for WGITMO. To share the workload, several group members were asked to lead some specific tasks.

WGITMO suggests further developing and advancing AquaNIS to better meet ICES requirements, and safeguard AquaNIS future by cooperating with the ICES Data Centre to obtain technical assistance and back-up. This would facilitate cooperation with CIESM and PICES in the field of data exchange.

1 Opening of the meeting

The meeting started at 09:00 on 18 March 2015 as a joint session with ICES/IOC/IMO Working Group on Ballast Water and Other Ship Vectors (WGBOSV). Sarah Bailey (Chair WGBOSV) and Henn Ojaveer (Chair WGITMO) welcomed all the participants. Anders Jelmet, Norway, acted as host of the meeting. Sarah Bailey and Henn Ojaveer chaired the joint session. The joint session finished at 17:00 on 18 March and the WGITMO meeting continued on 19–20 March.

2 Adoption of the agenda

The agenda was organized based on the Terms of Reference provided in the ICES Resolution 2014/2/SSGEPI04 (see below). In addition, invited presentations on a specific topic and/or of generic interest were accommodated into the agenda to foster discussions on potential ToRs for the coming years, (Annex 2).

3 WGITMO Terms of Reference

2014/2/SSGEPI04 The **ICES Working Group on Introductions and Transfers of Marine Organisms** (WGITMO), chaired by Henn Ojaveer, Estonia, will meet in Bergen, Norway, 18–20 March 2015, back-to-back with the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV) to:

a) Summarize information provided in national reports and through the AquaNIS information system. Develop annual summaries of new occurrences/introductions of aquatic non-indigenous species;

b) Continue addressing EU MSFD D2 on further developing alien species indicators, incl. based on information available in AquaNIS and other sources;

c) Continue identification and evaluation of climate change impacts on the establishment and spread of non-indigenous species. Produce draft manuscript outline on salinity change effects on non-indigenous species. This activity will mostly be carried out intersessionally and take several years;

d) Investigate and report on new developments in non-native species issues associated with biofouling (e.g. artificial structures in the marine environment and recreational boating) (joint Term of Reference with WGBOSV);

e) Investigate and report on new developments in non-native species issues in the Arctic, as a result of climate change and resource developments (joint Term of Reference with WGBOSV).

f) Investigate and report (incl. via AquaNIS) on new molecular tools for identification, early detection and monitoring of non-native species, in collaboration with ICES Working Group on Integrated Morphological and Molecular Taxonomy, WGIMT (joint Term of Reference with WGBOSV);

g) Produce draft outline of the alien scpecies alert report on Didemnum vexillum;

h) Produce four short paragraphs for the ICES Ecosystem Overviews on regional trends in invasive species, one paragraph for each of the following ICES ecoregions: Greater North Sea, Celtic Seas, Bay of Biscay & the Iberian coast and Baltic Sea.

i) OSPAR 1/2015 request:

Review of draft OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition

ICES is requested to advise OSPAR on the revision of the OSPAR JAMP Eutrophication Guidelines which will be revised by experts from Germany, The Netherlands and Sweden.

ICG-EUT 2014 concluded, and HASEC 2014 endorsed, that these guidelines were in need of a review. The guidelines should be revised to reflect new knowledge about phytoplankton and needs within (directives such as) the EU Marine Strategy Framework Directive (MSFD) and the Water Framework Directive (WFD).

It is the intention of the revision that the existing aims described in the guidelines1 will be supplemented with the following:

- to identify harmful algae species and blooms in line with MSFD Descriptor 5.
- to identify invasive (non-indigenous) species in line with MSFD Descriptor 2.
- to monitor effects of ocean acidification as e.g. on coccolithophorids (e.g. *Emiliania huxleyi*) in line with Descriptor 1 in MSFD.

The revised guidelines should incorporate coming monitoring and measurement techniques such as (but not limited to) spectrofluorometry, flow cytometry and qualitative observations of foam production, and should make use of existing standards, such as EN 159722 and EN 152043 and reflect developments within the OSPAR ICG – COBAM which is working on biodiversity monitoring and assessment. Data handling issues, such as the format required for reporting to ICES, should also be addressed.

WGITMO should address the issues related to invasive (non-indigenous) species and relevant monitoring and measurement techniques as mentioned above.

WGITMO will report by 10 April 2015 (via SSGEPI) for the attention of SCICOM.

Supporting Information

Priority:	The work of the Group forms scientific basis for essential advice to prevent future unintentional movements of invasive and/or deleterious aquatic species including disease agents and parasites with the legitimate trade in species required for aquaculture, table market, ornamental trade, fishing and other purposes and to assess the potential of species moved intentionally to become a nuisance in the area of introduction. The work of this Group supports the core role of ICES in relation to planned introductions and transfers of organisms.
Scientific justification and relation to action plan:	a) We continuously update, through the national report and AquaNIS information system submissions, knowledge of the new alien species introductions and expanding introductions not only in the ICES area, but also elsewhere (e.g. the Mediterranean Sea). b) The group will continue contributing to the MSFD Descriptor 2 issues, incl.

[1] 1. to establish the spatial distribution and frequency of phytoplankton blooms; 2. to establish temporal trends, over periods of several years, in phytoplankton species composition and their relative abundance; 3. to identify key phytoplankton species

[2] Water quality – guidance on quantitative and qualitative investigations of marine phytoplankton

[3] Water quality – guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermöhl method)

	further developing alien species indicators, especially those related to ecological impacts. c) We continue identification and evaluation of climate change impacts on the establishment and spread of non-indigenous species by starting investigating the salinity change impacts. e) We continue addressing one of the high-priority topics of ICES – Arctic – by investigating developments in non-native species issues in the area as a result of climate change and resource developments. f) We'll continue investigations on increasingly important issue of various artificial structures for alien species spread and invasions. g) We'll start producing the next alien species alert report – on the sea squirt Didemnum vexillum. h) Each paragraph should be maximum 150 words in length and can be support by one figure. Paragraphs for each ecoregion should be similar in style and address the overall state and comment on the pressures accounting for changes in state. These will go in section four of the ecosystem overviews and not supposed to be long descriptions, but a short synopsis of important points for managers and policy developers. i) OSPAR 1/2015 request need to be addressed in the WGITMO meeting 2015.
Resource requirements:	None required other than those provided by ICES Secretariat and national members
Participants:	WGITMO nominated members and invited experts from, e.g. Australia, and PICES and CIESM countries.
Secretariat facilities:	Meeting room provided by the host.
Financial:	None required
Linkages to advisory committees:	ACOM
Linkages to other committees or groups:	WGHABD, WGBOSV, WGBIODIV, WGAQUA, WGIMT, WGPDMO, WGBE, WGZE
Linkages to other organizations:	WGITMO urges ICES to encourage and support a continued dialogue with PICES, CIESM, IMO, HELCOM, OSPAR and EIFAC.

4 Progress in relation to Terms of Reference

The sections below provide information on the progress made on each of the Terms of Reference, amendments or conclusions/recommendations based on group discussions and contributions.

4.1 Term of Reference a)

Summarize information provided in national reports and through the AquaNIS information system. Develop annual summaries of new occurrences/introductions of aquatic non-indigenous species (ToR leads Henn Ojaveer and Sergej Olenin)

General

This Term of Reference was addressed by all meeting participants who provided information for their country according to the reporting template. This was done either via a short verbal report or in the form of more substantial presentation. In addition, three countries not in attendance at the meeting (Denmark, Greece and Spain) submitted their written contributions.

As agreed in 2014, WGITMO has shifted to reporting on new NIS via the AquaNIS information system http://aquanis.ku.lt. All group members have received detailed instructions on how to access the database and upload their information. Transition to online reporting, however, will take time since some countries are still in the process ofupdating their information. Presently, AquaNIS covers most areas in the North East Atlantic, while the Mediterranean remains with limited access. In 2014, invasion event information for the following new regions was included into the database: Hudson Bay complex (Arctic, LME 63); three North West Pacific LME's (countries: China, Japan, Korea and Russia) and South West Pacific LME 46 (New Zealand Shelf).

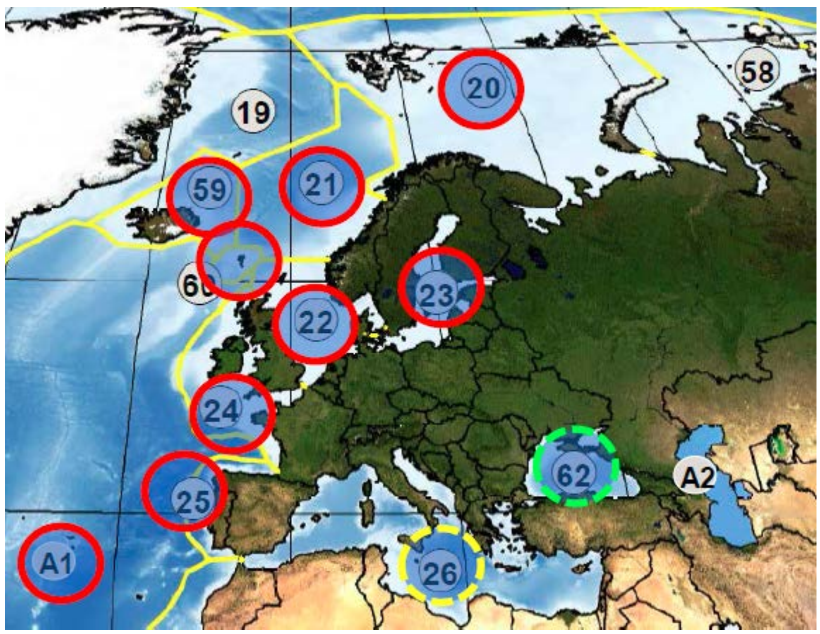


Figure 4.1.1. Status of data on AquaNIS in Europe: red circles – free access; yellow circle – limited access, green circle – in process.

The following sub-sections provide the summarized highlights of all national reports received. For details, please see Annex 3 (national reports).

4.1.1 Belgium

During 2014 a small population of the Manilla clam *Ruditapes philippinarum* was discovered and reported in the port of Zeebrugge. The Indo-Pacific leptomedusa *Lovenella assimilis* or *Eucheilota menoni* was found amongst the gelatinous plankton off the Belgian coast. During the summer of 2014, the clinging jellyfish *Gonionemus vertens* was reported in de Spuikom (Sluice Dock) Oostende. The mud worms *Boccardiella hamata* and *Boccardia proboscidea* are reported from Belgium. All other introduced species that were reported during previous years are still present and seem to be well-established and thriving.

4.1.2 Canada

Fisheries and Oceans Canada is currently developing regulations that would help address Aquatic Invasive Species. *Didemnum vexillum*, confirmed for the first time in 2013 in the upper Bay of Fundy (Minas Basin) of Atlantic Canada, and has since been reported spreading toneighboring sites in 2014. Other non-indigenous species that have already invaded Canadian waters continue to spread, including European green crab (*Carcinus maenas*), vase tunicate (*Ciona intestinalis*), oyster thief (*Codium fragile*), golden star tunicate (*Botryllus schlosseri*), clubbed tunicate (*Styela clava*), European sea squirt (*Ascidiella aspersa*) and violet tunicate (*Botrylloides violaceus*). For detailed information on

4.1.3 Denmark (by correspondence)

Two non-indigenous species of freshwater crayfish have been found in brackish waters in the Sound (Øresund). *Hemigrapsus sanguineus* and *H. takanoi* can now be considered established in the Danish Wadden Sea. The comb jelly *Beroe ovata* has been found in the Limfjord. The round goby, *Neogobius melanostomus*, continues to spread into Storebælt (Great Belt) and into freshwater streams.

4.1.4 Estonia

National non-indigenous species monitoring was continued with the same scope and aims as in previous years. One of the aims is to monitor non-indigenous species in the high-risk areas of new invasions. Base on surveys in vicinity of the largest port in the country – Muuga harbor – no new non-indigenous species were identified in 2014. The cryptogenic cirriped *Amphibalanus improvisus* and the non-indigenous polychaete *Marenzelleria neglecta* appear to form well established populations. The round goby *Neogobius melanostomus* declined in gillnet catches in the Gulf of Finland and the abundance of Chinese mitten crab *Eriocheir sinensis* continued to be low.

4.1.5 Finland

One new non-indigenous species was identified from Finnish waters in 2014, when white-finned gudgeon (*Romanogobio albipinnatus*) specimens were caught from the Saimaa Canal. The new gastropod species, found in 2013 in the Gulf of Finland, belongs to Murchisonellidae family. The species description is under way with international collaboration on morphological and bio-molecular characteristics. The round goby, *Neogobius melanostomus*, the gibel carp, *Carassius gibelio,* the grass prawn *Palaemon elegans,* and the mud crab *Rhithropanopeus harrisii* continue to increase in abundance. Port monitoring was suggested to be included in the revised national monitoring programme but due to resource retriction it has not been started. The ratification of the IMO's BWM Convention by Finland is still in the process and will hopefully take place in autumn 2015. The EU regulation on invasive species was taken into force 1.1.2015 and will be taken into the national legislation during 2015.

4.1.6 France

The Interreg Marinexus project, which ended in 2014, has demonstrated the value of molecular tools in the early detection of non-indigenous species. During 2014, two non-indigenous hydrozoans (*Lovenella assimilis* and *Eucheilota menoni),* two barnacles (*Hes-*

peribalanus fallax, Balanus trigonus) one crab species (*Percnon gibbesi)*, one bryozoan *(Celleporaria brunnea)* and two species of tetraontidae (*Lagocephalus lagocephalus, Sphoroides pachygaster*) previously unrecorded in France have been identified. In the French Caribbean, a large scale monitoring and population control program of the lionfish species *Pterois volitans* and *Pterois miles* has been deployed. In the French Overseas territory of New Caledonia, species complexes of *Asparagopsis armata* and *Asparagopsis taxiformis* have been identified, as part of the genetic research carried out under the ERANET NETBIOME project SEAPROLIF. Coordination on a national level is needed between the forthcoming EU invasive alien species regulation and the ongoing Marine Strategy Framework Directive work on non-indigenous species.

4.1.7 Germany

Several projects are ongoing regarding non-indigenous species for the implementation of the EU Marine Strategy Framework Directive. Intentional species introductions remain at a similar level as last year. A species of concern but not yet known from Germany is *Didemnum vexillum.* It is found in other European countries and it may be possible that this species becomes introduced to German waters with movements of living mussels and aquaculture gear or in the biofouling of vessels.

4.1.8 Greece (by correspondence)

In 2014, eight marine alien and cryptogenic species were reported for the first time from the Greek seas, two of them (the polychaete ***Marphysa adenensis and the crab*** *Actaeodes tomentosus*) being first records for the Mediterranean Sea. The new records include: the Indo-Pacific ascidian *Herdmania momus* from Kastelorizo Island; the shipworm ***Teredothyra dominicensis*** from the NE Aegean islands (Fourni island); the gastropod ***Syrnola fasciata*** and the polychaete ***Marphysa adenensis*** from Lesvos island; the xanthid crab ***Actaeodes tomentosus*** from Rodos isl.; the antenna codlet ***Bregmaceros atlanticus*** and the foraminiferal *Clavulina multicamerata* in Saronikos Gulf. The cryptogenic species ***Acartia tonsa, which*** had escaped our attention, is added to the list. In addition, 19 alien species have expanded their distribution in Greek waters, some of them such as ***Penaeus aztecus*** exhibiting invasive behaviour.

4.1.9 Italy

Two new species of algae, one polychaete, one bryozoan and two new species of fish have been added to the list of non-indigenous species recorded along the Italian coasts. Established non-indigenousspecies continued to extend their distribution. The ecology of native vs introduced Ascidians has been studied, and the spread of *Fistularia commersonii* has been analysed. A session on non-indigenous species was organized duringthe Italian Marine Biology Society Congress and provided updated information on their distribution and ecology on several species. Differences in the colonization by NIS in marine protected areas and adjacent reference sites did not show any advantage by protection.

4.1.10 Lithuania

In total, 30 NIS and 2 crypogenic species are registered in the Lithuanian waters of the Baltic Sea and the Curonian Lagoon; of them 4 species were introduced since 2000. All introductions are secondary ones, i.e. species entered the Baltic Sea via other countries and then spread to the Lithuanian waters either by human-mediated pathways or by natural means. Now new NIS reported in 2014, although routine monitoring (phytoplankton, zooplankton, zoobenthos, early stages of fish, commercial fish surveys) was performed as usual and biological research on macrophytes took place in the Lagoon.

4.1.11 Norway

There is no further genetic clarification of the origin of the Snowcrab *Chionoecetes opilio* (It has previously been established that there is a significant genetic distance from the Canada/Greenland stock). Based on several evaluations, it has been estimated that the stock in the SSB of the Barents Sea is 10 folds that of the king crab *Paralithoides camtschaticus* (mainly in the Russian EEZ). Slight increase in abundance of king crab *P. camtschaticus* stock from previous years, both in catchable males (CW<=130 mm) and total numbers. The population is now close to level that can sustain B_{MSY}. The free fishery (W of 26°E) has resulted in a reduction of the spreading rate, but does not prevent spread. There were no records of American lobster in Norway in 2014. Also, no new NIS have been reported in Norwegian waters (monitoring efforts are low). Several species have expanded range, e.g. *Crassostrea gigas, Gracilaria vermiculophylla* and *Crepidula fornicata.* High summer mortality of *C. gigas* associated with presence of OHV-1 μVar. A comparison of several Rapid Coastal Survey methods was conducted, but the results are not yet published. There seems to be a rebounce of a strong bloom of *Mnemiopsis leidyi*. during summer/early autumn, 2014.

4.1.12 Poland

Palaemon macrodactylus M.J.Rathbun, 1902 (Crustacea, Decapoda) was recorded for the first time in the coastal waters of the Baltic Sea - in the mouth of the Wisła Śmiała river near Gdańsk in 2014 (Janas and Tutak 2014). *Rangia cuneata* (G.B. Sowerby I, 1831) (Mollusca, Bivalvia) was recorded for the first time in the Wisła Śmiała River – coastal waters of the Gulf of Gdańsk, the southern Baltic Sea, in 2014 (Janas and Tutak 2014).

Acipenser gueldenstaedtii Brandt and Ratzeburg, 1833 (Pisces, Acipenseridae) was reported for the first time in the Puck Bay (the southern Baltic Sea) (in 1968 and in 2000's) and in fishing grounds on the western Polish Baltic coast (in 2011) (Skóra and Arciszewski 2013). *Acipenser baerii* Brandt 1868 (Pisces, Acipenseridae) was reported for the first time in the Reda River (Baltic Sea basin) in 2006 (Skóra 2012). *Ballerus sapa* (Pallas, 1811) (Pisces, Acipenseridae) was reported for the first time in the Reda River, a tributary to the Baltic Sea between 2005 and 2007 (Skóra and Skóra 2013).

4.1.13 Portugal

A list of 139 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems, 9 of which were new additions to the 2014 report. The inventory of NIS was restructured to include fish species, but freshwater species and cryptogenic species are not included. Portugal has a law on introduction of non-indigenous species, published in 1999, which is currently under revision (since 2009). Although the current law does not include a list of marine species the revision document included marine species and refers to IMO and ICES criteria for ballast water management. Concerning the implementation of the Marine Strategy Framework Directive the initial assessment reports for the Azores and Madeira islands (Macaronesia sub-region) were delivered, and both the monitoring programme and the programme of measures were submitted to the European Commission.

4.1.14 Spain (by correspondence)

Three new ship-mediated non-indigenous species are reported for Spain: i) the potentially toxic marine microalgae *Fibrocapsa japonica* Toriumi & Takano (Raphidophyceae), which was reported offshore in the Eastern Alboran Sea for the first time in autumn of 2006; ii) the marine nemertean *Cephalothrix cf. simula* AM-2013, which can affect natural populations by competitive exclusion, was reported for the first time in several locations along the Spanish coasts (i.e. in the North Atlantic coast of Spain in Galicia, Asturias and Cantabria, and in the Mediterranean coast in Catalonia) in a recent survey of nemertean diversity along the Iberian Peninsula coasts; and iii) the caprellid amphipod *Caprella mutica* Schurin, 1935, which has the potential impact of this species on native ecosystems and marine aquaculture first reported in October 2012 in Illa d'Arousa (42.56135º N 8.95594º W) and then during 2012 and 2013 in other sites of Ria d'Arousa, Galicia, NW Spain, Atlantic coast.

In addition, on the 31st of July 2014, an individual of the Indo-Pacific silver-cheeked toadfish, *Lagocephalus sceleratus*, was captured by deep bottom trawling in the Ibiza channel (approx. 39.06666º N, 0.31666º E), NW Mediterranean. This lessepsian species is worrisome due to its potential impact on local fisheries resources and to the tetrodotoxine present in its liver.

Moreover, the first occurrence of the yellow tang *Zebrasoma flavescens* and the clown triggerfish *Balistoides conspicillum* in the Western Mediterranean were reported. These tropical fishes were photographed in October 2008 off Sitges (Costa Daurada, NE Spain: 41°13′27.09″ N; 1°47′22.35″ E) and in July 2012 in front of Palamós (Costa Brava, NE Spain: 41°50′56.19″ N; 3°8′26.29″ E), respectively. Because of their importance as ornamental aquarium species, it is likely that these tropical fishes had been released from private aquaria.

The subcrenate ark shell *Anadara kagoshimensis*, previously reported from Spain (Ría de Vigo – Galicia, NW Spain -, Bay of Biscay – N Spain - and Catalonia – NE Spain), was reported for the first time in the Ría de Arousa (42o 37.260′ N 8o 46.790′ W), Galicia, NW Spain, in May 2013. The haemolymph of *A. kagoshimensis* contains nucleated erythrocytes packed with haemoglobin, which enables this clam to bind oxygen in oxygen-deficient conditions, and haematin, which is involved in the removal of sulphides. *Anadara kagoshimensis* is listed among the hundred worst invasive species in the Mediterranean Sea and can displace autochthonous bivalves. Aquaculture seems to be the most probable hypothesis to explain the presence of *A. kagoshimensis* in Galician waters.

4.1.15 Sweden

Two new crustacean species have been recorded in the Swedish part of the Baltic Sea, the amphipod *Grandidierella japonica* and the mud crab *Rhithropanopeus harrisii*. Occurence of the polychaeta *Ficopomatus enigmaticus* have also been discovered in the Baltic Sea. There have been several new reports of American lobster *Homarus americanus* in Kattegat/Skagerrak including egg bearing females and the round goby *Neogobius melanostomus* has expanded its range significantly in the Baltic Sea. A new herpesvirus (OsHV-1 μvar) caused massive mortality in Japanese Oyster *(Crassostrea gigas).*

4.1.16 United Kingdom

Various monitoring programmes and biosecurity projects have been completed during 2014 by institutes throughout the UK. These include a biosecurity Plan for the Shetland Isles developed and published which provides supplementary guidance to the Shetland Islands' Marine Spatial Plan. Guidance for preparing a non-native species biosecurity plan for sites/operations has been published by Scottish Natural Hetitage. The Environmental Research Institute has published results from a rapid assessment of marinas and harbours for marine non-native species and a study on biofouling of commercial vessels has been published. The Marine Biological Association have conducted a number of studies assessing the distribution of non-native species in English and Welsh marinas using rapid assessments. Data gathered have been compared to previous similar studies to assess spread.

Cefas is progressing work that examines the potential use of molecular tools in monitoring for non-native species from environmental DNA (eDNA) that is shed into the water column (in freshwater environments) and from scrape, sediment and water samples (in marine environments). Cefas and the University of Leeds have conducted a number of studies examining the use of hotwater as a biosecurity tools in the freshwater environment, with a range of invasive plant and inverterbrate species tested. Additionally a fact finding exercise was undertaken in New Zealand to examine how the awareness and uptake of the biosecurity programme 'Check, Clean, Dry' has been maintained for over a decade. Cefas has undertaken preliminary assessments of chemical control agents delivered through a spiked-bait feeding station system in the control of signal crayfish (*Pacifastacus leniusculus*) and killer shrimp (*Dikerogammarus villosus*). Cefas has coordinated the Marine Pathways Project on behalf of Natural Resource Wales and Defra. The project has had contributions from a number of organisations from across the UK and Republic of Ireland. Work conducted by the project has included the assessment of high risk location of introduction, the development of biosecurity advise for stakeholders, the development of monitoring and surveillance programmes and tools, including assessing the distribution of certain marine non-native species, in addition to examining control measures for certain marine invasive species. The Marine Pathways Project is due to end March 2015, but the group will continue to provide advice to Defra and devolved administrations. Cefas has continued to investigate methods of controlling invasive species of crayfish, with a 2.5 year trapping study due to end in March 2015, and to develop risk analysis tools, with new aquatic invasive species screening tool (Aquatic Species Invasiness Screening Kit (AS-ISK) due to be released in March 2015.

Other projects nearing completion include a Scottish Pacific oyster survey, an invasive non-native species early warning system project, a genetic study of UK populations of

Didenmum vexillum and the 2014 marina surveys in Orkney. A sighting of a Chinese mitten crab was reported from Norfolk while a moult was reported from the River Clyde. The Asian shore crab was reported from two locations in Wales in Kent and the quagga mussel has been identified from two nearby locations in the south east of the UK.

4.1.17 United States

Two new species of algae were reported in the Northwest Atlantic. A green alga *Ulva laetevirens*, from New Zealand was found in Connecticut and a red alga, *Laurencia caduciramulosa,* has invaded Key Biscayne, Florida. The polychaete, *Hediste* (=*Nereis*) *diversicolor*, long thought to be native in New England and Canada (Scituate, Massachusetts to the Minas Basin, Canada) originated in estuaries from the Baltic to Morocco, and the Mediterranean and Black Seas. A few species are expanding their range in the East coast. One species of fish, *Pterois miles/volitans* is a summer migrant that can be found in Long Island Sound, but has established populations throughout most of the south-eastern US to North Carolina. Only one carapace of a female Chinese mitten crab, *Eriocheir sinensis* was found in 2014 in the Mianus River, Long Island Sound.

General discussion

It was discussed and agreed that AquaNIS needs to be further developed, in order to better meet ICES needs. The following four major suggestions were made for improvement of the system:

1) Adding the option to enter georeferenced data. This would also allow documenting information of secondary spread both within a country or regional sea;

2) Terms of data use should be revisited. The current data terminology is based on the recently completed project VECTORS (EU FP7);

3) Presently, georeferencing in AquaNIS is limited to LME's and countries. However, it would be beneficial to provide the option of aggregating data by ecoregions in MSFD and ICES context;

4) Technical help and back-up by ICES Data Center should be sought.

4.2 Term of Reference b)

Continue addressing EU MSFD D2 on further developing alien species indicators, incl. based on information available in AquaNIS and other sources (ToR lead Sergej Olenin)

This ToR was started with general discussion led by Sergej Olenin. The following four points related to development of indicators were proposed:

1) Distinguish between GES indicators and Environmental Target indicators
    a. GES indicators: e.g. ratio between native / NIS; impacts on native spp, habitats, biodiversity etc.
    b. Environmental targets indicators (in relation to NIS?); e.g. "No new introductions through ballast water since the initial assessment"
2) Background data for indicators should be publically available for peer-review
    a. No "offline-available" databases can be allowed to be used
3) Regular updates by national experts

a. ICES; e.g. national nominees to WGITMO
b. Not based on 'pure enthusiasm'

4) A common basis for a regional approach

The criterion 1 of the MSFD D2 reads: 'Abundance and state characterisation of non-indigenous species, in particular invasive species'

- Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species.

The number of new non-indigenous species through primary invasion to a given country or eco-region is perhaps the most relevant management-oriented indicator (as pre-or at-border management is the only viable management option to reduce the risk of new invasions). However, one should be very careful when extracting such information from databases. The variability in monitoring approach and efforts among country may lead to false primary invasions records (form nearby countries or adjacent ecoregion).

On-going review of the COM DEC 2010/477/EU for Descriptor D2 and update of the EASIN *(by Konstantinos Tsiamis)*

JRC was invited to inform the WGITMO meeting regarding updated knowledge to support the implementation of the Marine Strategy Framework Directive (MSFD) Descriptor 2 "*Non-indigenous species*", as well as to present the EASIN network, highlighting recent updates in the context of the new EU regulation 1143/2014.

The review process taking place regarding the MSFD Descriptor 2 in the context of COM DEC 2010/477/EU was presented, pointing the aims, mandate and timeline of the review process. A brief description of the main results of the Commission's Stuff Working Document (SWD 2014/49) and the JRC's In-depth Assessment revisions were presented, mentioning the strengths and weaknesses regarding the adequacy, coherence and consistency of the EU Member States reports on MSFD Descriptor 2 (for MSFD Article 8: Initial Assessment, Article 9: Determination of GES, Article 10: Setting Environmental Targets). In addition, details were provided on the initial outcomes of the review process on the criteria and indicators of Descriptor 2, although the revision is still an on-going process.

Afterwards, a presentation of the EASIN network was followed (EASIN; http://easin.jrc.ec.europa.eu/). EASIN has been developed and managed by JRC, and it is operational since 2012. It has been conceived as a scientific tool aimed at providing scientific information in support to the EU policy on biodiversity and on invasive alien species (IAS), gathering and harmonizing information on biology, origin, and occurrence, from several sources worldwide. The EASIN catalogue currently includes more than 14.000 alien species recorded in Europe, and can retrieve related spatial occurrence records if present in the databases of the collaborators' network. EASIN uses publicly available data, providing links, and reference to all relevant data sources. EASIN is also the supporting tool for the implementation of the EU Regulation 1143/2014 on IAS, in force since 1 January 2015. To this end, the system is undergoing further development with a creation of an Early Warning System, through which MS must notify the EU Commission and the other MS about the detection of an IAS of EU concern, and to report on the eradication measures applied and their efficacy. To guarantee the quality of the data and their continuous update, an EASIN Editorial Board has been established.

The enlargement of the data providers is a key issue for EASIN to ensure a high quality of data. The WGITMO meeting participants were informed that EASIN is seeking to increase the number of data providers by establishing new collaborations.

A fruitful discussion followed the presentation, with many questions arising by the meeting participants regarding details on the review process of the MSFD Descriptor 2 as well as on the new EU Regulation on IAS. In addition, a discussion followed considering the possible collaboration of EASIN with AquaNIS.

General discussion

- Data validation in database(s) is very critical. This should be a task of editorial board (like in AquaNIS). Using non-verified sources available from internet is not justified and will likely result in biased outcomes.
- EASIN is facing amongst other issues the question on how to solve synonyms of NIS used in various primary sources/databases.
- Perhaps the most appropriate management-related indicator is the number of NIS throught primary vectors/pathways.
- The DAISIE database is out-dated and cannot be used for marine species. All marine data were transferred info AquaNIS.
- It was stressed that EASIN will benefit when using AquaNIS as a source of marine NIS.

Further activites:

1. One eco-region based methodological case-study in applying a single source (e.g. AquaNIS) for extracting the number of new NIS through primary invasions and relating the indicator to vector/pathway certainty (lead: Sergej Olenin)
2. Cross-regional comparison of selected NIS indicators and evaluating sensitivity/certainty of estimates (lead: Paula Chainho)

4.3 Term of Reference c)

Continue identification and evaluation of climate change impacts on the establishment and spread of non-indigenous species. Produce draft manuscript outline on salinity change effects on non-indigenous species. This activity will mostly be carried out intersessionally and take several years (ToR lead João Canning-Clode)

In the past four decades, biodiversity has been decreasing as has been shown recently by several biodiversity indicators, whereas indicators of pressures on biodiversity (including invasive alien species) showed increases (Butchart *et al.* 2010). More recently, the ICES Benthic Ecology Working Group has conceptualized a very complex model of the climate change effects on benthic organisms and benthoc interactions (Birchenough *et al.* 2015). This model clearly shows the influence of increased CO_2 and temperature directly affect abiotic (e.g. salinity, pollution, acidification) and biotic components (e.g. primary production, latitudinal shifts, larval supply). Pollution for example is considered a category of disturbance and has been suggested that certain levels of metal pollution in the marine system may promote invasions because it will increase the availability of resources as well as will decrease competition with native species (Piola and Johnston, Crooks *et al.* 2011). However, other studies confirmed that both native species and non-indigenous species are both sensitive to metal pollution, suggesting that pollution tolerance in NIS may be site specific (Canning-Clode *et al.* 2011a).

In addition, the global warming of the oceans and the ability of many successful invasive marine species to tolerate a broader thermal range than similar native species has led to range expansions. For example, a number of marine invertebrates have been reported to migrate from warmer waters to higher latitudes towards the poles. However, recent findings suggest that aperiodic and extreme cold winters may be a critical "reset" mechanism that will limit this NIS range expansions.

Finally, water temperature will increase due to climate change and this will cause changes in the salinity regimes. Climate change will certainly alter local precipitation because the frequency and magnitude of extreme weather events will increase and this will lead to salinity fluctuations. These salinity fluctuations will depend on proximity to river deltas, ice melting and major ocean currents and will affect the distribution of shallow estuarine species.

A recent global comparison assessed 8 data-sets on NIS in open coasts vs. NIS in estuaries and concluded that over 80% of NIS were present in estuaries. The authors argue that the higher prevalence of NIS in estuaries is due to 3 main aspects: i) Higher NIS propagule pressure in Estuaries; ii) Estuarine species are better adapted to Estuarine conditions; iii) Higher rates of anthropogenic activities in Estuaries.

Following the discussions of the ICES WGITMO meeting in Bergen, Norway, we decided to produce a review paper outlining a global comparison of salinity change effects on non-indigenous species based on a comprehensive literature survey. Patterns, mechanisms and processes will be further discussed. Authors of this manuscript are João Canning Clode – Lead (Portugal), Henn Ojaveer (Estonia), Anna Occhipini (Italy), Jim Carlton (USA), Chad Hewitt and Marnie Campbell (New Zealand). Other authors have already showed interest in contributing and may join the team as well. A finalised draft of this manuscript will be presented to the WGITMO at the next annual meeting (2016) and will be reviewed by the WG. Final submission is expected in 2016.

General discussion

Ocean warming is not uniform and spatio-temporal fluctuations occur. Also, regime shifts may have taken place in some ecosystems (i.e. conditions are not monotonous) and this might also affect responses of NIS.

Both pollution and acidification should be considered (preferentially together) when talking about climate change impacts and related salinity changes. This is essentially important in the context of susceptibility of invasions.

The salinity effect might be 'harder to see' than other climate induced effects (temperature). Local precipitation probably plays an important role in salinity changes and related effects.

In addition, effect of local/regional extreme events (e.g. floods) should be considered. In some parts of an estuary, no effects of floods may be detected while in other parts these effects are visible and measurable.

It was also stressed that organism/species physiology is a key factor for colonisation success and this is often a function of temperature and salinity. Also, salinity and acidification links are important. Some marine NIS may enter freshwater systems with very little time needed for adaptations.

Because of climate change we might lose site variation in salinity (sand dunes). This will influence/change the invasion risk for some areas.

4.4 Term of Reference d)

Investigate and report on new developments in non-native species issues associated with biofouling (e.g. artificial structures in the marine environment and recreational boating) (joint Term of Reference with WGBOSV); (ToR lead Cynthia McKenzie).

This Term of Reference was addressed with two presentations and corresponding discussion. Cynthia McKenzie began by reviewing the special session on this topic at the 2014 ICES ASC. The general conclusions at the ASC supported the earlier position of our Groups - that biofouling may become more of an issue with climate change. It is now timely to work on anti-fouling strategies and addressing the IMO Biofouling guidelines. Nathalie Simard then gave a presentation updating the Groups on a project to evaluate the risk of biofouling on recreational boats as a vector in Canada. It was noted that results are available for a similar study conducted by CEFAS and partners.

Marine recreational boating risk assessment (Presentation by Nathalie Simard)

Fisheries and Oceans Canada is conducting an evaluation of the risk of recreational boating as a vector for the introduction and spread of Aquatic Invasive Species (AIS) in Canada. Studies conducted in British Columbia and Nova Scotia provided information on recreational boating as vectors in these areas but did not include several regions of Atlantic Canada. Before a national risk assessment of this vector in the marine environment was attempted, additional data for these regions was collected (2011–2014). Taken together, the complete database includes recreational boater surveys (1457), manager surveys (262) and vessel hull video/scuba (567) that were collected in Atlantic Canada (Quebec, Gulf Region, Nova Scotia and Newfoundland). These surveys were based on questionnaires and methodologies used by the studies in British Columbia and Nova Scotia. This Marine Recreational Boating Assessment is comprised of four steps which will provide an overall vector risk assessment. The first step is an assessment of potential risk which will involve a statistical comparison of the various boat types and their maintenance (e.g. storage method, use of antifouling paint, etc.) in relationship to the biofouling observed on the vessel hulls. The next step is an assessment of the movement patterns of the vessels (# destinations and #days in destination port) within and between regions. The third step is the regional AIS background of the harbours and marinas. Finally, the step four or the realized risk per boat type and region will be determined using vessels, movement and biofouling then demonstrated using a risk assessment heat matrix.

General discussion

Following the presentations, the Group discussed the status of the IMO Guidelines for the Control and Management of Ships' Biofouling [Resolution MEPC.207(62)]. It was noted that the IMO agreed to keep the Guidelines under review as experience is gained, but that a decision to change the voluntary Guidelines into mandatory measures would be a long undertaking. The Group noted the research needs outlined within the Biofouling Guidelines, and agreed to contribute information to the IMO in future, when possible:

12.1 States and other interested parties should encourage and support research into, and development of technologies for:

.1 minimizing and/or managing both macrofouling and microfouling particularly in niche areas (e.g., new or different anti-fouling systems and different designs for niche areas to minimize biofouling);

.2 in-water cleaning that ensures effective management of the anti-fouling system, biofouling and other contaminants, including effective capture of biological material;

.3 comprehensive methods for assessing the risks associated with in-water cleaning;

.4 shipboard monitoring and detection of biofouling;

.5 reducing the macrofouling risk posed by the dry-docking support strips, (e.g., alternative keel block designs that leave less uncoated hull area);

.6 the geographic distribution of biofouling invasive aquatic species; and

.7 the rapid response to invasive aquatic species incursions, including diagnostic tools and eradication methods.

4.5 Term of Reference e)

Investigate and report on new developments in non-native species issues in the Arctic, as a result of climate change and resource developments (joint Term of Reference with WGBOSV); (ToR lead Anders Jelmert)

This Term of Reference was addressed with three presentations and corresponding discussion. Sarah Bailey began the work by reviewing the special session on Arctic biodiversity under climate change and other stressors at the 2014 ASC. The general conclusions at the ASC supported the earlier position of our Groups - the absence of historical data/knowledge/baselines in the Arctic hinders our ability to evaluate the current status, understand current mechanisms and make projections for the future. There was a general uncertainty if our understanding/knowledge from temperate ecosystems can be directly applied to Arctic ecosystems and a need to better understand the impacts of range extensions into the north. Finally, it was broadly recognized that bioinvasions and climate change are but two stressors currently active in the Arctic. It is expected that there will be a great demand for science advice in the near future as human activities continue to diversity and intensify in the Arctic.

Understanding ballast water as a pathway for introduction of aquatic invasive species (AIS) in the Arctic (Presentation by Nathalie Simard)

Ballast release associated with commercial shipping has been the source for a large number of invasions on a global scale and has been one of the main vectors for aquatic introductions in Canadian coastal waters. Although introductions into Arctic waters have been limited, climate warming, increased resource development and associated increases in shipping are expected to increase the risks for future introductions. We have limited understanding of the species found in the ballast water of vessels travelling into the Arctic, their interactions with native fauna, their ability to establish in the Arctic and their impacts. Furthermore, although regulations exist for international ships, domestic vessels (within Canada only) are currently unregulated. Most Arctic domestic ballast is brought in by ice-breakers travelling year-round; these vessels conduct voluntary exchange in northern Canadian coastal waters, however there are questions regarding the effectiveness of exchange (it may actually increase risk) and how this varies by season. In order to address these questions, we are conducting research on the content of ballast water being brought into two of the main Arctic ports identified as being at risk for ballast mediated introductions: Churchill, MB and Deception Bay, QC by sampling ballast water from arriving ships for water quality, and zooplankton/phytoplankton species composition (native, non-native) and densities. We are coupling this with more specific research aimed at better understanding risks associated with the currently non-regulated domestic shipping pathway through: 1) evaluation of a subset of the above samples from ice-breaking domestic vessels that travel on a more extended basis for seasonal variation in level of risk and 2) conducting sampling and analysis of ballast on vessels prior to exchange for comparison to above post-exchange samples. Information from this study will improve our abilities to understand and manage ballast-mediated species introductions, help guide voluntary ballast management practices by industry and feed into regulatory decisions by Transport Canada. Field work has started in 2014 and will continue in 2015. Publications are expected for 2016

Update on shipping traffic and ice conditions in the Northern Sea Route 2014 (Presentation by Anders Jelmert)

While the long-time trend for ice area / ice extent / ice volume appears to have declined rather monotonously since the eighties, the minimum ice area and –volume currently seems to have reached a (likely preliminary) minimum in the 2011/2012 seasons. The ice conditions in the 2014 navigable window were regarded as somewhat more challenging than the 2011 and 2013 seasons. The numbers of crossings over the Siberian route increased from 10 (2010) to 41(2011) to 46(2012) to 71(2013), and were expected to increase further in 2014. However, the traffic statistic now shows 31 complete crossings and 20 (long) Russian domestic transports within the NSR. The vessels were quite diverse, where oil/oil products / chemical tankers being the largest vessel type, general cargo the second largest vessel type. Total tonnage of crossing vessels was 463928 Gr.Ton. The largest vessel was a "Panamax" sized vessel 41061 Gr.Ton (76160 DWT). Average voyage time for all crossings: 18.1 d. Russian domestic traffic: 20 vessels, some 200 000 Gr. Ton., Average voyage: 12 days. Despite expected increase, and only slightly more challenging ice conditions than previous years, less traffic was observed in 2014. This indicates that other factors (e.g. world economy, rates, bunker prices, SAR/Ice-breaker costs, oil exploration activities, etc.) are (and will likely be) important factors dimensioning the future

Arctic traffic. A lowered-than-expected NSR traffic means that science still has an opportunity to explore important environmental issues (including e.g. baselines) before anticipated traffic increase will make these efforts more difficult.

In response to this presentation, it was noted that a commercial vessel completed the first unassisted passage of the northern route across Canada. There may be different risks along Canada's northern route since there are a number of resource (mining) companies setting up there, so there is port development as well as vessel transits.

General discussion

It was noted that effects of climate change which could facilitate non-native species invasions, such as decreased ice cover resulting in increased vessel traffic, are already being observed. There was discussion on the great difficulty for taxonomic identification of species and origins of phytoplankton sampled in the Arctic. It was noted that data from Canadian Arctic port surveys for invertebrates has already been uploaded to AquaNIS. The Groups then discussed the possibility that Russian Institutions should have extensive historical data that could be used to improve knowledge on baseline conditions – although likely there will be a need to translate historical materials. Although there are currently some political strains on cooperation with Russia, there are likely some avenues which could facilitate such collaboration and cooperation, such as the Arctic Council. The Groups also noted that various scientific research cruises conducted in the Arctic could be a source of baseline information. The Groups discussed an idea to initiate a workshop to bring experts on the topic together, to try to share the data to generate biodiversity baselines of the taxa most relevant to bioinvasions, improve knowledge, and made a plan to explore opportunities over the next year intersessionally, as well as to develop specific objectives and scope for such a workshop. The Groups suggested extending invitations to experts to attend the working group meetings next year. This should also involve communication with Arctic-related expert groups in ICES.

4.6 Term of Reference f)

Investigate and report (incl. via AquaNIS) on new molecular tools for identification, early detection and monitoring of non-native species, in collaboration with ICES Working Group on Integrated Morphological and Molecular Taxonomy, WGIMT (joint Term of Reference with WGBOSV); (ToR leads Sarah Bailey and Henn Ojaveer)

This term of reference was addressed by two presentations and corresponding discussions. Group member Phillipe Goulletquer solicited advice from expert colleagues, which was reviewed as a starting point for discussion. Generally, the comments identify some benefits, and some issues/warnings with the use of molecular tools for early detection:

In the past two-three decades, molecular tools have been used with success to help on three issues related to non-indigenous species: 1) Identifying non-indigenous species; 2) Tracing back the routes & processes; 3) Studying evolution in the introduction range (new range), particularly to examine hybridization with native species. In contrast, early-detection using molecular tools can be an issue because: 1) increasing lack of taxonomic expertise or reference to taxonomists; 2) species may be hardly distinguishable, particularly regarding the increased number of cryptic species (i.e. species that are morphologically similar); 3) taxonomic changes and revision and the resulting slow updating of databases (naming takes time).

There are several issues regarding identification of species that might be resolved with molecular tools:

- new non-indigenous go unnoticed because they look like native taxa, e.g. *Polysiphonia* genus (Geoffroy *et al.* 2012) and this may prevent early detection and warning; e.g. *Asterocarpa humilis* (Bishop *et al.* 2013) – see below
- new non-indigenous species go unnoticed because they are members of the cryptic species complex, e.g., colonial tunicates and bryozoans - *Watersipora; Botrylloides* sp.
- species are mistakenly described as new species (*Styela clava* first reported as a new non-indigenous taxa *Styela mammiculata*)
- Reinforcement by a species different from the targeted species (a very illustrative case study is with *Spartina densiflora* in California)

One solution is (meta)barcoding - using molecular information to identify taxa. Note that other molecular approaches are also useful, for instance population genetics and genomics to ascertain hybridization between native and non-indigenous taxa and putative emergence of successful hybrids.

Benefits of (meta) barcoding for species identification or early-detection are:

- Standardized and rapid procedure=> Reliability for comparison between labs
- No need for taxonomic expertise (when routine analysis is done and upstream research work has been correctly done. See below for the "warning and cautions")
- Global databases such as BOLD (Barcoding of Life Database) and Genbank remove geographic limitations; this is a very important aspect as by definition non-indigenous species are new in a given area, and are absent from regional fauna and flora taxonomic books (but this requires an accurate database; See below for the "warning and cautions")
- Particularly useful or needed when morphological traits are tricky to use or misleading, or when there is possible confusion between native and non-indigenous species, and to help in determining the species traits useful in the field (see an example with Sato *et al.* (2012) for discriminating between *Ciona intestinalis* species B and *Ciona intestinalis* species A - two evolutionary divergent cryptic species only recently recognized and which are two invasive species). In all the examples early detection is prevented because we do not have relevant traits to examine in the field.
- The only way when there is no morphological traits to be used and thus particularly relevant for studying small early life history stages. This is probably where most of the expectations are at the moment as we all know the importance of larvae and juveniles in introduction processes as all these stages can be easily transported by ballast water or with aquaculture exchanges. Thus this is where there is a great challenge in early detection: track the initial founders (e.g. larvae in ballast water).

- Work can be done using specimens that are degraded, disentangled or badly preserved. This includes, for instance, work with collection, herbarium or museum specimens to help confirm past identification or dating invasions.

Warning and Cautions

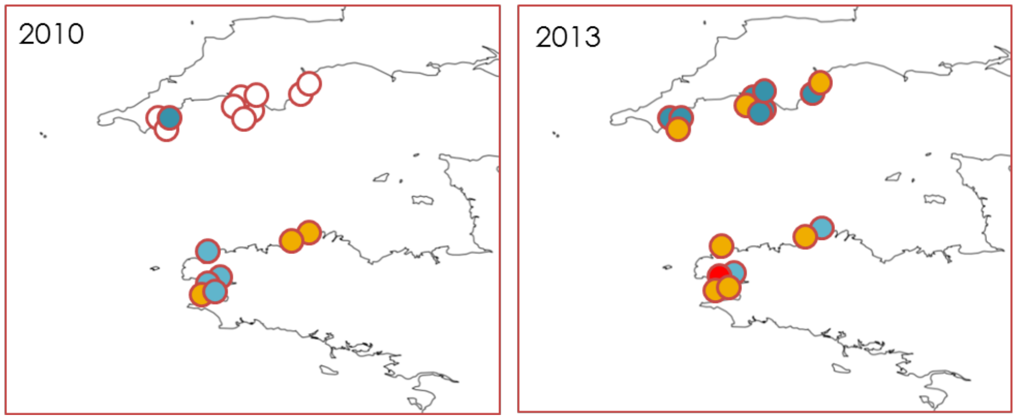
- Barcoding should not be restricted to a single marker (see on-going debates/arguments as part of the BOLD initiative). There are now more and more evidences that using a single gene may be misleading because a gene is not a species (e.g. selective effects may have occured on this particular gene)
- Database errors: errors in correct taxonomy can/do occur even in GenBank and BOLD (e.g. some *Botryllus* species named *Botrylloides* and vice versa)
- Lack of reference data: see the graph in Comtet *et al.* (2015) to illustrate that for many non-indigenous species, we just lack the reference, meaning that the upstream research work has still to be done
- Samples not preserved properly (e.g. using formalin) result in poor/no DNA recovery
- Conventional barcodes is more "taxa" oriented, but there are pitfalls for metabarcoding of metazoans (Cristescu 2014)
- Requires molecular expertise and equipment
- High cost of lab analysis

A step forward requires:

- improved protocols particularly for global analyses - to work on water samples is fine, but sampling on hard substrates or on rocks is much more difficult. In addition, there is still work to be done to assess the representativeness and certainty.
- dedicated databases, especially for metabarcoding approaches. These should not be focused on specific taxa but aim at global diversity assessment. Thus, an important need is to establish an accurate and global database for barcoding.
- integrative taxonomy research. Such research should focus on designing the barcodes.
- preservation of samples in adequate medium/buffer (e.g. ethanol). Often, the collected samples are preserved in a medium not suited for genetic analysis (e.g., formalin).
- promoting and popularizing the approach with the aim to enhance collaborations between geneticists and taxonomists.

Concluding remarks: Molecular tools are sensitive to help in early warning/early detection as, for instance, they are relevant and accurate for identifying early-stages likely to be introduced in ballast water or remain unnoticed, rare specimens or badly conserved specimens. They also do not need strong taxonomic expertise and there is a standard procedure available. New techniques are currently emerging for global assessment, such as e-DNA and metabarcoding. These have proven to be very promising, however, major efforts are still to be made to establish the reference database.

A simple example of detection with regular barcoding is given by Bishop *et al.* (2013, 2015). These two maps are documenting the abundance (semi-quantitative data) and site occupancy of *Asterocarpa humilis*. Morphological and molecular data were used to ascertain the species identification and later confirm its rapid spread in the English Channel.



Following the review of these comments, the Groups discussed how the traditional debate over definition of a species has carried over to the results of molecular tools – with molecular tools now identifying strains of species. Significant problems can occur where taxonomic decisions, such as splitting of species, is not peer reviewed and results are not generally agreed, but results get into the literature (non-peer-reviewed books). On the one hand, there can be negative impacts if managers of non-native species have to start managing strains of species, but on the other hand, understanding of impacts can be greatly improved when invasive vs. non-invasive genotypes are recognized.

As another issue, it was noted that there could be limitations on management activities if we can only detect species by molecular tools – unless management response is also a molecular-based tool. This line of discussion re-opens the question as to whether or not post-border management is even a realistic option for the aquatic environment – and re-affirms vector management as highest priority (see also Lehtiniemi *et al.* 2015).

The presentation on molecular information in AquaNIS (by Sergej Olenin) indicated that molecular information is available for 189 species involved in 1266 introduction events.

Table 4.6.1. Information on the availability of molecular information on non-indigenous species in AquaNIS.

Phylum	# of NIS
Chordata	71
Mollusca	55
Arthropoda	20
Rhodophyta	14
Annelida	9
Chlorophyta	4
Cnidaria	4
Ochrophyta	3

Bryozoa	2
Ascomycota	1
Ctenophora	1
Echinodermata	1
Magnoliophyta	1
Nemata	1
Porifera	1
Pteridophyta	1

Molecular information is available in AquaNIS for 58 species (674 introduction events) associated with vessel vectors (actual evidence of being found in samples in a particular vector from any world region).

Table 4.6.2. Availability of molecular information on the vessel vector-associated non-indigenous species in AquaNIS.

Phylum	# of NIS
Mollusca	17
Arthropoda	10
Rhodophyta	9
Chordata	8
Annelida	3
Chlorophyta	3
Cnidaria	2
Ochrophyta	2
Ctenophora	1
Magnoliophyta	1
Nemata	1
Porifera	1

Finally, the Groups discussed how the information in molecular databases has been increasing exponentially very recently. It was noted that it is premature to consider a positive eDNA record for a new species alone as confirmation of a new record. It is still important to have a physical specimen as well because the DNA could be a failed arrival, or an error due to primer selection, etc. Molecular tools can safely be used to discriminate cryptogenic species, when you have the correct baseline sequence collection (different populations globally).

General discussion

Although WGBOSV and WGITMO have been open to collaboration with WGIMT, the limited taxonomic scope of WGIMT, overlapping timing of group meetings and lack of intersessional activity has prevented progress under this ToR. In order to increase access to molecular experts, WGBOSV and WGITMO discussed inviting molecular experts that specifically conduct research on non-indigneous species identification and early detection to future meetings. The Groups have also identified a dedicated person to carry this activity forward during coming years.

4.7 Term of Reference g)

Produce draft outline of the alien scpecies alert report on Didemnum vexillum (ToR lead Cynthia McKenzie)

Following the completion of the ICES Alien Species Alert CRR on *Ensis directus* in 2014 (Palanga, Lithuania WGITMO 2014), discussion turned to appropriate species for the next Alien Species Alert CRR. Several species were discussed but the consensus within the working group was that the colonial tunicate, *Didemnum vexillum* (carpet tunicate), was the highest priority species for the next Alien Species Alert report. This species is a high priority for various reasons. The world-wide spread of this species is increasing, particularly in Canada and coastal Europe. Risk assessments in Canada and the United Kingdom place this non-indigenous species as a high impact invader and a detailed report of this species is needed. It has demonstrated and predicted impacts on the environment including biodiversity and fisheries resources particularly for aquaculture industries. As a biofouling organism the methods or vectors of introduction and spread are particularly important. Cynthia McKenzie (Canada) is the lead for this Alien Species Alert CRR and presented an outline of the proposed document and led the subsequent discussion on additional points to include in the manuscript and the coordination of the co-authors.

The draft outline for the *Didemnum vexillum* CRR is based on previous alien alert reports and will include an introduction, information on identification of the species, its distribution – where it is thought to originate (Japan) as well as its invasive status in North America (New England, Nova Scotia and British Columbia), Europe (UK-Wales, Venice and France), New Zealand and other locations. The document will also include information on the biology and ecology of the species as well as its current impacts both on the natural environment and fishery and aquaculture resources. Vectors for introduction will be a critical piece of information for this biofouling organism as well as what response actions or mitigation measures have been taken in areas where it has invaded. The prospect for further invasion and impact will be assessed as well as reviews of the previous risk assessment conducted in Canada and the United Kingdom.

There was considerable discussion that this CRR provide actionable recommendations and suggested the introduction of prevention measures, particularly regarding biofouling vectors. This information will also be included in the draft for discussion at the next WGITMO meeting. Linkages with other working groups for this Alien Species Alert CRR include WGBOSV, WGAQUA, WGBIODIV, WGMPCZM, SSGEPI and SSGIEA. Linkages to other organizations include CIESM, PICES, IUCN, EC, EEA, CAIA (Canadian Aquaculture Industry Association), Regional seas conventions, DFO and NOAA.

Authors of this alien alert report are Cynthia McKenzie – Lead (Canada), Lyndsay Brown (UK), Stephan Gollach (Germany), Judith Pederson (USA), Philippe Goulletquer (France) and Nathalie Simard (Canada). A finalised draft of the alien species alert report for *Didemnum vexillum* will be presented to the WGITMO at the next meeting (2016) and will be reviewed by the working group and a final document will be ready for submission in 2016.

4.8 Term of Reference h)

Produce four short paragraphs for the ICES Ecosystem Overviews on regional trends in invasive species, one paragraph for each of the following ICES ecoregions: Greater North Sea, Celtic Seas, Bay of Biscay & the Iberian coast and Baltic Sea (ToR lead Stephan Gollasch)

Greater North Sea

This region has 274 non-indigenous (NIS) and cryptogenic (CS) species. The majority have arrived between 1950 and 1999 (142 species) and since the beginning of the 21st century (60 species). From 2000 onwards 21 new NIS or CS to Europe were first recorded in the Greater North Sea region. The introduction rate increased between 1950–1999 and 2000–2014 (Figure 4.8.1).

The main vector for primary introductions is vessels, either through ballast water or hull fouling, followed by aquaculture. Natural spread from neighbouring countries is attributed to the introduction of a third of the NIS or CS.

The observed ecological impacts include significant reductions in the abundance of several important native species, changes to the physical and chemical composition of both sediments and the water column. Additional impacts include: out-competing native commercial species, fouling of aquaculture and fishing gear and fish kills through toxin production. However, some NIS are considered as valuable resources.

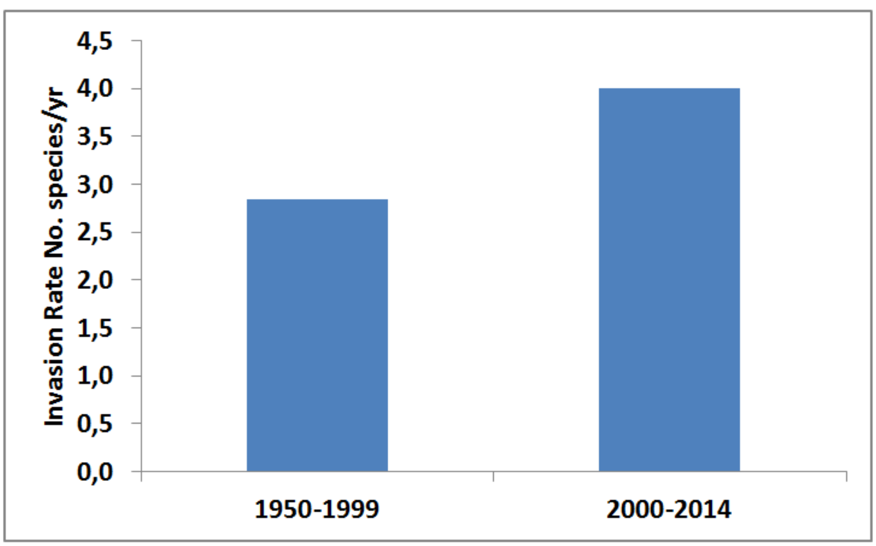


Figure 4.8.1. Annual rate of new non-indigenous and cryptogenic species introductions to the Greater North Sea in 1950–1999 and 2000–2014.

Celtic Seas

In total, 168 NIS and CS are known from this region. The majority (148 species) were found between 1950–1999. Since 2000, a total of 37 new species were recorded, of which approximately a third (14 species) represent the first European records. The rate of annual introductions slightly declined, from ≈ 3.0 species during 1950–1999 to ≈ 2.5 species during 2000–2014 (Figure 4.8.2).

The principal vectors/pathways transmitting species into this region are thought to be vessels (biofouling and ballast water), regional oyster and mussel stock movements and commercial activities as well as water currents (secondary spread from neighbouring areas).

The most impacting species are oyster disease agents and predators which result in summer mortalities of Pacific oyster stocks and caused oyster diseases with the demise of the native flat oyster production. Other species cause trophic competitions with native species, changes in communities, habitats and ecosystem functioning and fouling problems.

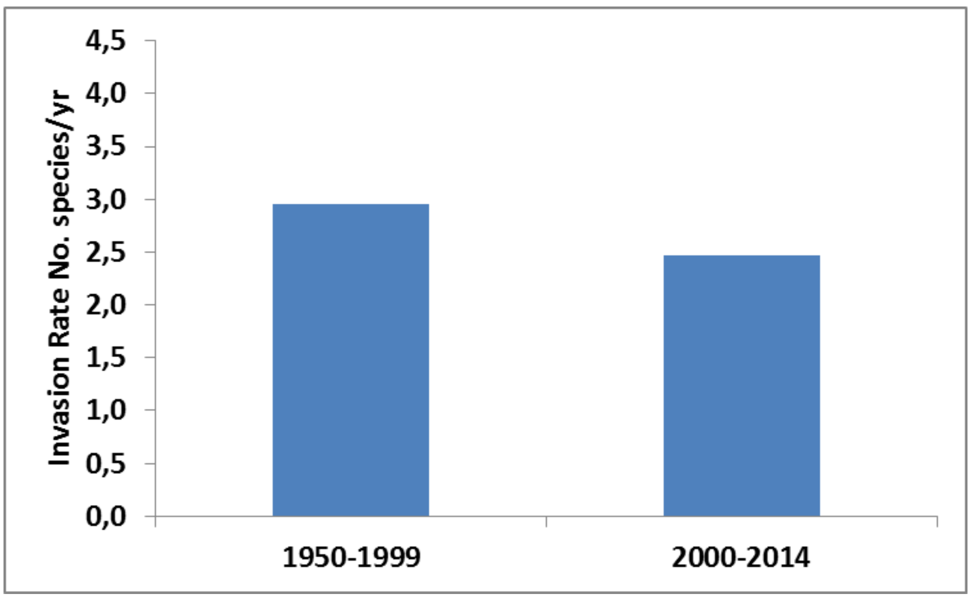


Figure 4.8.2. Annual rate of new non-indigenous and cryptogenic species introductions to the Celtic Seas during 1950–1999 and 2000–2014.

Bay of Biscay & the Iberian coast

This region has 217 known NIS and CS species. The majority of newly-recorded NIS and CS, 55 species, arrived between 1950 and 1999. Since 2000, a total of 25 new species were recorded of which 12 are unique, i.e. new to Europe. Consequently, the number of new species records increased from 1.1 per year during 1950–2014, to 1.7 per year during 2000–2014 (Figure 4.8.3).

Shipping, in particular ballast water and biofouling, as well as coastal water currents are the main species introduction vectors, followed by aquaculture activities (predominantly by shellfish transfers).

Ecological impacts such as declines of native species and structural changes in the benthic communities were observed. Other impacts include fouling of irrigation systems and clogging of fishing nets. Further modifications of the ecosystem functioning and affects to economic activities are known.

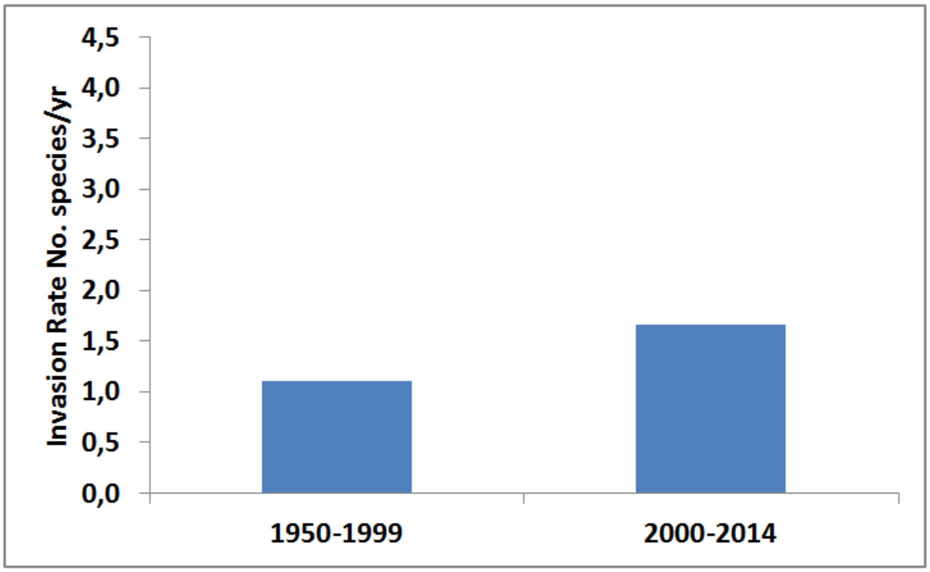


Figure 4.8.3. Annual rate of new non-indigenous and cryptogenic species introductions to the Bay of Biscay and Iberian Coast region during 1950–1999 and 2000–2014.

Baltic Sea

The total number of non-indigenous and cryptogenic species is 130, the majority having arrived in the second half of the 20th century (74 species) and in the beginning of the 21st century (46 species). The rate of introductions has increased recently more than 2 times (Figure 4.8.4). In the recent period (2000–2014), 13 species are primary introductions, while the rest (33 species) were recorded prior to the invasion in the neighbouring ecoregion (the North Sea) and probably have spread into the Baltic Sea by human mediated pathways and/or with sea currents. More than half of primary introductions (7) during 2000–2014 are attributed to shipping, others are probably associated with inland waterways (3) and culture activities (2).

The observed ecological impacts involve changes in physico-chemical habitat of sediments and water, abundance/biomass declines of several native invertebrate and serving as additional food supply. Other impacts include fouling of industrial installations, water supply systems, boats and fishing gear, and affecting fishery.

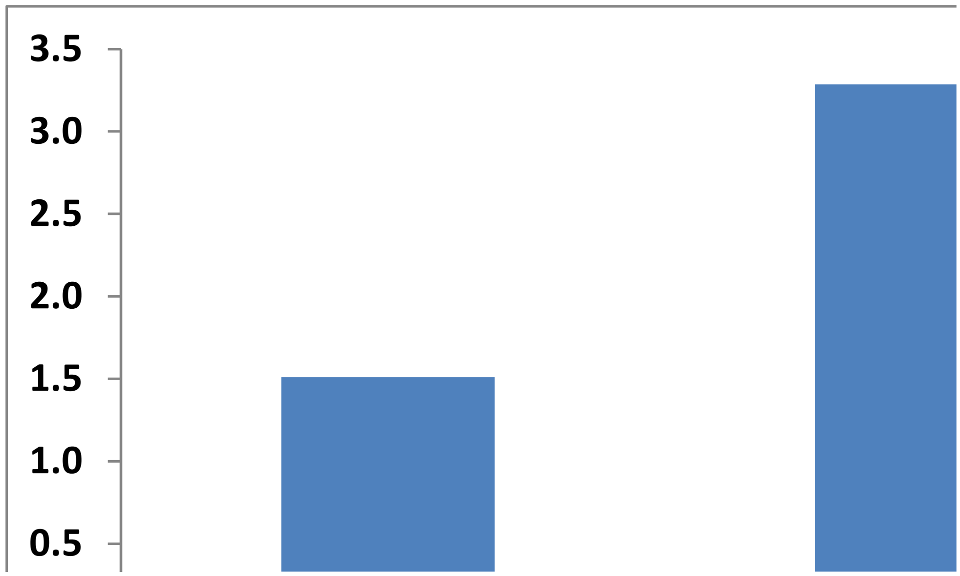


Figure 4.8.4. Annual rate of new non-indigenous and cryptogenic species introductions to the Baltic Sea in 1950–1999 and 2000–2014.

4.9 Term of Reference i)

OSPAR 1/2015 request: Review of draft OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition (ToR lead Lyndsay Brown)

A small group of experts reviewed the Eutrophication Guidelines in advance of the meeting to initiate this task. Suggested changes were then reviewed by WGBOSV and WGITMO during the joint meeting. In general, the Groups agreed that it would be beneficial to revise the Guidelines to include monitoring for non-native species in order to meet requirements under the Water Framework Directive, Marine Strategy Framework Directive and EU Regulation on invasive alien species. The Groups discussed the importance of using consistent and well defined terminology in the Guidelines – including native vs. non-native and introduced vs. invasive species. As it can be extremely difficult to correctly identify phytoplankton to the species level, and to know the origin of species in every location, the Groups agreed that species of cryptogenic status should also be noted. In addition, the Groups felt it was important that the Guidelines should not focus only on invasive species but rather on non-indigenous species in general, since impact can be difficult to measure, invasiveness is of dynamic nature and has both spatial and regional components or, if the introduction is recent, may occur in the future after some lag time has passed. Various members of the working groups have published papers explaining terminology and factors confounding our ability to measure impact, and these could be referenced in the Guidelines directly (e.g. Galil *et al.* 2014, Ojaveer and Kotta 2015).

After this general discussion, the Groups reviewed the Guidelines paragraph by paragraph. An annotated version of the suggested changes is attached as Annex 5. Specific changes suggested include direct linkage to the various regulations and directives that require monitoring of non-indigenous species and an additional objective specific to non-indigenous species. The Groups spent some time discussing the key species referenced in section four and suggested that it may be helpful to develop a checklist of 'Species of Concern' as an annex to the Guidelines. Such a checklist would need to be specific for different locations/sea areas/sub-ecoregions, since species may be native to some areas within OSPAR region, but non-indigenous in other areas. The Group discussed the importance of setting specific criteria for inclusion of species based on distribution, abundance and previous impact. Unfortunately, it was not possible to develop a checklist within the timeframe available; if such a checklist is created in the future, it will be important to keep the list open for revisions in the future as more knowledge is gained and if new species invasions occur. The Groups discussed the list of example 'key species' currently in the Guidelines, noting that the list was very broad and might benefit from some revision. As the examples are not exclusively related to non-indigenous species, it was decided to annotate this section as needing more consideration during the development of the final advice from ICES. The Groups supported specific additions on methods suggested by the smaller group of experts, asking only that such edits be detailed precisely. Finally, the Groups suggested specific recommendations regarding the documentation and reporting of new records of non-indigenous species.

4.10 Other discussion items and any other business

4.10.1 Establishing cooperation between WGITMO and WGAQUA

Thomas Landry gave a presentation on the Interaction between Aquatic Invasive Species (AIS) and Aquaculture. The goal of this presentation was to discuss and explore potential interactions between the WGITMO and the WGAQUA. Topics covered in the presentation included the growing role of Aquaculture (in relation to fisheries) within ICES and as a critical driver in the marine environment. While Aquaculture is recognized as one of the main vector of non-indigenous species, it is also one of the main marine activities impacted by the un-intentional introduction and spread of AIS. In the vector category, the topics of voluntary or intentional introductions, escapees and hitchhikers were further discussed. Advice and information on the risk and impacts of this vector is required to provide sound advice on the management of aquaculture in the marine environment. The presentation also touched on the development of Integrated Pest Management (IPM) approaches to deal with the impacts of AIS on Aquaculture. This was illustrated with the example of the non-native tunicate infestation on mussel farms. The outcome of this preliminary discussion is the recommendation to organize a joint workshop between WGIMO and WGAQUA to further discuss and develop common and standard approach to respond to similar topics, i.e. Risk Analysis. The WGITMO is presently exploring the impact of recent advancement in bio-molecular technologies on assessing the risk of introduction or transfer of marine organisms in relation to their genetic signature (i.e. species, sub-species, strains, types, stocks. The proposed workshop would be intersessional, held perhaps in 2016 and may lead to joint TorR. Tentatively proposed ToR: 'Review and report on the implication of new developments in bio-molecular technologies on definition of "species", strains, types or stocks for the provision of advice on introduction and transfers of marine organisms'. This will include implication for risk analysis and developments of new detection tools.

4.10.2 ICES–CIESM cooperation

Joint CIESM/ICES Workshop on *Mnemiopsis* Science, held in 2014, was welcomed by WGITMO and such one species oriented events are very useful for further developing bioinvasion science. The need for further strenghtening cooperation between ICES and CIESM is required and one very practical activity in this regard is information and data sharing through AquaNIS.

4.10.3 Amending the national report format

The national report format was briefly discussed. It was agreed that any updates and new information on molecular methods applied in and/or developed for NIS detection as well as species-based information will be added a as separate reporting item from 2016 onwards.

5 Closing of the meeting

The meeting was closed at 15:00 on 20 March 2015. The chair thanked the group for all their input and participation during the meeting and intersessionally. The chair also thanked Anders Jelmert for hosting the meeting.

Annex 1: List of participants

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Annex 2: Agenda

18–20th March, 2015
INSTITUTE FOR MARINE RESEARCH
Nordnesgaten 501
Bergen, Norway

WEDNESDAY 18 MARCH

JOINT MEETING WITH WGBOSV

09.00 Opening of the joint meeting

- Welcoming remarks from **Sarah Bailey, Henn Ojaveer** (Co-Chairs) and **Anders Jelmert** (Meeting Host)
- Introduction of participants
- Review of joint WGITMO/WGBOSV Terms of Reference and Agenda

09.30 ICES update: ***Henn Ojaveer***

09.45–10.30
ToR i) OSPAR 1/2015 REQUEST: Review of draft OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition. ***Lead: Sarah Bailey and Henn Ojaveer***

ICES is requested to advise OSPAR on the revision of the OSPAR JAMP Eutrophication Guidelines which will be revised by experts from Germany, The Netherlands and Sweden.

ICG-EUT 2014 concluded, and HASEC 2014 endorsed, that these guidelines were in need of a review. The guidelines should be revised to reflect new knowledge about phytoplankton and needs within (directives such as) the EU Marine Strategy Framework Directive (MSFD) and the Water Framework Directive (WFD).

It is the intention of the revision that the existing aims described in the guidelines1 will be supplemented with the following:

- to identify harmful algae species and blooms in line with MSFD Descriptor 5.
- to identify invasive (non-indigenous) species in line with MSFD Descriptor 2.
- to monitor effects of ocean acidification as e.g. on coccolithophorids (e.g. *Emiliania huxleyi*) in line with Descriptor 1 in MSFD.

The revised guidelines should incorporate coming monitoring and measurement techniques such as (but not limited to) spectrofluorometry, flow cytometry and qualitative observations of foam production, and should make use of existing standards, such as EN

159722 and EN 152043 and reflect developments within the OSPAR ICG – COBAM which is working on biodiversity monitoring and assessment. Data handling issues, such as the format required for reporting to ICES, should also be addressed.

WGITMO should address the issues related to invasive (non-indigenous) species and relevant monitoring and measurement techniques as mentioned above.

10.30–11.00 Coffee break

11.00–11.45
General/summary discussion under **ToR i)**

11.45–12.30
ToR d) Investigate and report on new developments in non-native species issues associated with biofouling (e.g. artificial structures in the marine environment and recreational boating) ***Lead: Cynthia McKenzie***

- Short overview of special session at ICES Annual Science Conference (by Cynthia McKenzie)
- Presentation: Biofouling on recreational boating (by Nathalie Simard)
- Presentation: TBD
- General/summary discussion under ToR d)

12.30–13.30 Lunch break (on your own)

13.30–15.00
ToR e) Investigate and report on new developments in non-native species issues in the Arctic, as a result of climate change and resource developments ***Lead: Anders Jelmert***

- Short overview of special session at ICES Annual Science Conference (Sarah Bailey)
- Presentation: examining risk of domestic vessels moving ballast water from St. Lawrence River to Canadian Arctic ports (Nathalie Simard)
- Presentation: Update on shipping traffic and ice conditions (Anders Jelmert)
- General/summary discussion under ToR e)

15.00–15.30 Coffee break

15.30–16.15
ToR f) Investigate and report (incl. via AquaNIS) on new molecular tools for identification, early detection and monitoring of non-native species, in collaboration with ICES Working Group on Integrated Morphological and Molecular Taxonomy (WGIMT) ***Lead: Sarah Bailey and Henn Ojaveer***

16.15–17.00

- Location of next meeting and joint 2016–18 WGBOSV/WGITMO ToR's
- Any Other Business/Wrapping up of joint meeting

17.00 End of joint meeting and close of the day

THURSDAY 19 MARCH

09.00 Review of WGITMO Terms of Reference and Agenda

ToR a) Summarize information provided in national reports and through the AquaNIS information system. Develop annual summaries of new occurrences/introductions of aquatic non-indigenous species. ***Lead: Henn Ojaveer and Sergej Olenin***

Highlights from national reports

Belgium	Francis Kerckhof
Canada	Nathalie Simard
Finland	Lauri Urho
France	Philippe Goulletquer
Germany	Manfred Rolke
Italy	Anna Occhipini
Lithuania	Sergej Olenin
Norway	Anders Jelmert

10.30–11.00 Coffee break

Highlights from national reports continued

Poland	Monika Normant
Portugal	Paula Chainho
Sweden	Ann-Britt Florin
United Kingdom	Gordon Copp
United States	Judy Pederson
Estonia	Henn Ojaveer

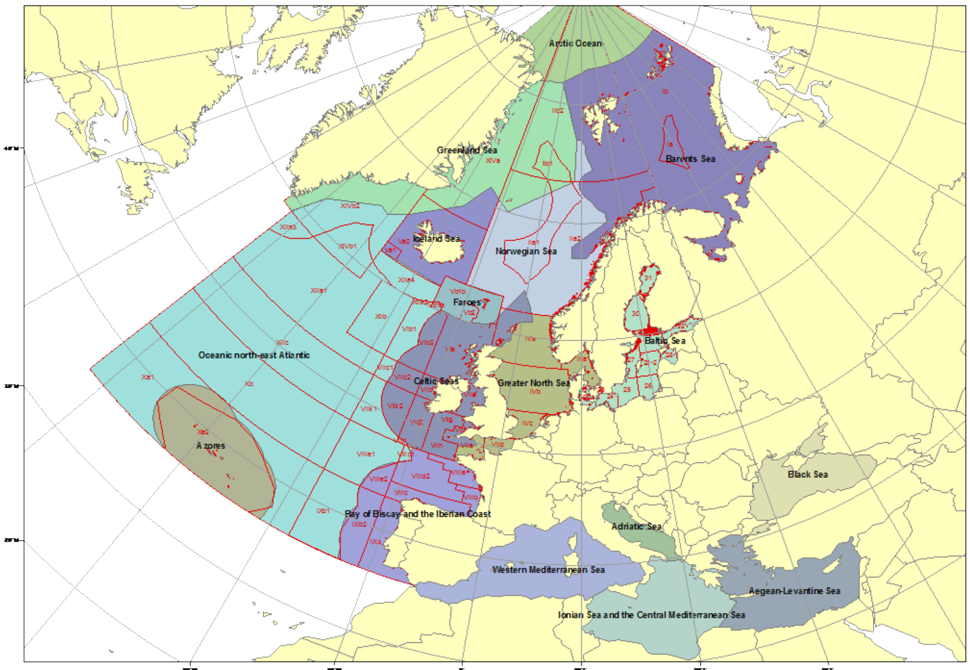
12.30–13.30 Lunch break (on your own)

13.30–15.00

ToR h) Produce four short paragraphs for the ICES Ecosystem Overviews on regional trends in invasive species, one paragraph for each of the following ICES ecoregions: Greater North Sea, Celtic Seas, Bay of Biscay & the Iberian coast and Baltic Sea. ***Lead: Henn Ojaveer***

Supporting information:

Each paragraph should be maximum 150 words in length and can be support by one figure. Paragraphs for each ecoregion should be similar in style and address the overall state and comment on the pressures accounting for changes in state. These will go in section four of the ecosystem overviews and not supposed to be long descriptions, but a short synopsis of important points for managers and policy developers.



15.00 – 15.30 Coffee break

15.30–17.15

ToR b) Continue addressing EU MSFD D2 on further developing alien species indicators, incl. based on information available in AquaNIS and other sources. ***Lead: Sergej Olenin***

- Konstantinos Tsiamis: On-going review of the Commission Decision on GES for non-indigenous species and a short up-date on EASIN

General discussion

17.15–18.00

ToR c) Continue identification and evaluation of climate change impacts on the establishment and spread of non-indigenous species. Produce draft manuscript outline on salinity change effects on non-indigenous species. This activity will mostly be carried out intersessionally and take several years. ***Lead: João Canning-Clode***

18.00 Close of the day

FRIDAY 20 MARCH

09.00–10.30

- Gordon Copp: The Aquatic Species Invasiveness Screening Kit (AS-ISK) – the ENSARS generic module converted into an electronic (FISK-type) decision-support tool

10.30 - 11.00 Coffee break

11.00–12.30

- Thomas Landry: Aquatic invasive species and integrated pest management

ToR g) Produce draft outline of the alien species alert report on *Didemnum vexillum*. ***Lead: Cynthia McKenzie***

12.30–13.30 Lunch break (on your own)

j) 13.30–15.00

- ToR's for 2015
- Any Other Business
  - Status of the previous species alert report on *Ensis directus*
  - Data submission through AQUANIS
  - National reporting format
  - ICES-CIESM Mnemiopsis workshop report
  - Joint paper ideas
  - Theme session at ICES ASC 2016
  - ICES-CIESM-PICES cooperation

15.00 Close of the meeting

Annex 3: National reports

Belgium

Prepared by Francis Kerckhof, MUMM, Marine Ecosystem Management Section, Royal Belgian Institute of Natural Sciences, with support of Lies Vansteenbrugge, Institute for Agricultural and Fisheries Research, Animal Sciences Unit - Fisheries

Highights

During 2014 a small population of the Manilla clam *Ruditapes philippinarum* was discovered in the port of Zeebrugge.

The Indo-Pacific leptomedusa *Lovenella assimilis* or *Eucheilota menoni* was found amongst the gelatinous plankton off the Belgian coast.

During the summer of 2014, the clinging jellyfish *Gonionemus vertens* has been rediscovered in de Spuikom (Sluice Dock) Oostende

The mud worms *Boccardiella hamata* and *Boccardia proboscidea* are reported from Belgium.

All other introduced species that were reported during previous years are still present and seem to be well-established and thriving.

1. Laws and regulations

There is no new national legislation to report. The various EU legislations are being implemented

2. Intentional introductions

There is no information available on intentional introductions if any.

3. Unintentional introductions:

On July the 4th 2014 one live specimen of *Ruditapes philippinarum* and 30 frehs empty specimens where found in an artificial gravelly environment in the port of Zeebrugge consisting of a dike and a shallow foreshore with shell hash, stones and a mix of sand and mud, dominated by the Pacific oyster *Crassostrea gigas*. Later the same month a dedicated sampling revealed the presence of several life individuals, indicating that a population of the pieces had established. During an eralier survey in May 2012 none were found. The species seems to be a recent introduction and another addition to the many introduced pieces already present in the port of Zeebrugge. This is the first record for Belgian waters and it is expected that the species will spread to other suitable habitats (ports, shallow lagoons, beaches) along the Belgian coast.

The Limnomedusa *Gonionemus vertens* A. Agassiz, 1862 has been observed in June 2014 in the Spuikom (Sluice dock) in Oostende. This is a small 2–4 cm clinging jellyfish probably with a northern Pacific origin. In the past, *Gonionemus vertens* had been observed in 1946 and 1947 by Leloup (1948) in the same location, but it has never been recorded since, although this particular species still survived in suitable habitats in the Netherlands (Wolff 2005). Leloup (1948) believed its presence in the Spuikom was due to accidental transport with American oysters *Ostrea virginica* from Long Island, USA. The American oyster had been introduced into the area in 1939–40. What the origin is of the recent discovery is unknown; but might be related with shellfish transports.

The Indo-Pacific leptomedusa *Lovenella assimilis* or *Eucheilota menoni* is found amongst the gelatinous plankton off the Belgian coast (Vansteenbrugge *et al.* 2015). The species seemed mainly present during late summer and autumn at the open sea and intermediate locations rather than the coastal or estuarine locations. It presence could be confirmed for the past 4 years, but the identification was difficult and the confirmation of it's true identity is under investigation.

All introduced species that were reported during previous years are still present and seem to be well-established and thriving.

4. Pathogens

No information

5. Meetings

6. Research projects:

The interreg clusterproject SE-FINS: "Safeguarding the Environment From Invasive Non-Native Species" was approved on January 16th 2014 in the 4th Cluster Call of the Interreg program 2 seas. It has at its theme: Risks management in the context of ICZM

The Cluster focuses on reducing the impact of invasive non-native species (INS) on native biodiversity in the whole 2 seas area, and predicting the impact of new INS that are likely to arrive in the near future. The cluster aims at conducting a joint update of species targeted. It will also review the communication tools that have already been developed by the projects, assessing the effectiveness of these tools and producing guidance on the most effective methods to communicate the risks and impacts associated with INS to different target audiences. The Cluster draws together expertise from two 2 Seas projects RINSE and MEMO.

SE FINS will also build upon experiences from the Interreg IVA grensregio Vlaanderen - Nederland project INVEXO.

In the first phase of the project, the partners made an evaluation of the present knowledge for inventarisation, detection, management and communication about already identified IAS. The main conclusion of this phase was that there was an urgent need to close some knowledge gaps. Four themes were identified for further research and attention. Within the theme of "knowledge transfer, training and advice" particular attention should be paid to constructive cooperation between policy, science and stakeholders. By closing the knowledge gap between academics and practitioners, it is possible to prevent introductions of IAS, to detect species at an early stage and to use efficient management. A second theme concerns "data sets": an online European information system is needed that is coordinated by experts in all ecological niches and which is accessible to all stakeholders. A third gap was "risk management and impact assessment", where systematic and efficient methods are required for prevention, early detection and prediction in combination with control techniques, monitoring and communication. Last, "citizen science and consciousness-raising" highlights the distance between the general public and policy. Cross-border cooperation and the use of communication and tools adapted to the specific requirements of the target groups are necessary. There is also a physical gap within IAS management and within the SE FINS cluster. Concerted efforts for the management of estuarine IAS is lacking and must be addressed. The estuarine zone, an important transitional area between the marine and freshwater environment, often escapes the attention of research and policy.

In the second phase, started on January 1st, 2015, work will continue on the above-noted gaps for a better management of these IAS in the long term. In practice, four estuaries within the Interreg 2 Seas area will be examined, namely the Scheldt (B / NL), Maas (B), Wash (UK) and Canche (FR). Work will be done on developing a cross-border information system, a method for early detection and monitoring, efficient communication and consciousness-raising, and an evaluation of already developed methods. ILVO will take the lead in the work package on risk assessment and will conduct a pilot study to develop an eDNA method for early detection of some "alarm" IAS in estuaries.

6. References and bibliography

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Canada

Prepared by Nathalie Simard DFO Quebec Region

Overview:

Fisheries and Oceans Canada is currently developing regulations that would help address Aquatic Invasive Species. *Didemnum vexillum*, confirmed for the first time in 2013 in Atlantic Canada in Minas Basin, in the upper Bay of Fundy, was reported at additional sites in 2014. Other species that have already invaded Canadian waters continue to spread, including European green crab (*Carcinus maenas*), vase tunicate (*Ciona intestinalis*), oyster thief (*Codium fragile*), golden star tunicate (*Botryllus schlosseri*), clubbed tunicate (*Styela clava*), European sea squirt (*Ascidiella aspersa*) and violet tunicate (*Botrylloides violaceus*).

1. **Regulations**:

Fisheries and Oceans Canada is developing a regulatory proposal to manage the threat of aquatic invasive species (AIS). The proposed Aquatic Invasive Species Regulations were published in the *Canada Gazette,* Part I, on December 6, 2014. The associated public consultation period concluded on January 5, 2015. The final Aquatic Invasive Species Regulations are expected to be published in *Canada Gazette*, Part II, in 2015.

The regulations include:

1. a **list of species** affected by the regulations;
2. a **prohibition structure** to avoid the introduction and spread of AIS by restricting activities such as importation, transport and possession of live AIS in various locations;
3. a **permitting scheme** to authorize specific low risk activities related to AIS in Canada (i.e. science); and
4. **Authorities for control and eradication** activities.

The initial list of species is limited to Asian Carps. Provision for adding species to the list is in the regulation, following a biological and economic risk assessment for species of concern. More information can be found at the following website; http://isdm-gdsi.gc.ca/ais-eae/index-eng.asp

Fisheries and Oceans Canada, along with the provinces and territories, currently manage disease, genetic, and ecological risks associated with aquatic animal movements through a variety of federal, provincial, and territorial regulations under the National Code on Introductions and Transfers of Aquatic Organisms. However, the Code is currently undergoing renewal to account for regulatory changes and lessons learned in the nearly 10 years since it has been implemented. In particular, the renewed Code will account for the Canadian Food Inspection Agency's new regulatory role in managing disease risks through the National Aquatic Animal Health Program under the Health of Animals Regulations. In the summer 2012, the Canadian Council of Fisheries and Aquaculture Ministers officially approved the formation of an Introductions and Transfers Renewal Task Group. The existing Code will apply until it is renewed. Consultations are ongoing.

2. Intentional Introductions:

For details on the intentional introductions by province for 2014, see

http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/intro-eng.htm.

3. Unintentional Introductions:

New Sightings

Didemnum vexillum, confirmed for the first time in 2013 in Atlantic Canada in Minas Basin, in the upper Bay of Fundy, was reported at additional sites in 2014. A total of 829 benthic dredge samples were taken during DFO scallop assessment surveys in offshore (Georges, Browns and German Banks) and inshore (Bay of Fundy) regions to delineate the presence of *D. vexillum* in Nova Scotia. With the exception of two observations: one off Yarmouth and on off Digby (southwest Nova Scotia), all remaining positive samples for *D. vexillum* (7 of 9 in total) were located in the upper Bay of Fundy.

Botrylloides violaceus was reported in Belle Isle Strait in August 2014 at a depth of 67 meters. Samples were sending for genetic analysis to confirm the identification. *Diadumene lineata* (orange-striped anemone) and *Ascidiella aspersa* were respectively reported for the second time in Halifax and Lunenberg harbours in Nova Scotia in 2014. These species have been reported for the first time in these areas in 2013.

Previous Sightings

The national data excel spreadsheet (separate document) provides as information on new detections and expansions of previously detected aquatic invasive species of interest to Canada and does not represent all data points collected during the 2014 sampling season. Canada has a database that is updated every year.

Records included here represent persistent AIS, or AIS that have been detected in the area in previous years, or species that are undergoing range expansion within the Canadian Atlantic zone. Range expansion has been identified for *Carcinus maenas*, *Ciona intestinalis*, *Botryllus schlosseri*, *Styela clava*, *Botrylloides violaceus*, *Membranipora membranacea* and *Codium fragile*.

Some specific examples include:

Carcinus maenas continues to spread into north-eastern New Brunswick, Prince Edward Island and Nova Scotia. Green crab continues to spread in Newfoundland in Placentia Bay and along the western coast of the province and was found in Fortune Bay on the south coast. It has also extended its range north to Port Saunders on the northern peninsula and was found in Harbour Breton for the first time. Captures of green crab in Magdalen Islands, Quebec have decreased during the last two years. Cold winters or control efforts are potential factors that could explained this important drop.

Ciona intestinalis is now established on the eastern shore of Nova Scotia, in Chedabucto Bay, Cape Breton, along the south and southwest shores of mainland Nova Scotia and in SW New Brunswick. It was also detected in Newfoundland for the first time in 2012, on the Burin Penisula in Placentia Bay. In 2014 it was reported in the north east entrance of the Bras d'Or Lake, Cape Breton. Vase tunicate has been observed in Cap-aux-Meules (Magdalen Islands Quebec) in limited numbers since 2006 with the exception of a small area which started to be highly infested in 2011. In order to prevent further spread of this invasive species, mitigation measures have continued in collaboration with the province of Quebec and an OGN (ZIP Îles-de-la-Madeleine). Since 2012, a total of 37 floating docks were removed, cleaned and treated with antifouling paint. The resting docks (10) will be treated in 2015 at the end of the fishing season. Mitigation activities in Little Bay, Placentia Bay, Newfoundland, have taken place in 2013 and 2014. The docks were removed and will be painted with antifouling paint in 2015 to test the use of antifouling paint on floating docks in the Newfoundland environment.

Botryllus schlosseri is now present in most Bays and harbors along the south, and south west coast of mainland Nova Scotia, as well as in coastal Cape Breton and the Bras D'Or lakes and Magdalen Islands. It is well established in SW New Brunswick and continues to spread into the NE of the province. Golden Star Tunicate was detected for the first time on Gaspesie, Quebec on collector plates in 2012 but was never observed in that area since that time. Scallop and mussels farmers on the Magdalen Islands have found high densities of golden star tunicate on their structures in 2014, a situation which is becoming a concern for that industry.

Botrylloides violaceus continued to spread to new locations in Nova Scotia. It is not yet widespread in SW New Brunswick, however it continues to spread in NE New Brunswick and Magdalen Islands. In Belleoram harbour, Fortune Bay, Newfoundland no *B .violaceus* was found in the harbour during the 2014 survey. This is the first time the species has not been detected in that location since its discovery in 2007.

Styela clava was reported in Nova Scotia for the first time in 2012. This species is now present in Chedabucto Bay on the East coast of the province between the mainland and Cape Breton.

Membranipora membranacea is well established on the Atlantic coast of Canada since 1990's. This year, high densities of brown macroalgae (Laminaria type) heavily covered with *Membranipora membranacea* were reported to be present on beaches all around Gaspe Peninsula. A rapid assessment will be conducted in 2015 in this region.

4. Pathogens

None reported.

5. Meetings

Monitoring Atlantic Zonal meeting, Mont-Joli, Qc, February 2014.

Canadian Aquatic Invasive Species Network II Annual General Meeting. Gatineau, Quebec, Canada. May 2014.

Canadian Science Advisory Sector Meetings

DFO. 2015. Marine Screening-Level Risk Assessment Protocol for Aquatic Non-Indigenous Species. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/nnn.

Future meetings

Canadian Aquatic Invasive Species Network II Annual General Meeting. Halifax, NS, April 2015

Marine Recreational Boating Risk Assessment Montreal, Quebec, November 2015.

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Denmark

Prepared by Kathe R. Jensen, Zoological Museum (Natural History Museum of Denmark, SNM), with contributions from P. Dolmer (Orbicon), H. U. Riisgård (SDU), O.G.N. Andersen (AU), S. Lundsteen (AU), M.H.Q. Caspersen (Nature Agency), S. Berg (DTU), K. Melbye (Vadehavscentret), T.H. Holm-Hansen (SNM) and S. Agersnap (SNM)

Highlights

Two alien species of freshwater crayfish have been found in brackish waters in the Sound (Øresund). *Hemigrapsus sanguineus* and *H. takanoi* can now be considered established in the Danish Wadden Sea. The comb jelly *Beroe ovata* has been found in the Limfjord. The round goby, *Neogobius melanostomus*, continues to spread into Storebælt (Great Belt) and into freshwater streams.

Regulations

Under the NOBANIS auspices potential ”door-knocking” alien species (including terrestrial and limnic) have been risk assessed by "experts" (see NOBANIS Newsletter No. 8, September 2014) and a report is forthcoming (probably April 2015).

In collaboration between the Danish Nature Agency and Department of Geosciences and Natural Resource Management at University of Copenhagen, a pathway analysis has been undertaken (Madsen *et al.*, 2014). This includes terrestrial, limnic and marine species.

The Danish Nature Agency is preparing for the inclusion of descriptor D2 (non-indigenous species) of the MSFD in the marine monitoring program (NOVANA) (Andersen *et al.*, 2014). A Nordic project has worked specifically on monitoring and management of *Crassostrea gigas* (Dolmer *et al.*, 2015).

Transfer activities of bivalves for aquaculture in the EU have been reviewed along with the legal framework from global to national levels (Muehlbauer *et al.*, 2014). Also, environmental impacts have been reviewed (Brenner *et al.*, 2014).

The Economic Council (De Økonomiske Råd) has carried out an analysis of the costs of invasive species in Denmark. This includes terrestrial and limnic species as well as marine ones.

Intentional introductions:

None reported.

11 000 juvenile eels were released in October 2014, 300m from shore north of Lolland in the Baltic Sea. This was a compensation for destruction of fishing gear and grounds by construction work (newslink at http://www.tveast.dk/artikler/baby-aal-i-vandet). The article doesn't say where the eels came from, but most likely had been cultured from imported glass-eels.

Import and Export (Source http://m.statbank.dk/, the official on-line database for national statistics)

A total of 16t of live saltwater aquarium fishes were imported in 2014. The majority, 12t, came from Indonesia. Other major imports came from Sudan, Sri Lanka and the Philippines. This means that the majority are tropical fish that will not survive in the wild. However, the statistics are not broken down to species.

A total of 100t of lobster, *Homarus* spp. were imported in 2014; 32t came from Canada, 14t from France, 8t from the Netherlands, 10t from Great Britain, 7t from Germany, and 30t from the USA. This means that probably 65% of the imports were American lobsters.

Only minor amounts of live fish, mostly salmon and trout, were imported in 2014. It is not possible to distinguish if they were for aquaculture, put-and-take ponds or for restaurants. The same is true for import figures for mussels and oysters.

Export of live fishes is mainly of freshwater trout (different species) from aquaculture, and mainly to other EU countries.

Fisheries statistics (2013) is available from http://webfd.fd.dk/.

Unintentional introductions:

Invertebrates:

For the first time a specimen of the Galician Crayfish, *Astacus leptodactylus* Eschscholtz, 1823, was found in brackish water in central Øresund (The Sound). It was collected by students from the Natural History Museum of Denmark on 2 July 2014, near Copenhagen Airport. It is uncertain how the specimen arrived at its brackish locality, which is a considerable distance from freshwater sources. Most likely it escaped from a pond. Samples have been taken for DNA analysis of possible hybridization (see photos in NOBANIS Newsletter No. 8, September 2014).

Also, a specimen of the Signal Crayfish, *Pacifastacus leniusculus* (Dana, 1852), was found in brackish waters of the southern Øresund. This specimen was also found by students from SNM on 15 September 2014, in Mosede Havn, a small harbor/marina south of Copenhagen. This is the second find of *P. leniuscula* in brackish waters. The first one was reported in 2010 from Bøgestrømmen in the Baltic Sea area. The Signal Crayfish has been spreading in freshwater streams in Denmark over the last 10 years or more and action plans have been developed for local eradication at municipal levels (see e.g. http://naturstyrelsen.dk/media/nst/attachments/78686/signalkrebsrapportendeligversion7311.pdf).

The two species of *Hemigrapsus, H. sanguineus* and *H. takanoi*, can now be considered established. They have been present in the Danish Wadden Sea since 2011 (K. Melbye, pers. comm.).

Three other crustacean species have been recorded from Danish waters for the first time (Andersen *et al.*, 2014). However, they are probably climate-driven northwards range extensions rather than introduced species.

Beroe ovata has been recorded for the first time in the Limfjord in November 2013 (Riisgård & Goldstein, 2014).

Research on biology and population dynamics of *Mnemiopsis leidyi* continues (Augustine *et al.*, 2014; Haraldsson *et al.*, 2014; Riisgård & Goldstein, 2014; Jaspers & Reusch, 2014; Jaspers *et al.*, 2014).

Potamopyrgus antipodarum from a freshwater lake in Denmark continues to be used as experimental organism for toxicology studies, using sediment from a brackish water locality in the Isefjord (Ramskov *et al.*, 2014).

A five-year survey of Pacific oyster population in the western Limfjord showed that the species is not expanding and presently is not a threat to the ecosystem (Groslier *et al.*, 2014).

Research on impacts on ecosystem function of *Marenzelleria viridis* in Odense Fjord has been continued (Jovanovic *et al.*, 2014; Kristensen *et al.*, 2014).

Fish: (Source: Fiskeatlas project, http://fiskeatlas.ku.dk/)

Neogobius melanostoma continues to spread in Danish coastal waters as well as into freshwater streams. During 2014 it has been found at the island Langeland in southwestern Storebælt (Great Belt), and also in southern Øresund. It also spreads into freshwater streams, e.g. in Bornholm.

A small specimen (74cm) of European sturgeon, *Acipenser sturio*, was caught in Øresund near the small island Saltholm on 11 February 2014.

Parasites:

A parasitic dinoflagellate of the genus *Ichthyodinium* was found in hatchery cultured eggs of European eel (*Anguilla anguilla*). It has previously been found in pelagic eggs of other fishes in the Atlantic as well as Pacific oceans, and in environmental DNA samples from the Caribbean (Sørensen *et al.*, 2014). Hence it is considered cryptogenic.

Meetings:

Round goby – need for collaborative science and management in Nordic and Baltic countries. 4–5 September 2014, Charlottenlund Castle. Norden, BIO-C3, BONUS, DTU-Aqua. Report available at http://www.bsac.dk/archive/Newsletter/2014/message14/ReportRoundgobyWkshpSept2014.pdf. Program available DTU-Aqua (http://www.aqua.dtu.dk/).

A planned meeting on marine invasive species in September 2014 had to be cancelled due to lack of participants with presentations.

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Riisgård, H.U. and Goldstein, J. 2014. Jellyfish and ctenophores in Limfjorden (Denmark) – Mini-Review, with recent new observations. Journal of Marine Science and Engineering 2: 593–615.

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Estonia

Compiled by Henn Ojaveer (with contributions from Jonne Kotta), Estonian Marine Institute, University of Tartu

Overview

National non-indigenous species monitoring was continued in the scope and aims as in previous years. One of the aims is to monitor non-indigenous species in the high-risk areas of new invasions. Base on surveys in vicinity of the largest port in the country – Muuga harbor – no new non-indigenous species were identified in 2014. The cryptogenic cirriped *Amphibalanus improvisus* and the non-indigenous polychaete *Marenzelleria neglecta* appear to form very abundant populations. The round goby *Neogobius melanostomus* declined in gillnet catches in the Gulf of Finland and the abundance of Chinese mitten crab *Eriocheir sinensis* continued to be low.

1. Regulations: An update on new regulations and policies (including, aquaculture and vector management)

The IMO BWMC ratification process is not yet finalized.

3. Unintentional introductions

An as-yet-undescribed, non-indigenous, polychaete species was found at very high densities in the north-eastern Gulf of Riga, Pärnu Bay in 2012. The species belongs to the sabellid genus *Laonome* Malmgren, 1866, but it could not be assigned to any of the previously described species. To date, the species has established a stable population after surviving a notably cold winter (2012/2013). The abundance of *Laonome* sp. exhibited strong seasonal variation, peaking between July and November. Besides seasonality, the quantity of decomposed microalgae in the sediment and wave exposure best explained the variation in abundance. This non-indigenous polychaete may potentially modify sediment morphology and chemistry and disrupt the natural infaunal communities. *Laonome* sp. could displace or even completely eliminate some species currently present in the study area and beyond if it spreads; however, it could also facilitate currently-present species through the provision of alternative substrate and/or food (Kotta *et al.* 2015).

In 2014, non-indigenous species monitoring was continued in the scope and aims as in previous years, with addition of port biological sampling according to HELCOM methodology. One of the aims is to monitor non-indigenous species in the high-risk areas of new invasions. Based on surveys both at and in vicinity of the largest port in the country – Muuga harbor (Port of Tallinn) – no new non-indigenous species were identified in 2014. The samples taken both from the harbour area as well as adjacent localities confirm that *Marenzelleria neglecta* was the most frequently found non-indigenous species in these areas (with co-domination in a few localities), with the other zoobenthic non-indigenous/cryptogenic species being *Potamopyrgus antipodarum*, *Amphibalanus improvisus* and *Mya arenaria* (Anon. 2015).

The other major aim of the non-indigenous species monitoring program is to track the long-term performance of the already existing non-indigenous species in Estonian coastal sea (please also see figures 1–6 at the end of this national report). Time-series are available for *Cercopagis pengoi*, *Evadne anonyx*, *Amphibalanus improvisus* larvae and *Marenzelleria neglecta* larvae. In 2014, the abundance of *M. neglecta* larvae was relatively low both in the Gulf of Finland and the Gulf of Riga, while *A. improvisus* larvae and *C. pengoi* were relatively high (compared to the long-term mean) in the Gulf of Finland, but low in the Gulf of Riga (Figures 1–4).

The benthic crustaceans *Chelicorophium curvispinum* and *Pontogammarus robustoides* are common at the SE coast of the Gulf of Finland (from Sillamäe to Narva-Jõesuu) and may dominate in the benthic invertebrate communities in this region. In 2014 *C. curvispinum* was first time observed in the south-western part of the Gulf of Finland corresponding to about 250 km westward spread of the species.

The bloody-red shrimp *Hemimysis anomala* has been increasingly found in the Estonian coastal sea. Although its densities are very low, a number of new localities have been observed in recent years: Pärnu Bay (Gulf of Riga) in 2009, 2012 and 2013; Muuga Bay (Gulf of Finland) in 2012 and Tallinn Bay (Gulf of Finland) in 2013. In 2014 no *H. anomala* were recorded in benthic samples. However, it is important to note that this species occurs only sporadically in the traditional monitoring samples due to its very specific habitat range.

Based on the most recent evidence, the grass prawn *Palaemon elegans* has colonized the whole Estonian coastal sea by having been found in multiple localities in the Gulf of Finland, West-Estonian Archipelago Sea, NE Baltic Proper and the Gulf of Riga. In 2014 the species still dominates among palaemonids in all these basins.

The Harris mud crab *Rhithropanopeus harrisii* was first found in Estonian waters in 2011. Further investigations in 2012 evidenced that the species has colonised whole Pärnu Bay and already occurring outside the area in the NE Gulf of Riga. There is no evidence on the further expansion of the distribution area of the species in 2014.

Catch index of the Chinese mitten crab *Eriocheir sinensis* has been monitored in gillnet fishing nets in Muuga Bay (Gulf of Finland) since 1991. While until 2002, the species was relatively rarely found, significantly elevated catch index level was recorded since then. However, no or only a very few crabs were found in the bay during the past years (Figure 5; Anon 2015).

The round goby *Neogobius melanostomus* continues to increase in population abundance in the Gulf of Finland. The center of the distribution area is Muuga Bay where the species has increased exponentially since 2005 to until 2010, and this increase has slowed down during a few past years. In 2014, proportion of the species decreased in gillnet catches of both large and small mesh size (Figure 5, Anon 2015).

The gibel carp *Carassius gibelio* was introduced to fish ponds in Estonia during the mid-1950s and was first found in the sea in 1985. Out of the routinely investigated coastal fish monitoring stations, this non-indigenous fish is most abundant at the southern coast of Saaremaa (Kõiguste) in the northern Gulf of Riga with relatively stable values during the several past years (Figure 6, upper panel), and in recent few years also in the Gulf of Finland (Figure 6, lower panel). The fish occurs in several coastal fish monitoring sites at low abundances and is therefore considered as a common species in coastal fish communities.

4. Website

Distribution of benthic invertebrate species (both non-indigenous, cryptogenic and native species) in Estonian coastal sea can be found at: http://loch.ness.sea.ee/gisservices2/LiikideInfoportaal/index.html

The underlying database is updated operationally (as new data becomes available).

5. Pathogens

Nothing to report.

6. Meetings

Co-organising the workshop on 'Round goby – need for collaborative science and management in Nordic and Baltic countries', held on 4th -5th September 2014 in DTU-Aqua Charlottenlund, Denmark. The workshop was co-funded by BONUS BIO-C3 and NORDEN. Scientists from all Baltic countries were invited and attended. Key-note lecture was given by Dr. D. Heath, Canada. In addition to scientists, various stakeholder representatives participated. These include: Baltic Sea RAC, ICES, the Danish Ministry of Environment, GEMBA Seafood Consulting, Ministry of Food, Agriculture and Fisheries of Denmark. The meeting was attended around 50 participants.

On behalf of Estonia, the following oral presentations were given:

Nurkse, K., Kotta, J., Ojaveer, H. and Orav-Kotta, H. 2014. Food consumption and dietary preference of the round goby (*Neogobius melanostomus*) under experimental conditions.

Kotta, J., Ojaveer, H., Puntila, R. and Nurkse, K. 2014. Distribution of the invasive round goby *Neogobius melanostomus* in a brackish water ecosystem: relative contribution of natural and anthropogenic drivers.

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Galil B, Marchini A, Occhipinti-Ambrogi A, Minchin D, Narščius A, Ojaveer H and Olenin S. 2014. International arrivals: widespread bioinvasions in European Seas. Ethology, Ecology and Evolution 26(2–3): 152–171.

Kalaus, M. and Ojaveer, H. 2014. Over one decade of invasion: the non-indigenous cladoceran *Evadne anonyx* G.O. Sars, 1897 in a low-salinity environment. Aquatic Invasions 9(4): 499–506.

Kotta J, Bick A, Bastrop R, Väinölä R and Kotta I. 2015. Description and ecology of the invasive polychaete *Laonome armata* sp. nov. (Sabellida, Sabellidae) in the Baltic Sea. Aquatic Invasions 10 (in press).

Kotta J, Torn K, Reisalu G, Veber T. 2014. Relationships between mechanical disturbance and biomass of the invasive amphipod Gammarus tigrinus within a charophyte-dominated macrophyte community. Marine Ecology 35(Suppl. 1): 11–18.

Lehtiniemi M, Ojaveer H, David M, Galil BS, Gollasch S, McKenzie C, Minchin D, Occhipinti-Ambrogi A, Olenin S, Pederson J. (2015). Dose of truth - Monitoring marine non-indigenous species to serve legislative requirements. Marine Policy 54: 26–35.

Nurkse, K., Kotta, J., Orav-Kotta, H., Pärnoja, M., Kuprijanov, I. 2015. Laboratory analysis of the habitat occupancy of the crab *Rhithropanopeus harrisii* (Gould) in an invaded ecosystem: The north-eastern Baltic Sea. Estuarine, Costal and Shelf Science 154: 152–157.

Ojaveer, H., Galil, B.S., Campbell, M.L., Carlton, J.T., Canning-Clode, J., Cook, E.J., Davidson, A.D., Hewitt, C.L., Jelmert, A., Marchini, A., McKenzie, C.H., Minchin, D., Occhipinti-Ambrogi, A., Olenin, S. and Ruiz, G. 2015. Classification of non-indigenous species based on their impacts: considerations for application in marine management. PLOS Biology (in press).

Ojaveer H, Galil B, Minchin D, Olenin S, Amorim A, Canning-Clode J, Chainho P, Copp GH, Gollasch S, Jelmert A, Lehtiniemi M, McKenzie C, Mikuš J, Miossec L, Occhipinti-Ambrogi A, Pećarević M, Pederson J, Quilez-Badia G, Wijsman JWM, Zenetos A. 2014. Ten recommendations for advancing the assessment and management of non-indigenous species in marine ecosystems. Marine Policy 44: 160–165.

Ojaveer, H., Galil, B.S., Gollasch, S., Marchini, A., Minchin, D., Occhipinti-Ambrogi, A. and Olenin, S. 2014. Identifying the top issues of marine invasive non-indigenous species in Europe. Management of Biological Invasions 5(2): 81–84.

Ojaveer H, and Kotta J (2015). Ecosystem impacts of the widespread non-indigenous species in the Baltic Sea: literature survey evidences major limitations in knowledge. Hydrobiologia 750: 171–185.

Olenin S, Narščius A, Minchin D, Galil B, Gollasch S, Occhipinti-Ambrogi A, Ojaveer H and Zaiko A. 2014. Making non-indigenous species databases practical for management and useful for research: an aquatic perspective. Biological Conservation 173: 98–107.

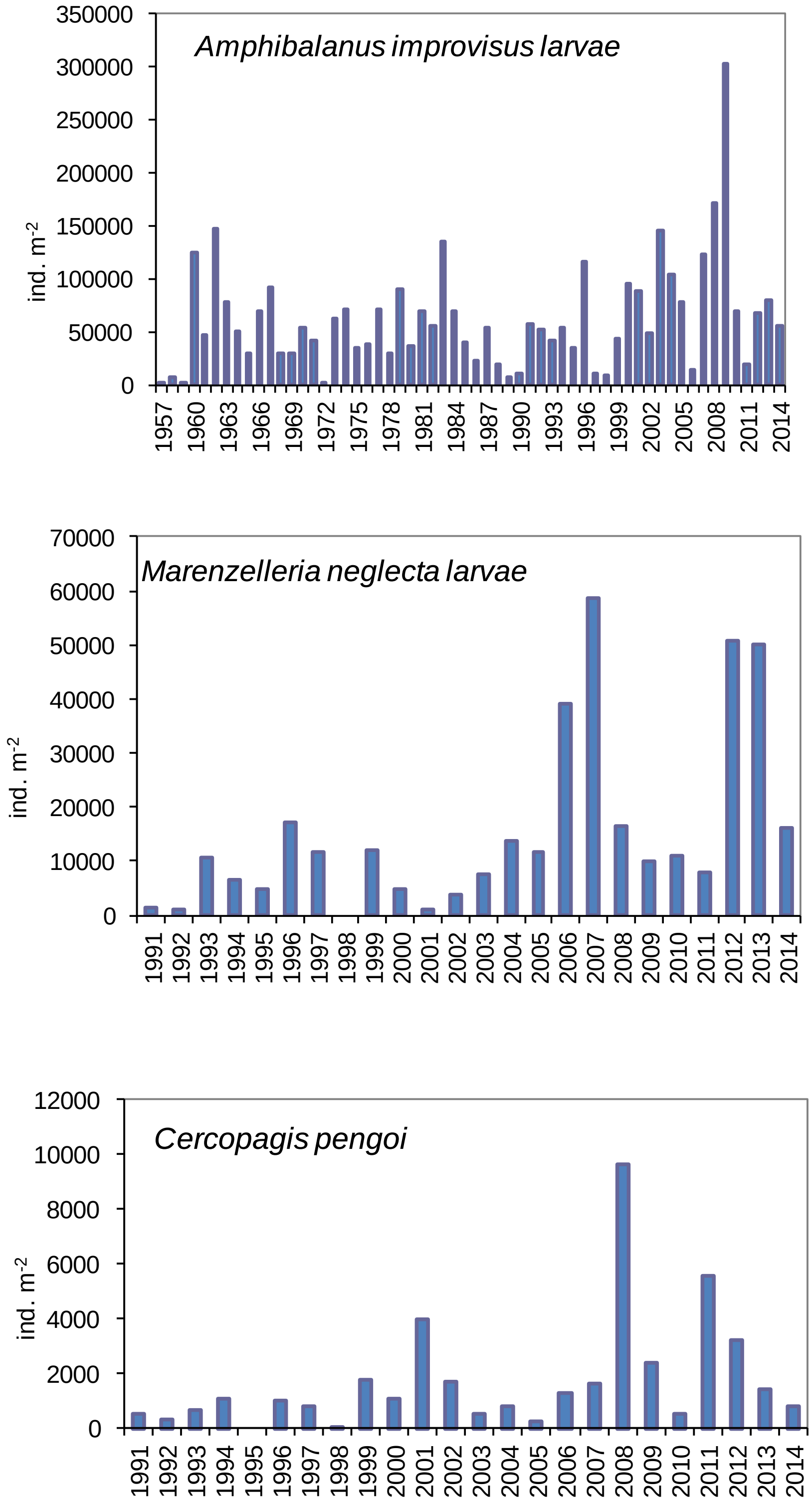


Figure 1. Long-term abundance dynamics of *Amphibalanus improvisus* larvae, *Marenzelleria neglecta* larvae and *Cercopagis pengoi* in the NE Gulf of Riga (Baltic Sea). Anon 2015.

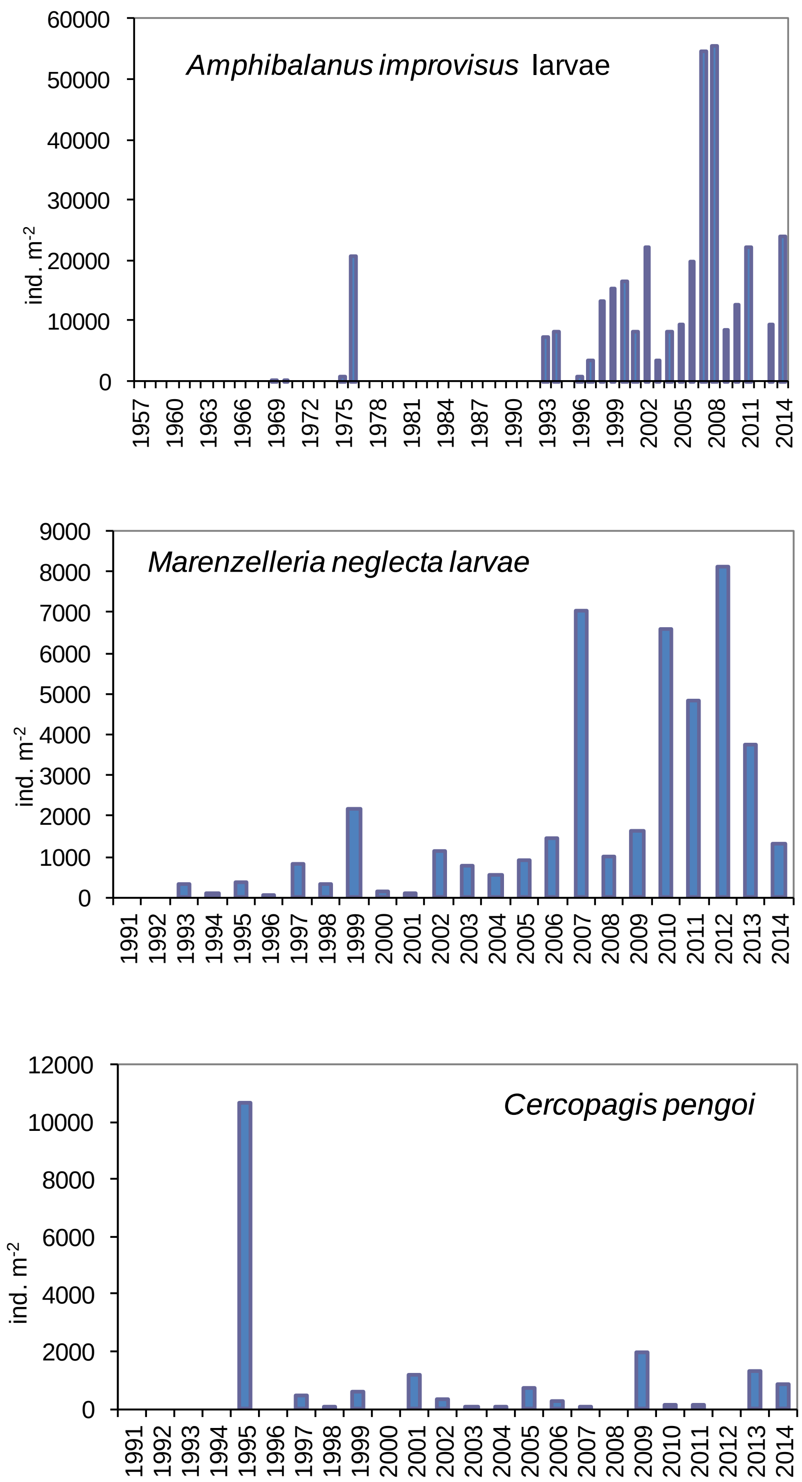


Figure 2. Long-term abundance dynamics of *Amphibalanus improvisus* larvae, *Marenzelleria neglecta* larvae and *Cercopagis pengoi* in Tallinn and Muuga Bays (Gulf of Finland, Baltic Sea). Anon 2015.

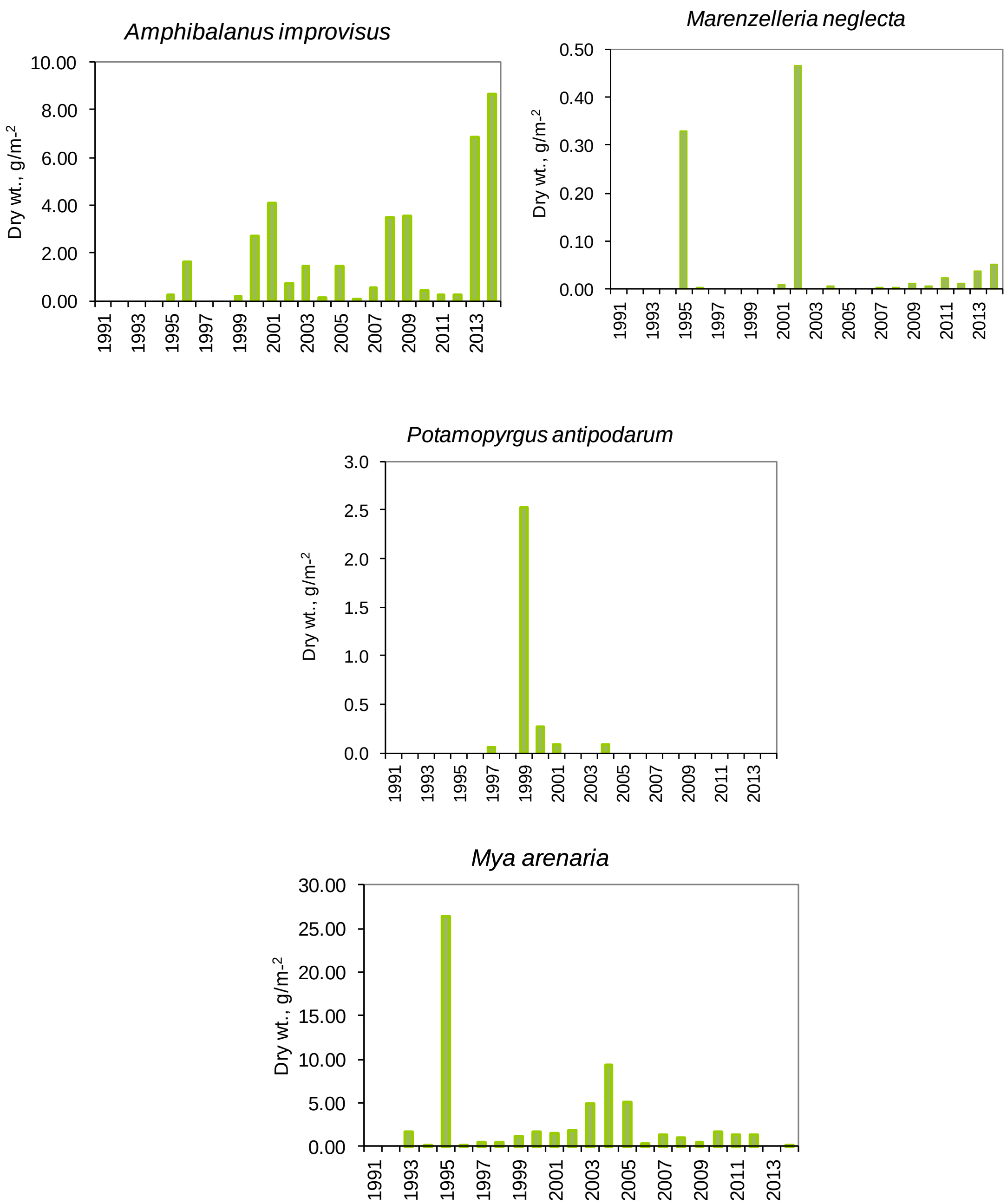


Figure 3. Long-term biomass dynamics of selected benthic non-indigenous and cryptogenic species in Tallinn and Muuga Bays (Gulf of Finland, Baltic Sea). Anon 2015.

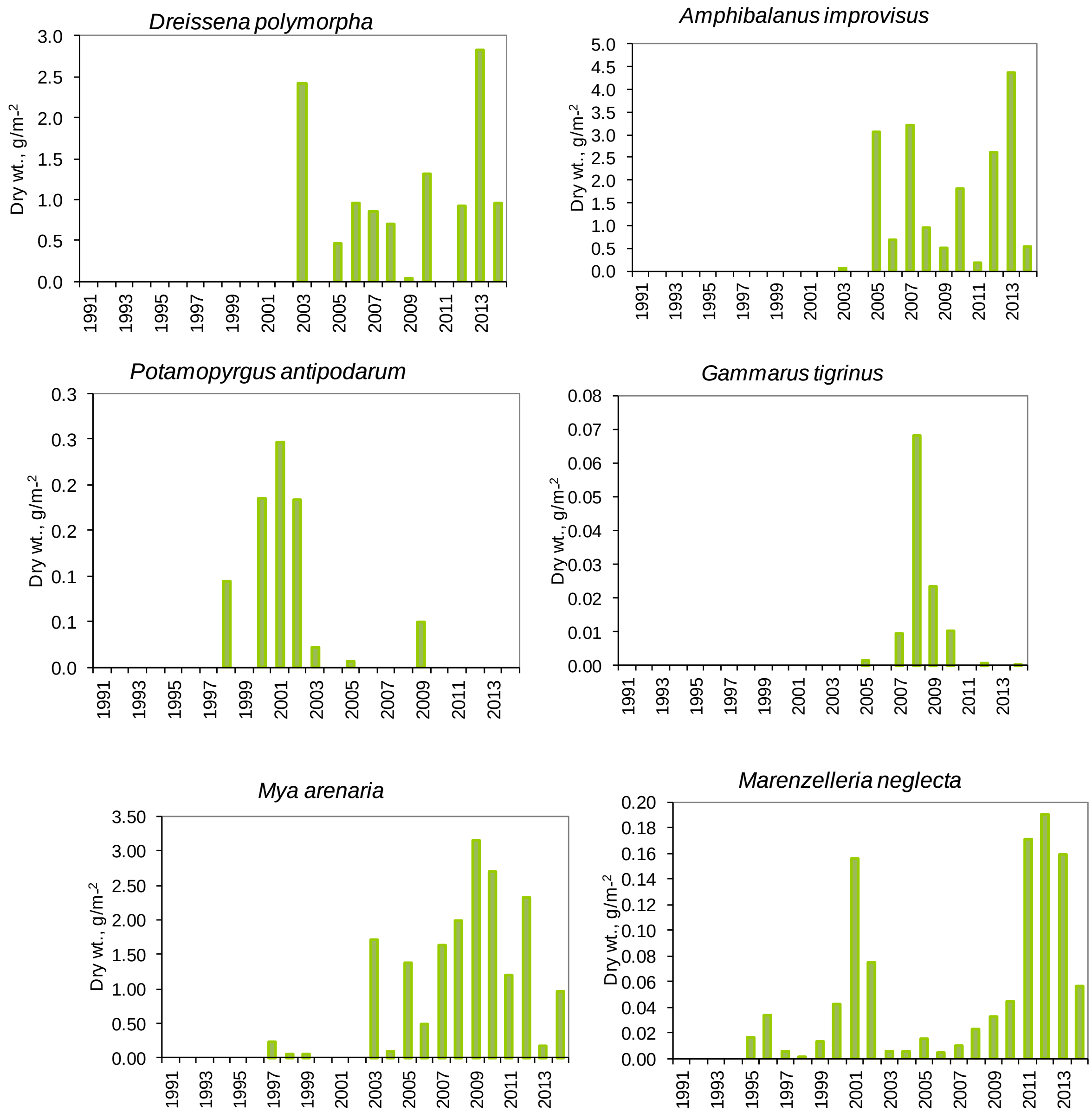


Figure 4. Long-term biomass dynamics of the selected benthic non-indigenous and cryptogenic species in the Gulf of Riga (Baltic Sea). Anon 2015.

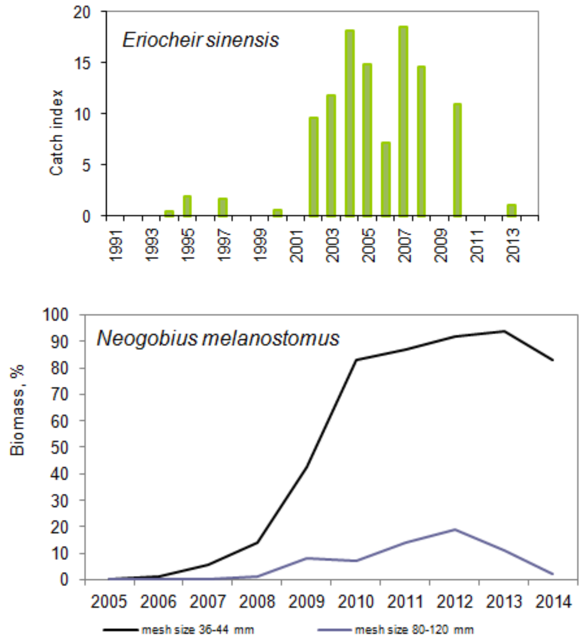
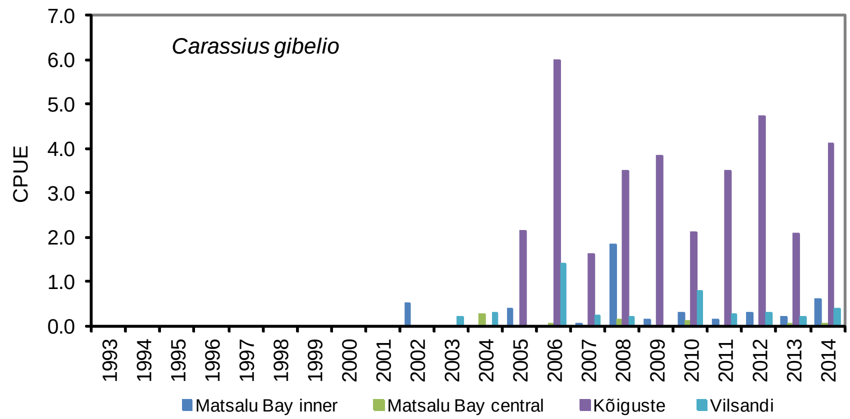


Figure 5. Catch index of the Chinese mitten crab *Eriocheir sinensis* (left panel) and percent contribution of the round goby *Neogobius melanostomus* (right panel) in experimental gillnet catches in Muuga Bay (Gulf of Finland, Baltic Sea) (Anon 2015).



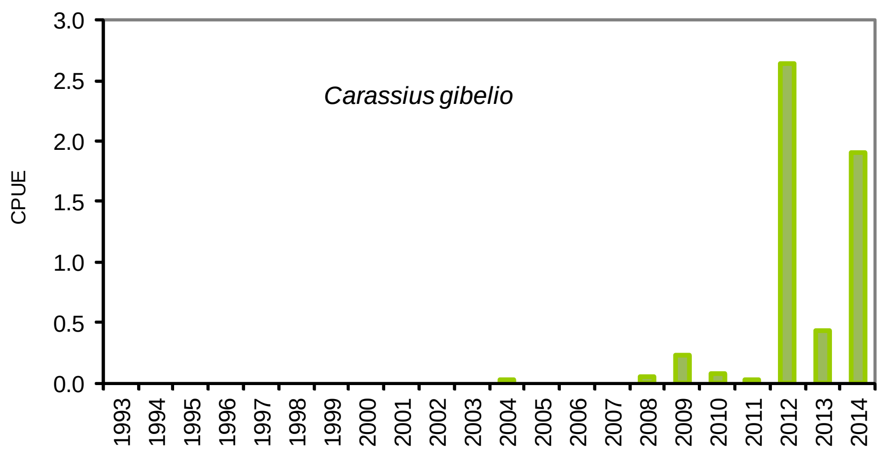


Figure 6. Catch per unit effort (CPUE) of gibel carp *Carassius gibelio* in various locations in Estonian coatsal sea: upper panel: Matsalu Bay (West-Estonian Archipelago Sea), Kõiguste (southern coast of Saaremaa in the Gulf of Riga), Vilsandi (west coast of Saaremaa Island) and lower panel: Käsmu (southern coast of the middle Gulf of Finland). Anon 2015.

Finland

Compiled by Maiju Lehtiniemi, Finnish Environment Institute and Lauri Urho, Natural Resources Institute Finland

Overview

One new alien species was identified from Finnish waters in 2014, when the white-finned gudgeon (*Romanogobio albipinnatus*) individuals were caught from the Saimaa Canal. The new gastropod species, found in 2013 in the Gulf of Finland, belongs to Murchisonellidae family. The species description is under way in international collaboration based on morphological and molecular characteristics. The round goby, *Neogobius melanostomus*, the gibel carp, *Carassius gibelio,* the grass prawn *Palaemon elegans,* and the mud crab *Rhithropanopeus harrisii* are still found to increase in abundance. Port monitoring was suggested to be included in the revised national monitoring programme but due to resource deficiency it has not been started. The ratification of the IMO's BWM Convention by Finland is still in the process and will hopefully take place in autumn 2015. The EU regulation on invasive species was taken into force 1.1.2015 and will be taken into the national legislation during 2015.

1. Regulations:

The EU regulation on invasive species was accepted in autumn 2014 and was taken into force 1.1.2015. The needed acts will be taken into the national legislation during 2015 and will be in force 1.1.2016.

Finland has been in the ratification process already years and is going to ratify the International Maritime Organization's International Convention for the Control and Management of Ships' Ballast Water and Sediments (the BWM Convention) in autumn 2015.

A scheme (parameters, stations/areas, frequency, methods) for alien species monitoring for Finnish waters was developed and suggested to be included into the national monitoring program in order to fulfill the requirements of the MSFD descriptor 2. This program also included the developed port monitoring program, which would serve in addition to the BWMC also MSFD. However due to resource limitations this monitoring program has not been started.

2. Intentional:

Deliberate releases into the Baltic Sea were (including rivers draining into the Baltic) for fisheries and fish stock enhancement purposes in 2014 as follows (all updated numbers 2014 not yet available):

No newly hatched and 1.4 million older salmon (*Salmo salar*), and

0.9 million newly hatched and 0.3 million older sea trout (*Salmo trutta* m. *trutta*),

something around 25,9 million newly hatched and 4.8 million older whitefish (*Coregonus lavaretus*).

Salmonids, mostly Rainbow trout (*Oncorhynchus mykiss*) were imported from Denmark, Sweden and USA for cultivation. Eels were imported from Sweden.

Rainbow trout were exported to Estonia, German and Sweden; whitefish (*Coregonus* spp.) to Sweden, Austria, Latvia and Italy; salmon to Sweden and Italy; grayling to Austria and German; sturgeons to German; arctic char to Austria (TRACES).

3. Unintentional:

Invertebrates:

A new gastropod species, which was found in the Gulf of Finland in 2013, belongs to tribe Murcinellidae. The species description is under way in international collaboration based on morphological and molecular characteristics.

There were changes in species abundance and distribution in established alien species.

The crustacean, mud crab *Rhithropanopeus harrisii* (first observed in 2009) has still continued to increase in abundance as well as in distribute on in the south-western archipelago of Finland. It has spread north from the Archipelago Sea and was the first time found in the Bothnian Sea, near Uusikaupunki in 2014 (Figure 1). Locally the species is so abundant that people report to collect hundreds of them from their own piers by small traps.

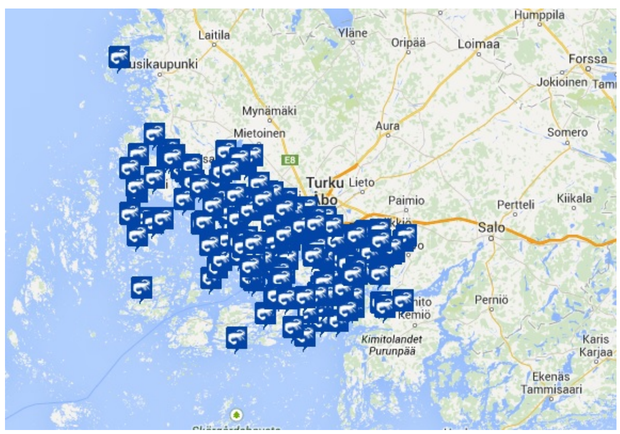


Figure 1. Observations reported through the alien species internet portal on the mud crab *Rhithropanopeus harrisii.*

The grass prawn *Palaemon elegans* (first observed in 2003) is abundant on the southern coast of Finland (Gulf of Finland) and in the Archipelago Sea. The species is not observed in the biological monitoring program and thus exact information on its abundance and distribution is very difficult to obtain.

The non-indigenous cladocerans *Cercopagis pengoi* (first observed in 1995) and *Evadne anonyx* (first observed in 2001) are widely distributed in the Gulf of Finland, and *C. pengoi* also in the Bothnia Sea. *C. pengoi* is most abundant in late summer and the variation between years in density is remarkable due to clear temperature dependence. In 2014 lower abundances were observed compared to previous years. Although *E. anonyx* is found in all sampling stations it is always less abundant than *C. pengoi.*

Fish:

The white-finned gudgeon (*Romanogobio albipinnatus*) was found from the Saimaa Canal. It is a transportation canal between Russia and Finland that connects the Lake Saimaa to the Gulf of Finland in the Baltic Sea. The species is also known from the eastern part of the Gulf of Finland (Russian side), where it was found already in 2005.

The round goby, *Neogobius melanostomus* continues to disperse. It is known to occur near several ports along the coast. During the last years, it has been caught in some areas between the ports, still near the shipping routes.

Previous Sightings

Not Seen Species Yet

The Amur sleeper, *Perccottus glenii*, has not been observed in Finnish waters, although it is known to occur in the Russian side of the Gulf of Finland. *Pontogammarus robustoides* (Sars) has not been observed in Finnish waters although it is common in the Estonian coastal sea in Narva Bay, and in the Russian waters in the eastern Gulf of Finland. *Paramysis intermedia* (Czerniavsky) has not been recorded either although it is present in the eastern Gulf of Finland.

4. Pathogens

No pathogen samples were taken in 2014 for NIS.

5. Meetings

National meetings concerning NIS monitoring with the Ministry of Environment, concerning EU proposal for a regulation on IAS with the Ministry of Agriculture and Forestry and concerning the BWMC with the Finnish Safety Agency.

Round goby workshop. Charlottenlund, Denmark, September 2014.

Benthic Ecology Meeting. 19.- 22.3.2014 in Jacksonville, USA: Puntila, R., Fowler, A., Riipinen, K., Lehtiniemi, M. and Vesakoski, O. 2014: Evaluating impacts of invasive Harris mud crab (*Rhithropanopeus harrisii)* predation on grazer community in the northern Baltic Sea. Oral presentation.

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France

Compiled by Amelia Curd and Philippe Goulletquer (Ifremer) with contributions from Jean-Claude Dauvin (CNRS – University of Caen), Patrice Francour (University of Nice Sophia Antipolis), Laurent Guerin (MNHN – Dinard), Frédérique Viard (CNRS – Station Biologique de Roscoff), Franck Mazéas (DEAL Guadeloupe), Jean-Philippe Maréchal (Marine Institute of Martinique), Herlé Goraguer & Laurence Miossec (Ifremer)

Highlights

The Interreg Marinexus project, which ended in 2014, has demonstrated the value of molecular tools in the early detection of non-indigenous species. During 2014, two non-indigenous hydrozoans (*Lovenella assimilis* and *Eucheilota menoni)*, two barnacles (*Hesperibalanus fallax, Balanus trigonus)* one crab species (*Percnon gibbesi),* one bryozoan *(Celleporaria brunnea)* and two species of tetraontidae (*Lagocephalus lagocephalus, Sphoroides pachygaster*) previously unrecorded in France have been identified. In the French Caribbean, a large scale monitoring and population control program of the lionfish species *Pterois volitans* and *Pterois miles* has been deployed. In the French Overseas territory of New Caledonia, species complexes of *Asparagopsis armata* and *Asparagopsis taxiformis* have been identified, as part of the genetic research carried out under the ERANET NETBIOME project SEAPROLIF. Coordination on a national level is needed between the forthcoming EU invasive alien species regulation and the ongoing Marine Strategy Framework Directive work on non-indigenous species.

1. Regulations:

The new regulation (n° 1143/2014) on invasive alien species was published in the Official Journal on 4 November 2014. It will enter into force on 1 January 2015. The regulation foresees three types of interventions; prevention, early warning and rapid response, and management. A list of invasive alien species of Union concern will be drawn up and managed with Member States using risk assessments and scientific evidence. This should coincide with the updating of the non-indigenous species list planned for the revision of both the Good Environmental Status (GES) definition under the Marine Strategy Framework Directive. The Commission Decision (2010/477/EU) on criteria and methodological standards on GES of marine waters is also being reviewed during 2015.

National guidelines are currently being drafted by the French Environment Ministry (MEDDE, 2015), in order to define risk assessments of NIS introductions through ballast water, in anticipation of the ratification of the International Ballast Water Management Convention.

2. Intentional:

2.1 Invertebrates

Mollusca

Summaries of the production per shellfish farming region of the Pacific Oyster *Crassostrea gigas* can be found in a report from the ministry of agriculture (Agreste, 2015).

3. Unintentional:

3.1 New Sightings

Cnidaria

Two non-indigenous hydrozoans, *Lovenella assimilis* (Browne, 1905) and *Eucheilota menoni* (Kramp 1959), have had their presence in the Eastern part of the English Channel and North Sea confirmed since 2007 (Brylinski *et al.*, 2015). Their taxonomy is under review, and their vectors of introduction have been identified as ballast water and ship fouling.

Crustacea

The non-native barnacle *Hesperibalanus fallax* (Broch 1927) has been confirmed as present in the Bay of Biscay (Morbihan, Loire Atlantique, Vendée - Charente Maritime) since 2008 (Gruet *et al.*, 2014). The first, sighting initially misidentified in Le Havre harbour, dates back to 1976 and is now confirmed. *Balanus trigonus,* also known as the triangle barnacle, has been found in the Sables d'Olonne harbour and offshore on the Rochebonne bank. Its presence in Brest harbor has also been confirmed as dating back to 2007 (Gruet, Vimpère & Viaud, 2014).

The sally lightfoot crab *Percnon gibbesi* (H. Milne Edwards, 1853) has been reported for the first time in Fautea, South Corsica, Mediterranean Sea (Sartoretto, pers.comm.)

Algae

Blooms of *Asparagopsis* algae in the French Ovserseas Territory of New Caledonia have been reported. Considering the taxonomic complexity of this genus with numerous cryptic clades identified, some of which are particularly invasive, molecular studies were carried out to examine the lineage(s) found in New Caledonia and other un-explored regions of the southern Pacific. This work was carried out as part of the ERA-NET NET-BIOME project SEAPROLIF (see "General Information" section) and was the subject of PhD by Laury Dijoux (defended in September 2014). Unexpected results were obtained (Dijoux *et al.* 2014): a new clade of *Asparagopsis armata* had been evidenced with a set of three different markers, thus supporting the hypothesis of an undescribed cryptic species within the nominal *A. armata* species. This new putative species is, so far, restricted to New Zealand-Australia-New Caledonia and appears to be in "its natural biogeographic range". A new lineage was also discovered in the same region in the *A. taxiformis* species complex. These results highlight the need for better surveying of unexplored regions and how molecular tools can help in examining the native vs. non-native status of proliferating taxa.

Bryozoa

The non-native bryozoan *Celleporaria brunnea* has been confirmed as present in Arcachon Bay since 2007 (André *et al.*, 2014). It was initially misidentified as *Celleporaria aperta.*

A paper by Harmelin (2014) has recorded fourteen non-indigenous species of bryozoans along the coast of Lebanon. These fourteen cheilostome species (one cryptogenic) were collected by diving in 17 locations. This set of exotic bryozoans comprises ten genera, including four previously unreported in the Mediterranean, while *Celleporaria* spp. is the most successful extra Mediterranean genus with four species in the survey collection. A new Celleporina species, *C. bitari* n. sp., also collected in the Red Sea, is described. Although lessepsian migration through the Suez Canal is the main pathway for exotic bryozoans in this region, the geographic origin of some species suggests that shipping through Gibraltar Strait is also responsible to a large extent (Harmelin, 2014).

Fish

Three specimens of *L. sceleratus* were captured (Kara *et al.* 2015) on the eastern coast of Algeria during the winter of 2013–2014. These are the first records of this invasive species in Algeria, providing further evidence of its occurrence along North African coasts and confirming its entry in the Western basin of the Mediterranean. It is therefore likely that its range will expand to the whole Western Mediterranean and possibly to French waters within a relatively short time span (6 months – 1 year) (P. Francour, pers. comm.). The consequences that this toxic fish may have for human health in this region are discussed in Kara *et al.* (2015).

Two further species of Tetraontidae, *Lagocephalus lagocephalus* and the (possibly) herculean *Sphoeroides pachygaster,* were caught in the south of France during the spring/summer 2014. Two *L. lagocephalus* specimens were caught, in Gruissan and Villefranche-sur-mer, in May and September 2014 respectively (P. Francour, pers. comm.). A *S. pachygaster* specimen was caught off near the port of Antibes in May 2014 (P. Francour, pers. comm.; Fronzes, 2014).

3.2 Previous Sightings

Ctenophora

The earliest records of *Mnemiopsis leidyi* were from surveys carried out in autumn 2005 in Le Havre harbour (Bay of Seine, EEC) and coincided with the historical introduction of the species in other Northern European waters. Since 2009, the species has also been frequently observed along the French coast of the North Sea. Results published in Antajan *et al.* (2014) indicate *M. leidyi* has established a self-sustaining population in the Bay of Seine, which may act as a source population for northern European harbours via commercial shipping.

Crustacea

A study by Gothland *et al.* (2014) presents the current distribution of a non-indigenous species, the brush-clawed shore crab *Hemigrapsus takanoi,* as well as the species population characteristics (size distribution and cohorts), based on a five-year survey (2008—2012) along the French coast of the English Channel. This species is currently found only in harbours and their vicinity; *H. takanoi* thus exhibited a discontinuous distribution along the 700 km of coastline. These results are discussed regarding sediment preference and potential introduction vectors. *Hemigrapsus takanoi* is now considered as established on the French coast and further studies are needed to evaluate the consequences of its introduction on the structure and functioning of the impacted shores.

A study by Pezy and Dauvin (2015) concluded that mussel beds are an important habitat for the settlement of the Asian shore crab *Hemigrapsus sanguineus.* A further paper by Pezy, Dauvin & Vincent (2015) indicated this habitat is also important for the settlement of the Chinese mitten crab *Eriocheir sinensis* juveniles. Seventy-one years of observations along the Normandy coast and in the Seine estuary, as well as in the ship-canals and inner seaport of Le Havre, have recorded a total of 65 individuals from this species at 33 locations.

Following the first sightings of the European green crab *Carcinus maenas* in Saint-Pierre and Miquelon in 2013, three new sightings were recorded in 2014, in the Grand Etang de Miquelon. As part of collaboration between the Department of Fisheries and Oceans (Canada) and Ifremer (France) on the monitoring of aquatic invasive species, a biologist from Bedford Institute of Oceanography visited the French overseas territory in November 2014, in order to recommend how the ongoing AIS monitoring can be improved.

Tunicata

The taxa known as *Ciona intestinalis* is composed of at least 4 cryptic species (Zhan *et al.* 2010), two of them occurring in sympatry in Brittany. Type B is native from the Northern Atlantic (incl. Brittany) whereas type A is supposed to be of Pacific origin and introduced into Europe. As part of the Marinexus programme and the ANR project HySea (coord. F. Viard), a PhD (Sarah Bouchemousse, supervised by F. Viard) was started in 2012 to study the hybridization processes between the two *Ciona* species that were found to be interfertile in laboratory. Bi-annual surveys carried out from 2012 and 2014 showed that the two species are co-existing in the wild with a higher relative proportion of the non-native species (up to 90% in some localities in Brittany) during autumn. Besides documenting the sustainable settlement of the non-native species, this study illustrates the importance to take into account the life cycle in monitoring protocols, in particular for short-lived species (Bouchemousse *et al.* submitted). Molecular studies showed that only a small number of adult specimens show traces of hybridization with type B, suggesting that efficient barriers to hybridization are acting in the wild.

Fish

In August 2014 a decree was signed by the appointed prefect to the Martinique region (French Caribbean) authorizing a list of 125 SCUBA divers to cull the two lionfish *Pterois volitans* and *Pterois miles* by means of a specialized spear (known as a"foëne"). This decision is part of an overall strategy to control lionfish populations being put into place by the regional directorates for the Environment (DEAL) for Guadeloupe and Martinique. A website dedicated to lionfish population control in the French West Indies http://www.poissonlion-antillesfrancaises.com/, by the Marine Institute of Martinique (OMMM). Information is available in both English and French. A monitoring program initiated by the OMMM in 2011 to monitor the invasion and adjust local control efforts has shown how fast lionfish have been able to invade new littoral areas, especially hard bottom habitats. Results are discussed in a study by Trégarot *et al.* (2015). Only three years after *P. volitan*s was first recorded in Martinique, and despite control measures to prevent the increase of lionfish population densities, in some areas maximum density has reached 1320 individuals per hectare, with a maximum fish size of 41 cm total length observed (Trégarot *et al.*, 2015). A book for the general public on the subject has recently been published (Rolland, 2015).

Angiosperms

Since its first recorded occurrence off the coast of Martinique in 2006 (Maréchal *et al.*, 2013), the tropical seagrass *Halophila stipulacea* has continued its range expansion throughout the eastern Caribbean islands, warranting further investigation into its ecological interactions with the indigenous seagrasses.

Algae

A recent paper by Peña *et al.* (2014) on the diversity of seaweeds on Atlantic European maerl beds recorded eleven non-native species already pervading NE Atlantic beds, with the most widely distributed species being *Bonnemaisonia hamifera* stadium *Trailliella intricata*. This census provides a baseline that can be used to assess changes to these habitats over the coming years.

3.3 General Information

The Marinexus project (http://www.marinexus.org; leader, M. Cock, Station Biologique de Roscoff) an interreg IV A project launched at the beginning of January 2010 and built upon a network of marine specialists from Plymouth (UK, lead) and Roscoff (France), ended in June 2014 (see website http://www.marinexus.org/ for deliverables and reports). Aquatic invasions were addressed in a dedicated work package (co-supervised by J. Bishop, MBA-UK and F. Viard, Roscoff-France). As the project has now ended, below is a summary of some of the major outcomes of the project regarding non-native species:

- Reports of new introduced species or taxa in European waters or the English Channel, for instance the tunicates *Asterocarpa humilis* (Bishop *et al.* 2013) and *Botrylloides violaceus* and *B. diegense*.
- Monitoring of non-native expansions and establishment in new locations for previously reported NIS in marinas, such as the bryozoans *Watersipora subtorquata*, as well as in natural habitats, for instance the kelp *Undaria pinnitifida*.
- The importance of seasonal monitoring for short-lived species in estimating the relative abundance of non-native species, as exemplified with the tunicate species *Ciona intestinalis* type A (Bouchemousse *et al.* submitted).
- The high prevalence of non-indigenous species in marinas of the Western English Channel with very similar lists of NIS in Brittany and Devon-Cornwall. An interesting outcome of these surveys were the rapid changes observed over 3 years, with an apparent cluster of new arrivals, seemingly starting in France but crossing over to England with a small delay (Bishop *et al.* 2015). These survey results are in line with genetic data showing a single origin at the English Channel level (e.g. *Botrylloides violaceus*, Viard *et al.* in prep.).
- The role of leisure crafts and ferries in promoting the spread of native and non-indigenous species. For instance a survey of 72 recreational boats in Devon and 50 boats in Brittany showed a mean number of 3.8 and 4.4 NNS per boat on average, respectively. Regional ferries were also shown to transport numerous species (most of them native or cryptogenic) on hulls and within ballast tanks.

- The value of a molecular approach in identifying or ascertaining the identification of new non-indigenous taxa and in tracing back introduction processes. This is exemplified with molecular barcoding tools (Bishop *et al.* 2013; Comtet *et al.* 2015).
- Effects of environmental changes on emblematic invaders were shown, for instance the encapsulation of *C. fornicata* embryos do not protect them against the deleterious effects of predicted pCO2 increase although C. *fornicata* larvae seemed less affected than other mollusk species (Noisette *et al.* 2014).

Altogether, this project showed the usefulness of regular surveys in targeted areas, including introduction hot-spots such as marinas. It also demonstrates that 1) new species are still recorded: surveys/monitoring efforts should thus be pursued without neglecting artificial habitats such as marinas, 2) cost-effective and easy-to use protocols are still needed for carry out accurate and efficient monitoring, 3) tools, and in particular DNA-based tools are needed, for instance to ascertain correct species identification.

The ANR project HySea (ANR-12-BSV7–0011; resp. F. Viard) started in November 2012 (ending in November 2016) is targeting the genomic processes involved in hybridization between related species that come into secondary contacts. This includes recent secondary contacts due to human-aided transportations. Among the non-native species targeted in this project are *Ciona intestinalis* type A (to be compared with *Ciona* type B) , *Crassostrea gigas* and *C. angulata*, in Europe. More information (in French only) can be found on the project website http://www.hysea-anr.fr/. An important aspect of this project is to improve links between evolutionary and ecological studies which are obviously complementary. The evolutionary-based approach, often neglected in surveys, is crucial to help predict and manage marine invasions (Rius *et al.* 2015).

The project SEAPROLIF (2012–2015; coord. C. Payri) is a project carried out under the ERA-NET programme NetBiome. This project aims to study macro-algal proliferations on coral reefs in several subtropical and temperate areas, using as a case study algae from the genus *Asparagopsis* with two cosmopolitan and introduced species. Field studies, chemical ecology and genetic/genomic studies are carried out. As part of the PhD work of Laury Dijoux, one outcome has been to further examine and discriminate among lineages and taxa, including those that were reported as proliferating in New Caledonia (see Asparagopsis spp. above) (Dijoux *et al.* 2014). More information as well as leaflets and posters can be found on the project web site: http://seaprolif.ird.nc/.

In April 2014, the IUCN Centre for Mediterranean Cooperation released today a new app for smart phones, and an online tool to help managers of marine protected areas (MPAs) control the spread of invasive species in the Mediterranean Sea. The application is supported by an online platform, which includes an identification guide of the most important invasive species found in the Mediterranean Sea. The online reporting system is based on a recent publication by IUCN in the context of the MedPAN North project (Otero *et al.*, 2013) which describes and maps around half a hundred species. The Smartphone's application is free and available in English, French and Spanish, and can be downloaded from: http://www.iucn-medmis.org

4. Pathogens

No new findings were reported since last year's meeting.

5. Meetings

Past year (2014)

AIS (Aquatic Invasive Species) Monitoring Atlantic Zone meeting. (Maurice Lamontagne Institute, Mont-Joli, Quebec, 4–6 February, 2014).

Interreg IVA Capitalization Event 3c Channel Catchment Cluster : Pegaseas. Marine non-native species monitoring: sharing best practice across the Channel (Plymouth, United Kingdom, 5–6 March 2014).

OSPAR Convention Meeting of the Intersessional Correspondence Group on the Coordination of Biodiversity Assessment and Monitoring (ICG-COBAM) (1) (Brussels, Belgium, 25–27 March, 2013)

ICES/CIESM Joint Workshop on *Mnemiopsis* Science (JWMS) (Coruña, Spain 18–20 September 2014).

OSPAR ICG-COBAM (2) (back to back with HELCOM CORESET II – 1 October 2014) (Gothenbürg, Sweden, 2–3 October 2014)

Sea Tech Week, 9th Marine Science Conference – Biofouling Day (Brest, France, 13 October 2014)

OSPAR ICG-COBAM (3) (Madrid, Spain, 2–4 December 2014)

Meetings in 2015

AIS (Aquatic Invasive Species) Monitoring Atlantic Zone meeting. (Maurice Lamontagne Institute, Moncton, New-Brunswick, 10–12 February, 2015).

OSPAR Convention Meeting of the Intersessional Correspondence Group on the Coordination of Biodiversity Assessment and Monitoring (ICG-COBAM) (Paris, France, 8–9 April, 2015)

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Germany

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Overview

Several projects are ongoing regarding non-indigenous species for the implementation of the EU Marine Strategy Framework Directive. Intentional species introductions remain at a similar level as last year.

A species of concern but not yet known from Germany is *Didemnum vexillum.* It is found in other European countries and it may be possible that this species becomes introduced to German waters with movements of living mussels and aquaculture gear or in the biofouling of vessels.

Content:

1. Regulations: An update on new regulations and policies (including, aquaculture and vector management)

As reported last year, the Platform for Information Exchange on Neobiota continues with approximately semi-annual meetings. This platform facilitates the exchange of information in the framework of the "Federal and States Marine Montitoring Programme" the national body that takes care of the duties arising from national and international obligations. This work includes the development of a trend indicator (rate of new invasions) and an impact indicator (invasiveness) for Descriptor D2 of the Good Environmental Status. The EU Marine Strategy Framework Directive (MSFD: 2008/56/EC) requires Member States to achieve or maintain Good Environmental Status (GES) by 2020. One of the key issues is how to identify the "bottom line", i.e. what is currently the number of alien species so that newly found aliens are "really" new introductions and not over-looked earlier introduced species. This is also important to answer questions like "Does vector management reduce the arrival of new alien species?"

To support the above mentioned activities a regular alien species monitoring programme was established along both, the German North and Baltic Sea coasts. A comprehensive summary of German coastal monitoring activities is available online at:

http://www.blmp-online.de/Seiten/Berichte.html

http://www.bsh.de/en/Marine_data/Observations/MURSYS_reporting_system/index.jsp

AquaEcology in cooperation with MariLim run a German EPA project to develop concepts and methods to determine and evaluate selected anthropogenic environmental pressures for the implementation of the EU Marine Strategy Framework Directive. The work addresses Descriptor 2 (NIS). The project ended in early 2014, but no report is yet available. For more information contact:

duerselen@aquaecology.de

Another pilot study ran until the end of 2014 to determine and evaluate non-indigenous species (Neobiota) after the EU Marine Strategy Framework Directive and HELCOM in coastal waters of Mecklenburg-Vorpommerns. For more information contact:

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Development of a Non Indigenous Species Trend Indicator for the MSFD in Germany, OSPAR, HELCOM and beyond

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The Marine Strategy Framework Directive (MSFD; 2008/56/EC) stipulated a set of "Descriptors" to assess the state of the marine environment. The goal of Descriptor 2 states that "Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems". The COMMISSION DECISION of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU) then lead to the development of a NIS Trend Indicator in Germany.

In 2009 a research and development project started to investigate potential introduction pathways, mainly harbors, with a "Rapid Assessment" monitoring program, that targets the macrofauna and -flora. The limitation to a single compound of the marine environment was deemed necessary, because other aspects like plankton or meiofauna are much harder or even impossible to identify to species level. Also, the rapid assessment was identified as the most cost-effective monitoring, with a potential to be established in a large number of European countries. Based on the NIS monitoring, a Trend indicator was developed to measure the rate of the introduction of new species to defined locations.

The indicator works with three parameters: species, inventory and dispersal. Most important is the species parameter, which measures the number of new arrivals to a location in a given time period. This parameter only is assessed in the result of the indicator, and the number is set back to zero at the beginning of the next period. Otherwise, a region with a high number of NIS not reaching GES (Good Environmental Status) would not be able to get any better. The inventory parameter records the whole set of NIS at a location over time and the dispersal parameter the spread of NIS from one location to another. Both give very relevant information for the state of the NIS population, but are not assessed for the indicator result to avoid a dilution of the indicator message.

At the combined Coreset-Cobam meeting in Gothenburg on 01.10.2014 ways for the development of coherent or integrated OSPAR and HELCOM MSFD Indicators were explored. The indicator best suited for a common approach was identified as the NIS Trend indicator. The experts present at the workshop agreed to try to develop a unified indicator concept. As a first step, the German concept was integrated to the OSPAR indicator (lead UK with Paul Stebbing, CEFAS) and the resulting "NIS3 Trends in arrival of new non-indigenous species" was adopted for promotion to "common" indicator in OSPAR regions II, III, and IV at BDC on 03.03.2015.

The next step is the integration of the OSPAR concept to the provisional HELCOM CORESET II Trend indicator, which, if agreed on, should be finished by mid-March and discussed by the relevant HELCOM groups in May. The task managers have been contacted with a proposal in late February. In June 2015 both HELCOM and OSPAR indicators are presented for final adoption at the HOD meetings of the Regional Sea Conventions. Finally, due to its basic and straight-forward concept the NIS Trend Indicators can also be adapted to the other RSCs (a representative of the Barcelona Convention already has expressed an interest during the Gothenburg workshop)and to marine regions outside of the EU.

2. Intentional:

No major changes since last year's National Report. The species which were imported earlier include Sturgeons, salmonid species, rainbow trouts, carps, *Crassostrea gigas, Homarus americanus* and the red alga *Palmaria palmata*.

Seed mussels (*Crassostrea gigas*) were imported to the northern Wadden Sea from Ireland, United Kingdom and the Netherlands.

3. Unintentional:

The planktonic copepod ***Oithona davisae*** was first recorded in Germany in 2008 (Sylt Island near List) and was found since then several times. The species identification was confirmed in 2014. It also seems to be able to reproduce in German waters as copepodite stages, males and females with egg sacks were found in 2014 (Cornils & Wend-Heckmann 2015).

One adult individual of the tropical ***Auxis rochei*** (bullet tuna) was caught 29. July 2014 in the Kiel Fjord as reported by a fisherman.

Rangia cuneata (Bivalvia) was first recorded 2013 in the Kiel Canal near Brunsbüttel (Lackschewitz *et al.* (in prep.)).

Pileolaria berkeleyana (Polychaeta) was first found at Helgoland in 2013 (Lackschewitz *et al.* (in prep.)).

The most up-to-date list of alien species in German coastal waters can be found at

www.aquatic-aliens.de/species-directory.htm.

Previous Sightings

The Chinese mitten crab (*Eriocheir sinensis*) was introduced to German waters already more than a century ago, but it was only shown now to transmit the crayfish plague pathogen (*Aphanomyces astaci*) (Schrimpf *et al.* 2014).

In summer 2012 *Himanthia elongata* (Bryozoa) was found on Helgoland on drifting macroalgae (Kuhlenkamp & Kind 2013), since it is searched for on several stations in the North Sea, but was not yet found (Kuhlenkamp pers. comm.).

Not yet seen species

One species of concern is *Didemnum vexillum*. This is found in European countries, but not yet known from the German coast. It may be possible that this species becomes introduced to German waters with movements of living mussels and aquaculture gear or in the biofouling of vessels.

4. Pathogens

No new findings were reported since last year's meeting.

5. Meetings

The Platform for Information Exchange on Neobiota had two meetings since the last WGITMO meeting and works towards a harmonized alien species monitoring programme to address the Good Environmental Status (GES).

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Greece

Prepared by: Argyro Zenetos, Maria Corsini-Foka & Maria- Antonietta Pancucci-Papadopoulou

Overview

In 2014, eight marine alien and cryptogenic species were reported for the first time from the Greek seas, two of them (the polychaete *Marphysa adenensis and the crab Actaeodes tomentosus*) being first records for the Mediterranean Sea. The new records include: the Indo-Pacific ascidian *Herdmania momus* from Kastelorizo Island; the shipworm *Teredothyra dominicensis* from the NE Aegean islands (Fourni island); the gastropod *Syrnola fasciata* and the polychaete *Marphysa adenensis* from Lesvos island; the xanthid crab *Actaeodes tomentosus* from Rodos isl.; the antenna codlet *Bregmaceros atlanticus* and the foraminiferal *Clavulina multicamerata* in Saronikos Gulf. The cryptogenic species *Acartia tonsa, which* had escaped our attention, is added to the list. In addition, 19 alien species have expanded their distribution in Greek waters, some of them such as *Penaeus aztecus* exhibiting invasive behaviour.

1. Regulations: An update on new regulations and policies (including, aquaculture and vector management)

The IMO BWMC ratification process is not yet finalized.

2. Intentional introductions

Nothing to report

3. Unintentional introductions

New alien species for Greek waters (Table 1)

1. ***Actaeodes tomentosus*** (H. Milne Edwards, 1834)

During biological surveys on the shallow rocky habitat of Rodos Island, two male *Actaeodes tomentosus* (H. Milne Edwards, 1834), were collected by hand at a depth of 2 m (Corsini and Kondylatos, 2015). The first crab was collected during daytime on 13 September 2013, at Kolimbia, the second sample was collected during night time on 20 October 2014 in Lindos Bay. The former was noted after a slight movement of small stones covered with algae, under which it remained strongly attached, hidden in a crevice, whereas the latter was found anchored to the surface of a rock. This finding is the first report of the species in the Mediterranean Sea.

2. ***Marphysa adenensis*** (Gravier, 1900)

The polychaete *Marphysa adenensis* (Gravier, 1900) was reported for the first time from the Mediterranean as a cryptogenic species (Katsiaras *et al.* 2014) in Sigri Bay, Lesvos island. It is known to occur mainly in Indian Ocean locations, e.g. in Madagascar and in the Gulf of Aden. In the area of Sigri Bay, one specimen of *M. adenensis* was discovered in soft substrate samples in the northern part of the bay.

3. ***Herdmania momus*** (Savigny, 1816)

The first occurrence of *Herdmania momus* (Savigny, 1816), from Greek territorial waters was observed during SCUBA diving in the semi-submerged "Blue Cave" in Kastelorizo Island in October 2010 (Gerovasileiou and Issaris, in Katsanevakis *et al.* 2014). More than 10 individuals were observed on a sciaphilic assemblage of the semi-dark cave dominated by encrusting calcareous rhodophytes, sponges, and scleractinians. The species has been previously reported as a cave-dweller from other eastern Mediterranean locations (Gewing *et al.* 2014).

4. ***Teredothyra dominicensis*** (Bartsch, 1921)

A single specimen of *Teredothyra dominicensis* (Bartsch, 1921) was found in a piece of driftwood recovered off the coast of Fourni Island (Greece) (Shipway *et al.* 2014). *T. dominicensis* has also been found in Kas, southern Turkey, during August 2010 and June 2011 on the shipwreck Uluburun III, approximately 36m below sea level (Shipway *et al.* 2014).

5. ***Syrnola fasciata*** (Jickeli, 1882)

The first occurrence of *Syrnola fasciata* (Jickeli, 1882), was noted in Hellenic territorial waters. Five specimens in total were collected at the macrofauna sampling stations in the northern part of Sigri Bay, Lesvos island (Evagelopoulos *et al.* 2015). The species is considered as established in the study area.

6. ***Clavulina cf. C. multicamerata*** (Chapman, 1907)

Clavulina multicamerata (Chapman, 1907), is a tropical Indo-Pacific benthic foraminiferal species. Meriç *et al.* (2008) has described *Clavulina* cf. *multicamerata* from the eastern Mediterranean (south-western coast of Turkey). A very rare presence of *Clavulina* cf. *multicamerata* has been reported from Saronikos gulf, sampled on January 2012 at the depth of 90 m, in the framework the EU FP7 PERSEUS: Policy-Oriented Marine Environmental Research for the Southern European Seas (Triantaphyllou and Dimiza, in Katsanevakis *et al.* 2014). Sediments at the sampling site are characterized by relatively high mud percentages and high occurrence of *Bolivina* spp. and *Nonion fabum*.

7. ***Bregmaceros atlanticus*** (Goode & Bean, 1886)

On July 31st 2014, a female individual identified as *Bregmaceros atlanticus* (Goode & Bean, 1886), was caught in the area of Saronikos Gulf (depth 90–91 m), and on August 2nd 2014, another seven individuals (three female and four male) were caught in the same general area (Dogrammatzi and Karachle , in Zenetos *et al.* 2015a). The origin of *B. atlanticus* in the basin remains unclear and further investigation is needed in order to clarify whether it was previously overlooked, introduced, or, as other fishes recently reported in the Mediterranean, just a "repatriated" species (Por 2009).

8. *Acartia tonsa* (Dana, 1849

The calanoid copepod *Acartia tonsa* (Dana, 1849) was first registered in the framework of a project run by the Technological Institute of Ipeiros, aiming at studying the secondary production in the water column with emphasis on copepods at the Amvrakikos lagoons (Tsoukalio, Rodia). It was discovered for the first time in 2005 (Cladas *et al.*, 2010). Its abundance throughout the winter period, switching its dominance with the calanoid *Calanipeda aquaedulcis* during summer.

Table 1. Details on the new records for Greece. * denotes first record for the Mediterranean

Species name	Collection date	Co-ordinates /location	source
**Marphysa adenensis*	15.9.2009	39.07° N, 26.47° E 39.02° N, 26.53° E 39.09° N, 26.60° E	Katsiaras *et al.* 2014
Herdmania momus	Oct. 2010	36.13° N, 29.58° E	Gerovasileiou and Issaris, in Katsanevakis *et al.* 2014
Teredothyra dominicensis	NA	Fournoi Ikarias	Shipway *et al.* 2014
Syrnola fasciata	2013	39.22° N, 25.86° E 39.22° N, 25.85° E	Evagelopoulos *et al.* 2015
**Actaeodes tomentosus*	20.10.14 13.9.13	36.10° N, 28.09° E 36.27° N, 28.20° E	Corsini and Kondylatos, 2015
Clavulina cf. *multicamerata*	2012	37.53° N, 23.32° E	Triantaphyllou and Dimiza, in Katsanevakis *et al.* 2014
Bregmaceros atlanticus	2.8.14 31.7.2014	37.50° N, 23.20° E 37.51° N, 23.30° E	Dogrammatzi and Karachle, in Zenetos *et al.* 2015a
Acartia tonsa	2005	Amvrakikos lagoons: Rodia, Tsoukalio	Cladas *et al.* 2010

Establishment and Range expansions within 2014 (Table 2)

The input of information on alien occurrence acquired, filtered by experts and inserted into the ELNAIS Database (Zenetos *et al.* 2015b) allows continuous update of alien establishment and range expansion in the Hellenic waters, including also smaller islands, giving consequently great contribute to fill alien distribution gaps in the complex underwater habitats of the Aegean and Ionian Seas.

Of the species reported in ELNAIS website (http://elnais.hcmr.gr) and recent literature (Table 2) worth mentioning is the shrimp *Penaeus aztecus* first reported in Greece as *Farfantepenaeus aztecus (Ives, 1891) from North Aegean (*Nikolopoulou *et al.* 2013). Since then, the species appears to be well established in the North Aegean (Kevrekidis 2014; Minos *et al.* 2015) and has been documented in other Greek Seas such as the Ionian (Kapiris *et al.* 2014), South Aegean (Zenetos *et al.* 2015a) and central Aegean (Minos *et al.* 2015)

Caulerpa cylindracea and *Stypopodium schimperi* continue to expand their distribution (see ELNAIS maps in Zenetos *et al.* 2015b)

Other records include:

- *Cerithium scabridum*. The record from Lesvos island fills a gap in its distribution in the east Aegean Greek waters (Evagelopoulos *et al.* 2015). It was recorded only from Rodos isl. (Zenetos *et al.* 2009).
- *Erugosquilla massavensis*. The present finding reveals significant expansion in the Aegean, from south-outheast westward, to Saronikos Gulf.
- *Fistularia commersonii*, abundant-invasive in the South Aegean, was observed in the Ionian Sea (Kyllini, West Peloponnisos). In addition it was reported as widespread in Lipsi isl. (Servonnat and Drakulić, in Zenetos *et al.* 2015a).
- *Halophila stipulacea*. Its northernmost expansion and establishment in the eastern Aegean Greek waters was documented by Evagelopoulos *et al.* (2015).
- *Lagocephalus sceleratus*. Multiple records of small and young specimens, in South Peloponnisos, Lakonikos Gulf, between Aegean and Ionian Seas, indicate an evident population explosion in the area during summer.
- *Melibe viridis* exhibits a range expansion from central-western and south-western Aegean to southeastern Aegean, Rodos isl. (Kondylatos and Corsini-Foka, in Zenetos *et al.* 2015a).
- *Penaeus hathor* appears to have a rapid expansion in Greek waters from the Levantine waters of Kastellorizo up to the western Aegean, Saronikos (Kapiris and Chalari, in Zenetos *et al.* 2015a).
- *Pinctada imbricata radiata* seems to be widespread, from the Aegean to the Ionian Sea (Kefalonia island) and Maliakos Gulf (North Aegean) (Theodorou and Tzovenis, in Zenetos *et al.* 2015a).
- *Septifer cumingii*, as well as *Smaragdia souverbiana* already known from the south Aegean, were reported from the North Aegean Sea (Lesvos island) (Evagelopoulos *et al.*, 2015).
- *Siganus luridus* was collected in the Ionian Sea (Kerkyra isl).
- *Torquigener flavimaculosus* known from Rodos isl., appears to be established in NE Kriti isl.
- *Synaptula reciprocans,* which seemed to be limited to the Dodecanese islands, area was photographed from Kriti isl.

- *Lagocephalus sceleratus, Sargocentron rubrum* and *Stephanolepis diaspros were recorded* around Lipsi island (Aegean Sea, Greece) (Ríos and Buchet, in Zenetos *et al.* 2015a; Servonnat and Drakulić, in Zenetos *et al.* 2015a).

Table 2. Range expansion of already known alien species in Greek waters.
NA= Non Available info

Species name	Collection date	Location	Co-ordinates	Source
Asparagopsis taxiformis	19/05/2014	Kriti isl. : Irakleion	35.34°N, 25.13°E	Poursanidis and Tsiamis, in Katsanevakis *et al.* 2014
Cerithium scabridum	2013	Sigri Bay, Lesvos isl.	39.22°N, 25.85°E	Evagelopoulos *et al.* 2015
Erugosquilla massavensis	1/7/2014	Saronikos Gulf: Alimos	NA	ELNAIS, 2014: K. Charalambous
Fistularia commersonii	15/10/2014	Kyllini, West Peloponnisos, Ionian Sea	NA	ELNAIS, 2014: M. Giavasi
Fistularia commersonii	July-August 2014	Lipsi Island	37.17° N, 26.45° E	Servonnat and Drakulić, in Zenetos *et al.* 2015a
Halophila stipulacea	2013	Sigri Bay, Lesvos isl.	39.22°N, 25.84°E 39.21°N, 25.85°E 39.22°N, 25.85°E	Evagelopoulos *et al.* 2015
Lagocephalus sceleratus	Summer 2014	Githio, Kotrona, Skoutari, Kokkaka, Lakonikos Gulf	NA	ELNAIS NEWS: E. Sotiropoulou
Lagocephalus sceleratus	2014	Lipsi Island	37.30°N, 26.75°E	Ríos and Buchet, in Zenetos *et al.* 2015a
Melibe viridis	14/9/2014	Faliraki, Rodos isl.	36.34°N, 28.21°E	Kondylatos and Corsini-Foka, in Zenetos *et al.* 2015a
Penaeus atzecus	Nov 2013	Kerkyra isl.	39,62°N, 20,10°E	Kapiris *et al.* 2014
Penaeus aztecus	1/11/2014	Chalki isl.	36.24°N, 27.62°E	Kondylatos and Corsini-Foka, in Zenetos *et al.* 2015a
Penaeus aztecus	Nov 2013	Thermaikos: outer Gulf	NA	Kevrekidis 2014
Penaeus aztecus	Dec 2013	Nestos estuary	NA	Minos *et al.* 2015
Penaeus aztecus	NA	Argolikos gulf	NA	Minos *et al.* 2015

Penaeus hathor	November 2014	Flisvos area (Saronikos Gulf)	37.92ºN, 23.69ºE	Kapiris and Chalari, in Zenetos *et al.* 2015a
Percnon gibbesi	1/9/2014	Kefalonia isl.: Lixouri	NA	ELNAIS NEWS: A. Zenetos
Pinctada imbricata radiata	1/9/2014	Kefalonia isl.: Lixouri	NA	ELNAIS NEWS: A. Zenetos
Pinctada imbricata radiata	2005	Agios Ioannis, Maliakos Gulf	38.89°N, 22.66°E	Theodorou and Tzovenis, in Zenetos *et al.* 2015a
Sargocentron rubrum	April to November 2014	Lipsi Island	37.30°N, 26.75°E	Ríos and Buchet, in Zenetos *et al.* 2015a
Septifer cumingii	2013	Sigri Bay, Lesvos isl.	39.22°N, 25.85°E	Evagelopoulos *et al.* 2015
Siganus rivulatus	20/8/2014	Kerkyra	NA	ELNAIS NEWS: Y. Cladas
Siganus luridus	20/8/2014	Kerkyra	NA	ELNAIS NEWS: Y. Cladas
Smaragdia souverbiana	2013	Sigri Bay, Lesvos isl.	39.22°N, 25.84°E 39.22°N, 25.85°E	Evagelopoulos *et al.* 2015
Stephanolepis diaspros	July-August 2014	Lipsi Island	37.18°N, 26.45°E 37.17°N, 26.45°E 37.19°N, 26.43°E	Servonnat and Drakulić, in Zenetos *et al.* 2015a
Synaptula reciprocans	11/04/2014	Kriti isl., Loutro Sfakion Chania	NA	ELNAIS NEWS: D. Poursanidis
Torquigener flavimaculosus	10/9/2014	Sitia, NE Kriti	NA	ELNAIS NEWS: Y. Issaris

Notes for SE Aegean (see also Corsini-Foka *et al.* 2014):

Torquigener flavimaculosus. All sizes are common since 2013 in fishing gears from the coastal waters of NE and NW Rodos isl. Large population also on *Halophila stipulacea* meadows, Tourist Port of Rodos, summer 2014.

Gonioinfradens paucidentatus, abundant-invasive at local level of Rodos isl., since 2013.

Lagocephalus sceleratus. Abundant in certain hauls in Rodos isl. coastal waters, generally common in all types of fishing gears. Economic negative impact continues to be of large dimensions in the area.

Siganus luridus, Siganus rivulatus, Fistularia commersonii. Always abundant and/or common in fishing gears in Rodos isl. coastal waters, 2014. *Siganus luridus, Siganus rivulatus* are, since long, of commercial value.. *F. commersonii* was present in fish market of Rodos in 2014.

Apogonichthyoides pharaonis, common in Rodos isl. coastal waters, 2014. [Very young specimens at 0.5m depth, winter 2014–2015].

Pempheris rhomboidea (ex *P. vanicolensis)*. Very young specimens at 0.5m, collected by hand, in Chalki isl. (November 2014).

Portunus segnis. Common in Rodos. It was seen at the local fish market in 2014.

Penaeus pulchricaudatus (ex *Marsupenaeus japonicus*). Common in Rodos.

Pteragogus trispilus (ex *P. pelycus), Sargocentron rubrum, Stephanolepis diaspros.* Always abundant and/or common in fishing gears in Rodos isl. coastal waters, 2014. No commercial value.

Conomurex persicus. Very abundant in Rodos. Frequently present now in Tavernas.
Upeneus pori. Common now in Rodos.

4. Website

The Ellenic Network on Aquatic Invasive Species based at the Hellenic Centre for Marine Research (HCMR) , which has been operational since 2007 was revised. The new ELNAIS site (ELNAIS: http://elnais.hcmr.gr/), is developed in the free open source WordPress web software. ELNAIS initially included nine Research Institutes/Universities and more than 34 Greek scientists who carry out research relating to aquatic alien species. Presently, the experts' registry counts 77 experts (see experts details: http://elnais.hcmr.gr/experts/) from 14 Research Institutes/Universities/NGOs (see ELNAIS Sites Map: http://elnais.hcmr.gr/map.jpg). The ELNAIS on-line information system on aquatic alien species is freely accessible to all including policy makers and scientists who can download the latest publications, programs and results.

The underlying database is updated operationally (as new data becomes available) and updates are regularly published. By December 2014 the ELNAIS list included a total of 322 aquatic species 239 marine, and 83 freshwater and/or brackish). Details on the data providers and examples of distribution maps are presented in Zenetos *et al.* (2015b).

5. Pathogens

Nothing to report.

6. Meetings

In the framework of the COST 1209 'Aliens Challenge' Action, a Training school was organized in Rodos isl, Greece 7–11 April 2014. The School included 1) overview on NIS all over the Med and European Seas, Vectors of introduction, Impact of most Invasive Species, Legislations at National and European level, Management- Early Warning System, Running projects, Networks, state of art in Rodos, 2) Field trips (fishing, rapid assessment of epifouling on artificial structures, snorkeling), 3) Lab work, 4) analysis and divulgation of results at local level.

'Biological Invasions' was one of the main topics at the 7th National Congress of Ecology, organized by the Hellenic Ecological Society. The Congress, which was entitled "***Ecology: linking systems, scales and disciplines***" took place on the campus of the University of Aegean at Mytilene (Lesvos Island, Greece) from the 9th to the 12th of October, 2014. http://www.helecos.gr/en/activities/helecos-congresses/7th-congress

In the frame of the 11th Symposium of Oceanography & Fisheries, that will take place in Mytilene, Lesvos Island, Greece (13–17 May 2015), there is a session with 6 oral presentations on non-indigenous species, as well as several posters on the same subject. The oral presentations are scheduled on **Saturday 16/5** (12.30–14.00 hours), whereas the posters will be on display through out the symposium.

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Italy

Note: This report is the outcome of a special working group of the Italian Marine Biology Society (SIBM) on a voluntary basis. It does not reflect an official position or knowledge of the relevant Italian Government bodies.
It has been prepared according with the guidelines for ICES WGITMO National Reports; it updates the Italian status of 2014.

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Overview

Two new species of algae, one polychaete, one bryozoan and two new species of fish have been added to the list of non-indigenous species recorded along the Italian coasts. A few already established species continued to extend their distribution. The ecology of native vs introduced Ascidians has been studied, and analyses of spreading *Fistularia commersonii* have been performed. A session of the Italian Marine Biology Society Congress has dealt with alien species and provided updated information on their distribution and ecology. Differences in the colonization by NIS in marine protected areas and adjacent ones did not show any advantage by protection.

1. *Regulations: An update on new regulations and policies (including, aquaculture and vector management)*

No information.

2. *Intentional introduction*

No new intentional introductions have been reported.

3. Unintentional introduction

New Sightings

<u>Algae & higher plants</u>

The use of DNA barcoding has allowed Armeli Minicante *et al.* (2014) to identify and report two new alien macroalgae of Japanese origin along Italian coasts*: Ulva ohnoi* (Chlorophyta, Ulvales) and *Pyropia yezoensis* (Rhodophyta, Bangiales). Samples of *Ulva ohnoi* were collected in Cape Peloro Lagoon (Messina, Sicily). This is the first time the species has been found in the field: in fact *U. ohnoi* was previously isolated by Flagella *et al.* (2007) only in a sample taken in a ballast tank of a ship visiting the Port of Salerno and coming from Port Said (see Italian national Report of 2005). Samples of *Pyropia yezoensis* were collected in Venice Lagoon in March 2010.

Encrusting colonies of the ascophoran bryozoan *Celleporaria brunnea* were detected in samples collected in the 2010 and 2011 in the harbours of La Spezia, Olbia and Lampedusa during a survey aimed at studying non-indigenous species in Italian harbours and marinas. These findings represent the first sightings of the species in Italy and in the western Mediterranean Sea (Lodola *et al.*, in press)

Presumably native to the Pacific coasts of North America, *C. brunnea* was first recorded in the Mediterranen Sea in the inner part of Izmir Bay near Alsancak harbour (Turkey) in 2004 and later reported along the Lebanese coasts (Harmelin *et al.*, 2009; Harmelin, 2014). It was recently detected in Cascais marina in Portugal (Canning-Clode *et al.*, 2013) and also in the Arcachon Basin (France) (see French national Report 2014). Hull fouling is the most likely vector. The species may be expected to appear soon in other harbours of the Mediterranean basin.

<u>Invertebrates</u>

Atzori *et al.* (2014) found the orbiniid polychaete *Naineris setosa* in aTyrrhenian lagoon, Santa Gilla, (southern Sardinia) in samples taken during September 2013, December 2013 and April 2014.
This species is native to the subtropical-tropical American area and was first found in Bermuda and is now well-distributed in the north-western Atlantic. It has been recorded twice in the Mediterranean area. Indeed, in 2011, *N. setosa* was reported for the first time in a closed aquaculture facility (and not registered for this reason in the Italian National Report) in Brindisi, Adriatic Sea (Blake and Giangrande, 2011). The second occurrence was recorded by Khedhri *et al.* (2014), in Boughrara lagoon (Tunisia).

<u>Fish</u>

The blackbarred halfbeak *Hemiramphus far,* an Indo-Pacific species, distributed from the Red Sea and the Indian Ocean to the Samoan Islands, was recorded for the first time in the Mediterranean (Palestine) in 1927, moving both northwards to Lebanon, Syria, Turkey and the Aegean Sea, and westwards from the Gulf of Suez to the eastern Libyan coasts, Tunisia and Algeria. In January 2013, about 70 specimens of *Hemiramphus far* of similar size were caught in the coastal waters of Lampedusa Island (Straits of Sicily. A single capture of a larger individual also occurred in the summer of the same year (Falautano *et al.*, 2014).

The silver-cheeked toadfish *Lagocephalus sceleratus* is considered one of the most toxic representatives among pufferfish. This species, native to the tropical Indo-West Pacific Ocean, is a lethally-poisonous invasive guest in the Mediterranean. In October and November 2013, two *L. sceleratus* specimens were caught at Lampedusa Island at a depth of 20 m, on a sandy/seagrass bottom (Azzurro *et al.*, 2014a). In January 2014, another specimen of *L.sceleratus* was caught with a trammel net by fishermen in Avola, near Syracuse (south-east Ionian Sea) (Tiralongo & Tibullo, 2014).

Previous Sightings

<u>Algae & higher plants</u>

A review of the information on alien microalgae, updating the findings of *Alexandrium catenella* and *Ostreopsis ovata* in Italy, has been published by Penna (2014), and highlights the difficulties in the taxonomy of these organisms. Densities of *A. catenella* in a three-year monitoring programme in Syracuse harbour, on the Ionian coast of Sicily, reached

2.5–3 x 10^6 cells l^{-1} on April 26, 2012, together with high densities of *A. minutum* (1.2 x 10^6 cells l^{-1}) (Giacobbe *et al.*, 2012, 2014).

Thalli of *Asparagopsis armata* from Linosa Island (Sicily Channel) were investigated for the presence of associated microfungi. Only 5 species of epiphytic microfungi and no fungal endophytes were associated with the invasive red alga (Garzoli *et al.* 2015).

Within the framework of the Flagship Project RITMARE, Cecere *et al.* (2014) studied alien seaweeds in the areas of Taranto and Naples. They reported the finding of *Codium fragile* subsp. *fragile* from the Miseno Lake, a coastal lagoon near Naples.

The study of a regressed meadow of the seagrass *Posidonia oceanica* from a series of historical data, spanning over a period of 25 years (1987–2012) around the island of Bergeggi (near Savona, Ligurian Sea), has shown re-colonization by either native or alien substitutes. The meadow experienced a great decline through time, accompanied by the replacement of *P. oceanica* by the other common Mediterranean seagrass *Cymodocea nodosa* and the alien green alga *Caulerpa racemosa*, leading to an ecosystem phase shift. The meadow has shown signs of recovery in recent years, while unpredictability on the effects of alien substitutes does not permit us to foresee future conditions (Oprandi *et al.*, 2014).

The slender strain of *Caulerpa taxifolia* var. *distichophylla*, recorded in one Sicilian locality (Punta Braccetto) in 2008, was monitored in the same area in 2012 and 2013 (Musco *et al.*, 2014). The seaweed colonized both natural and artificial rocky bottoms, where it often co-occurred with *C. cylindracea.* The invader alga was most abundant on dead matte of *P. oceanica* and was the dominant algal species. In addition, it was recorded in 2 out of 22 sites monitored along the Sicilian shores, one of which was located on the south-western coast (Strait of Sicily), and the other on the northern one (Tyrrhenian Sea).

The application of a Geographic Profiling technique proved to be effective in assessing the spreading origin of the *Caulerpa* invading species in the Mediterranean. This method, used in criminology, was calibrated with the distribution data of *Caulerpa taxifolia*, whose spread in the Mediterranean Sea is known to have started from the aquarium of Monaco (Papini *et al.*, 2013). The application on *Caulerpa racemosa* var. *cylindracea* showed that the probable spreading center of the alga is located in western Sicily for the Mediterranean (Musco *et al.*, 2014).

<u>Invertebrates</u>

Bertolino *et al.* (2014) report an expansion of the calcareous sponge *Paraleucilla magna* in the Ligurian waters and in the coastal Lake of Faro, near Messina (Sicily).

The opistobranch *Bursatella leachii* has established abundant populations on the northern Sardinian littoral in the region of Olbia. A local vet reported the death of four dogs, having apparently ingested stranded individuals, and probably being intoxicated by algal toxins accumulated by the molluscs (A. Manunta, personal comm.). *Haminoea cyanomarginata* has expanded its distribution from the Calabrian shores to 3 localities in Sicily, including Pantelleria Island (Stasolla *et al.*, 2014). The same Authors also report the finding of *Melibe viridis* and *Pinctada imbricata radiata* in Sardinia.

Deidun *et al.* (2014) provided morphometric characterization of populations of the bivalve *Pinctada radiata* in Maltese waters.

Tapes philipphinarum is a sediment-feeder and filter-feeder: the potential risk of dioxin (PCDD/F) and dioxin-like PCB (DLPCB) bioaccumulation has been studied by Sfriso *et al.* (2014) in two contaminated areas of the Venice lagoon. The final concentrations were much lower than the legal limit; the main contaminant source is the suspended matter.

In August 2013, several specimens of *Callinectes sapidus* were collected by local fishermen at two sites on the border of the Basilicata and Apulia regions, Ionian Sea (Stasolla & Innocenti, 2014). Both sites are characterized by brackish water and sandy bottoms. These reports confirm the evidence of fully established populations of *C. sapidus* at least in the Adriatic Sea and the Ionian Sea.

In the same paper, Stasolla & Innocenti (2014) also report the presence of an ovigerous female of *Percnon gibbesi* in June 2012, at a depth of 1 m, in the Integral Natural Reserve of Montecristo Island in the Tuscan Archipelago. Although this species does not seem to have established viable populations along the Tuscan coastline, the presence of an ovigerous female in the Island of Montecristo could represent a stage in the ongoing spread of this successful invader.

Six specimens of the oriental shrimp *Palaemon macrodactylus* were collected in the Venice Lagoon (north Adriatic Sea) in a shallow water habitat near the Malamocco sea inlet, during May 2012 (Cavraro *et al.* 2014). A well-established population of *P. macrodactylus* was confirmed by data from Cuesta *et al.* (2014). Several adults were collected in 2013 in brackish habitats in the Grado and Marano Lagoon, in the Sacca di Goro, and in one station off the Po Delta.

In summer 2008, Airoldi *et al.* (2015) surveyed assemblages of ascidians at 22 coastal sites, representative of about 200 km of hard substrata along about 500 km of coastline. The survey was designed to comprise sites on both natural reefs and artificial habitats. Differences in the structure and distribution of assemblages of ascidians were analysed in relation to habitat type, characteristics and location using mixed-model asymmetrical analyses. Out of the 30 ascidian species identified, 19 are native to the Mediterranean Sea, whereas 4 (*Diplosoma listerianum, Clavelina lepadiformis, Ascidiella aspersa, Styela plicata)* are considered NIS by the authors and 3 cryptogenic (*Ciona intestinalis, Botryllus schlosseri, Botrylloides leachi)*. Four taxa were determined to genus level. Assemblages of ascidians differed significantly between natural and artificial habitats, regardless of their location or characteristics. Compared with artificial habitats, natural reefs had significantly larger species richness and abundance of native species, while NIS and cryptogenic species were generally scarce. The species composition of assemblages in artificial reefs was more similar to that of marinas than of natural habitats. Most native species of ascidians were virtually absent from any artificial habitats for coastal defense built along the extensive sandy coastlines of the North Adriatic Sea, despite the fact that many of these structures have been in this region for more than 60 years. In these man-made systems, NIS may have an advantage over natives, leading to regional-scale changes in their relative abundances.

<u>Fish</u>

Preliminary data on age, growth and diet of the bluespotted cornetfish *Fistularia commersonii* in the central Mediterranean Sea (4 sites around Sicily) have been reported by Castriota *et al.* (2014). The fish showed piscivorous behaviour, focusing mainly on labrids, clupeids and sparids. Prey composition suggests that bluespotted cornetfish explore various habitats for hunting. Prey fish were mainly juveniles and their size showed positive correlation with predator size. The analysis of growth rates indicates that it is a fast-growing species (k = 0.49 year^{-1}). Regarding weight-length relationship, the results show positive allometry, indicating that bluespotted cornetfish becomes heavier for its length as it increases in size. By means of vertebrae readings, the age of *F. commersonii* was estimated as between 2 and 4 years, within the size range of examined specimens (the majority ranged from 75 to 85 cm).

A comprehensive survey of *Fistularia commersonii* records has been published by Azzurro *et al.* (2013b) covering the period from its first detection in the Mediterranean Sea in January 2000 to October 2011. A total of 191 observations were used to reconstruct the invasion sequence, to provide estimates of the rate of spread, and to construct an environmental suitability model. *F. commersonii* has been able to colonize almost the entire Mediterranean region in only a few years after its first sighting: few examples of this kind are available for marine fish worldwide. The three most important variables, explaining around 80 % of the variance in the model, were depth, chlorophyll-a concentration and salinity, indicating that the bluespotted cornetfish invades coastal areas of average biological productivity and high salinity, and avoids highly productive areas, such as the northern Adriatic or the Gulf of Lions, as well as highly oligotrophic areas, such as the Libyan coasts. Information on the reproductive cycle of *Fistularia commersonii* were provided by Bariche *et al.* (2013), including reproductive parameters, gonad morphology and spawning pattern in its exotic environment. The cycle is characterized by a prolonged reproductive season, a multiple spawning pattern, and good conditions during reproduction.

Species not yet seen

Two established populations of the amphipod *Paracaprella pusilla*, originally described in Brasil, were found in Mallorca and Ibiza during a survey of caprellid amphipods carried out in 2011 - 2012, in marinas along the Balearic Islands by Ros *et al.* (2013). It is the first Mediterranean record of this species, probably introduced by ship fouling. The authors compared the reproductive traits of *P. pusilla* with *Caprella scaura,* found during the same survey and known to be very invasive. *P.pusilla* showed a higher fecundity than *C. scaura* for the same female size: taking into account this evidence, the species may be expected to appear in other Mediterranean areas. In actual fact, it has already been found (in Israel in March 2014) living on floating colonies of the bryozoan *Bugula neritina* (Ros *et al.*, 2015).

Natural range expanding species

According to molecular studies conducted on the Mediterranean specimens (Valdés *et al.*, 2013), *Aplysia dactylomela* originates from the Atlantic, and entered naturally in the Mediterranean. Sicilian records of this species till now include the eastern Sicilian shores from Messina to Syracuse. A total of 18 specimens were found in a new Sicilian locality along the coasts of the Island of Favignana (Egadi Islands marine protected area, western Sicily) in July 2013. Furthermore, in August three specimens of *A. dactylomela* were recorded in the Island of Marettimo, the furthest island of the Egadi Islands (Mannino *et al.*, 2014)

The genus *Kyphosus* is present in the Atlantic, on both eastern and western coasts, with two sister species, *K. sectatrix* and *K. incisor,* which cannot be easily recognized, as they differ only by meristic characters. As a result, the presence of *K. incisor* was underestimated. The first Mediterranean record of *K. incisor* was based on two adult specimens caught at Portofino in 2009 (Orsi Relini *et al.*, 2010) and a second record (Azzurro *et al.*, 2013c), in the form of a smaller specimen stored in a freezer in 1998 (which had been caught eleven years earlier in the Alboran Sea). The two sister species of *Kyphosus* are often associated in the Mediterranean (Orsi Relini, 2014).

The opah *Lampris guttatus* is a rare species with worldwide oceanic distribution in tropical to temperate waters including the Mediterranean, where documented records exist from Italy (Ligurian Sea and Tyrrhenian Sea), Spain, the Balearic islands, Adriatic Sea, Greece (Aegean Sea), Algeria, French Mediterranean coast of Provence, and Corsica. Therefore, it should be considered a native species, contrary to the classification of expanding species given in the Italian NR of 2013.

4. Pathogens

No new information.

5. Meetings and research projects

The project BALMAS - Ballast water management for Adriatic Sea protection – in the framework of the IPA Adriatic Cross-border Cooperation Programme, started in November 2013 – will continue until March 2016 (www.balmas.eu). Special attention will be devoted to Harmful Aquatic Organisms and Pathogens (HAOP). SEAWATCHERS, a new interactive website (www.seawatchers.org/) aimed at acquiring geo-referenced observations of exotic fish species at the Mediterranean scale, is available on-line (Azzurro *et al.*, 2013a).

A whole session of the Italian Marine Biology Society held in Venice (May 2014) was dedicated to alien species. Occhipinti-Ambrogi (2014) introduced this session with a historical account of the achievements of the Alien Species Group over nearly two decades. Among the numerous papers presented, we note the following. A revision of the number of macro-algal NIS in the Italian coasts (Sfriso & Marchini, 2014) shows an alarming increase of alien macro-algae (48 taxa), both invasive and occasional sightings, while a few cryptic species (8–10 taxa) require further investigation. The review on crustaceans (Froglia & Marchini, 2014) accounted for a total of 21 species, of which only 6 have established permanent populations. In Sardinian waters, 8 species of alien fish have been censused (Mulas *et al.*, 2014). Ferrario *et al.* (2014), gave an account of the known distribution of *Zoobotryon verticillatum*, considered a pseudo-indigenous species, having been largely distributed in the Mediterranean Sea. The influence of non-indigenous species (NIS) in the succession of the fouling community was analysed by Lezzi *et al.* (2014) by exposing PVC panels in the Gulf of Taranto. Data on DNA sequencing and microsatellite loci of introduced and native populations of Manila clam from 12 sites were collected by Chiesa *et al.* (2014) to infer the introduction history and reconstruct the invasive pathways. A coupled biophysical ecology (BE)-bioenergetic mechanistic modelling approach was presented by Sarà & Montalto (2014). It was used to generate spatially-explicit predictions of physiological performance (maximal size and reproductive output) for the invasive mussel, *Brachidontes pharaonis*. Felline *et al.* (2014) studied the effects of *Caulerpa racemosa* var. *cylindracea* on herbivorous fish of ecological and economic importance, such as the white sea bream *Diplodus sargus*. The authors followed Belton *et al.* (2014) in using the new denomination of *Caulerpa cylindracea*. A secondary metabolite of *C. cylindracea* has the potential to enter in trophic chains and accumulate in fish tissues; moreover alterations in the antioxidant activity and decrease in fatty acid composition were observed in fish accumulating caulerpin.

Italy has a central role in the introduction and spread of NIS in the Mediterranean and in Europe, according to the paper by Galil *et al.* (2014a). Italy is placed fifth as regards the number of introductions, after the countries directly influenced by the Suez canal. Many of the "widespread species" (that is those found in 10 or more European States) have established large populations along Italian shores, and the peninsula is a crossroads along the "stepping stone" paths of species showing different origins and transport modes. These international repercussions should be kept in mind when considering large projects, such as the doubling of the Suez canal (Galil *et al.*, 2014b).

A number of studies have reviewed the current knowledge on fish introductions and invasions in the whole Mediterranean Sea, including Italy (Golani *et al.*, 2013; Guidetti *et al.*, 2014; Azzurro *et al.*, 2013d, 2014b). A thorough revision of the list of alien fish by the relevant CIESM commission was carried out in 2013 (Orsi-Relini, 2014; http://www.ciesm.org/atlas/appendix1.html).

Golani *et al.* (2013) observed that in the last decade no less than 33 Red Sea (Lessepsian) fish species have invaded the Mediterranean, including coral-associated species; there are 19 Atlantic species and aquarium/mariculture escapees; numerous indigenous species have extended their range northwesterly in the Mediterranean. All these data indicate a profound "sea change" faunal shift in the Mediterranean, due to either temperature rise or the wider, deeper Suez Canal.

Azzurro *et al.* (2013d) provide a dynamic reconstruction of exotic fish occurrences in the Mediterranean Sea: data were mainly extracted from published sources, resulting in a total of 2456 geo-referenced observations, from the year 1896 to 2013.

Guidetti *et al.* (2014) investigated the responses of fish assemblages in Marine Protected Areas (MPA) and in areas open to fishing, across a wide geographical gradient in the Mediterranean Sea (from Spain to Turkey). They found that a high degree of protection (no or minimal fishing) always resulted in increased fish biomass and in the density of carnivores and apex Mediterranean fish species. NIS, on the contrary, showed comparable densities between MPAs and unprotected areas. The greater species diversity of fish documented in MPAs does not appear to result in lower invasibility. The lack of observable effects of MPAs on NIS fish densities suggests that the mechanisms of invasion are not affected by protection.

Azzurro *et al.* (2014b) developed a method for predicting the success of invasions, based on the theory of unsaturated ecological niches, and explored to what extent the abundance of an introduced fish can be explained by its morphological traits, testing the hypothesis that morphological relationships are related to population abundance. Using fish invasions of the Mediterranean, the authors show that the abundance of non-indigenous fish correlates with the location and relative size of occupied morphological space within the receiving pool of species.

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Lithuania

Prepared by Sergej Olenin

Overview

In total, 30 NIS and 2 crypogenic species are registered in the Lithuanian waters of the Baltic Sea and the Curonian Lagoon; of them 4 species were introduced since 2000. All introductions are secondary ones, i.e. species entered the Baltic Sea via other countries and then spread to the Lithuanian waters either by human-mediated pathways or by natural means. Now new NIS reported in 2014, although routine monitoring (phyto-plankton, zooplankton, zoobenthos, early stages of fish, commercial fish surveys) was performed as usual and biological research on macrophytes took place in the Lagoon.

1. Regulations: An update on new regulations and policies (including, aquaculture and vector management)

No new national regulations concerning introductions to marine environment.

2. Intentional introductions

No new intentional introductions.

3. Unintentional introductions

No new unintentional introductions found, although routine monitoring (phytoplankton, zooplankton, zoobenthos, early stages of fish, commercial fish surveys) was performed as usual and biological research on macrophytes took place in the Lagoon.

4. Pathogens

No information about pathogens.

5. Meetings and projects

<u>Meetings</u>

The round goby workshop. BONUS project BIO-C3 meeting. September 4th-5th 2014, Charlottenlund, Castle, Denmark.

- Jūratė Lesutienė, ArtūrasSkabeikis, Andrius Šiaulys. Seasonal and ontogenetic dietary changes of round goby (Neogobius melanostomus) in the exposed coastal waters of SE Baltic Sea

Littoral 2014. Facing Present and Future Coast Challenges. 22–29/09/2014. Klaipėda, Lithuania.

- Dan Minchin & Sergej Olenin. Between Scylla and Charybdis: invasive species in aquaculture
- Sergej Olenin and Dan Minchin. DPSIR approach applied to marine biological invasions: a framework for environmental quality assessments.

<u>Projects:</u>

- VECTORS. Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors (2011–2015)

The main outcome of this project is AquaNIS, an information system on aquatic non-indigenous and cryptogenic species. The Lithuanian team has commitment to maintain this system after the project is over (January, 2015). Presently, AquaNIS contains data on species introductions to European and neighboring marine regions, as well as remote areas, such as Canadian Arctic, North West Pacific (Japan, South Korea, China and Russia) and New Zealand.

- DEVOTES. Development of innovative tools for understanding marine biodiversity and assessing good environmental status (2012–2016)

The aim of this project is to test the indicators proposed by the EC for the Marine Strategy Framework Directive, and develop new ones for assessment at species, habitats and ecosystems level. KUCORPI team is mostly involved in development of NIS indicators.

- INSIST – Invasive species adaptation and its impact on aquatic ecosystems of varying complexity (2012 -2014). Research council of Lithuania. Contact person: Dr. J. Lesutienė <jurate@corpi.ku.lt>
- IANUS – Study of invasive species adaptation mechanisms by synthesis of new methods (2012 -2014). Dr. R. Paškauskas <ricardas.paskauskas@botanika.lt>

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Information systems

Marine Science and Technology Center, Klaipeda University develops and maintains an online information system on the aquatic non-indigenous species and cryptogenic species (AquaNIS). The system is available at www.corpi.ku.lt/databases/aquanis. The system stores and disseminates information on NIS introduction histories, recipient regions, taxonomy, biological traits, impacts, and other relevant documented data.

Publications (since the 2014 national report)

Butkus R. *et al.* (2014) Distribution and current status of non-indigenous mollusc species in Lithuanian inland waters. Aquatic Invasions (2014) Volume 9, Issue 1: 95–103

Lesutienė J., Gasiūnaitė Z., Strikaitytė R., Žilienė R. (2014). Trophic position and basal energy sources of the invasive prawn *Palaemon elegans* in the exposed littoral of the SE Baltic Sea. Aquatic Invasions (2014) Volume 9, Issue 1: 37–45

Zaiko A, Minchin D, Olenin S (2014) "The day after tomorrow": anatomy of an 'r' stratagist aquatic invasion. Aquatic Invasions 9(2): 145–155

Zaiko A., Daunys D. (2015). Invasive ecosystem engineers and biotic indices: Giving a wrong impression of water quality improvement? Ecological Indicators 52: 292–299

Zaiko A., *et al.* (2015) Metabarcoding approach for the ballast water surveillance – An advantageous solution or an awkward challenge? Marine pollution bulletin (article in press).

Norway

Prepared by Anders Jelmert, with contributions from J. Sundet, A.L. Agnalt, Torjan Bodvin and Vivian Husa, IMR

Summary:

- No further genetic clarification of the origin of the Snowcrab *Chionoecetes opilio* (It has previously been established that there is a significant genetic distance from the Canada/Greenland stock). Based on several assumptions, it has been estimated that the SSB of the Barents Sea stock is 10 times the SSB of the king crab (Mainly in the Russian EEZ).
- Slight increase in king crab *P. camtschaticus* stock the later years, both catchable males (CW<=130 mm) and total numbers. Population close to level that can sustain B_{MSY}.
- Free fishery W of 26°E reduces but does not prevent spread.
- No records of American lobster in Norway n 2014.
- No new NIS to Norwegian waters have been reported (but consider very low efforts)
- Several species have expanded range, e.g. *Crassostrea gigas, Gracilaria vermiculophylla* and *Crepidula fornicate.* High summer mortality ov C. gigas associated with presence of OHV-1 μVar)
- One comparison of several Rapid Coastal Survey methods. Results not yet published.
- Rebounce of strong bloom of *M. leidyi*. during summer/early autumn.

1. **Regulations:** No new issues to report:

2. **Intentional:**

No records of new alien species (*proper)* intentionally introduced have been reported. There is quite widespread translocation of several wrasse species in the aquaculture industry (employed for biological de-lousing of salmon). Eventual regional differences in the genetically structure of the populations of the various wrasse species have not been completed. Work in progress on this. Contact Stein Mortensen, IMR

3. **Unintentional:**

New sightings

Now new records have been recorded

But the low efforts should be observed.

General information:

No new records of American Lobster ***Homarus americanus*****(fe):** in 2014, but >20 found in Swedish waters close to the Norwegian border. Analysis of genetical origin confirmed at IMR

Contact: Ann-Lisbet Agnalt, IMR Ann-lisbeth.agnalt@imr.no

King crab: Stock size: Biomass of catchable males (CL ≥ 130 mm) has increased the three last years, and is in 2014 close to B_{msy} (The biomass supporting maximal long term yield). The fishery-mortalityhas increased regularily from the onset of fishery in 1996 and has since 2009 fluctuated around 1.7 F_{msy}. Production: The net production of the stock for 2015 (biomass available for the fisheryt) is ca 99 % of MSY. Catch strategy: The quota-regulated fishery targets large males exclusively. As a result, the average size for catchable male crabs has been reduced, and this may have negative consequences for the catchable female crabs as well. Spread: The spread of the king crab west of the quota-regulated fishery area seems considerably reduced since 2010 Apparently the free fishery seems to have a curbing effect on the spread. No new studies for ecosystem effects of the King crab have beenreported for 2014.

A substantial commercial fishery for the Snow crab have been initiated in the non-regulated (Mainly Russian vessels, outside both Russian and Norwegian EEZ) zone in the Barents Sea. Total landings were approx 4000 tonnes in 2014. (Fram Forum, 2015)

Previous Sightings.

Range expansions:

Following an unusually warm summer, *Mnemiopsis leidyi* rebounced in high numbers along the coast from the Swediah border to approx. Hordaland/ Bergen.

Snow Crab: *Chionoecetes opilio.* First observed in Russian sector 1996, 2004 in Norw. EEZ. Slowly increasing in Norwegian waters, but the large expansion/ pop. increase in Russian waters. Northward and eastward expansion.

Prefer colder water (typ 3–4 C) than red king crab. N & E distribution, may even retract if the Arctic gets warmer. SSB now > 10 timesKing crab SSB. May populate Svalbard/Spitzbergen. Contact. Jan.h.sundet@imr.no

Erradication programmes:

Crassostrea gigas: no practical measures taken during 2014.

The "free" fishery for the King Crab west for 26 E appears rather successful. While not preventing spread completely, the numbers and range expansion appear to grow slowly

Not Yet Seen Species:

No observations of *Didemnum vexillum*, Contact V. Husa, IMR.

4. Pathogens

Massive "Summer mortality" on Crassostrea gigas, and confirmed findings of Osterid HerpesVirus µVar-1 in sick and diseased specimen. No apparent concurrent mortality on other mollusks in the afflicted areas. OHV µVar-1 is currently not regarded as a NIS.

5. Meetings

Arctic Frontiers, Tromsø, 19 - 24 January 2014

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Fram Forum, 2015 Editor Janet Holmén Freelance editor

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Poland

Prepared by Aldona Dobrzycka-Krahel and Anna Szaniawska, Department of Experimental Ecology of Marine Organisms, Institute of Oceanography, University of Gdańsk

Overview

Palaemon macrodactylus M.J.Rathbun, 1902 (Crustacea, Decapoda) was recorded for the first time in the coastal waters of the Baltic Sea - in the mouth of the Wisła Śmiała river near Gdańsk in 2014 (Janas and Tutak 2014). *Rangia cuneata* (G.B. Sowerby I, 1831) (Mollusca, Bivalvia) was recorded for the first time in the Wisła Śmiała River – coastal waters of the Gulf of Gdańsk, the southern Baltic Sea, in 2014 (Janas and Tutak 2014).

Acipenser gueldenstaedtii Brandt and Ratzeburg, 1833 (Pisces, Acipenseridae) was reported for the first time in the Puck Bay (the southern Baltic Sea) (in 1968 and in 2000's) and in fishing grounds on the western Polish Baltic coast (in 2011) (Skóra and Arciszewski 2013). *Acipenser baerii* Brandt 1868 (Pisces, Acipenseridae) was reported for the first time in the Reda River (Baltic Sea basin) in 2006 (Skóra 2012). *Ballerus sapa* (Pallas, 1811) (Pisces, Acipenseridae) was reported for the first time in the Reda River, a tributary to the Baltic Sea between 2005 and 2007 (Skóra and Skóra 2013).

1. Regulations:

16.04.2014 The European Parliament adopted a Regulation on alien species (PE-CONS 70/14, 13266/14 ADD 1). The most important element of the new document is a priority list of alien species, for which the Member States undertake to implement special procedures. Depending on the phase of the invasion will be to prevent the introduction, taking action to total elimination of the species in the early phase after detecting the presence or long-term management in the event of a significant spread in the territory of the country.

2014–09–29 Council of the European Union adopted a Regulation on alien species. It enters into force on 1 January 2015. As any EU regulation, this document will be in each Member State directly applicable and all the authorities of the Member States will be required to follow and use it. This regulation will not require the adoption of implementing acts in Poland. However, it will need to change the current legal records regarding alien species in Poland, as well as the introduction of a number of important organizational changes.

2. Intentional:

In 2014, in rivers draining into the Baltic Sea, deliberate releases of salmon *Salmo salar,* sea trout *Salmo trutta morpha trutta,* whitefish *Coregonus lavaretus,* Atlantic sturgeon *Acipenser oxyrinchus* and European eel *Anguilla anguilla* were conducted (information from Inland Sea Fisheries Institute in Olsztyn).

3. Unintentional:

Palaemon macrodactylus M.J.Rathbun, 1902 (Crustacea, Decapoda) was recorded for the first time in the coastal waters of the Baltic Sea in 2014 (Janas and Tutak 2014). 169 individuals of this species were collected. Prawns were caught in July – August and October 2014 in the yacht harbor situated in the mouth of the Wisła Śmiała river near Gdańsk (coordinates: 18°46.708′ E 54° 22.078′N). *P. macrodactylus* is native to Japan, Korea and northern China (Newman 1963). Ashelby *et al.* (2013) has noticed that *P. macrodactylus* come from the vicinity of international harbours and suggested the ship transportation is the most probable mechanism of introduction. It is an omnivorous species but its diet largely consists of animals such as: mysids, copepods, amphipods, barnacles, polychaetes, small bivalves and fish larvae (Sitts and Knight 1979; González-Ortegón *et al.* 2010, 2014). The species itself may be consumed by fish or birds that already prey on *P. adspersus* and *P. elegans* in the Baltic Sea.

Rangia cuneata (G.B. Sowerby I, 1831) (Mollusca, Bivalvia) was recorded for the first time in the Wisła Śmiała River – coastal waters of the Gulf of Gdańsk, the southern Baltic Sea, on the 1st August 2014 bivalve individuals were collected during macrofauna sampling in the Wisła Śmiała River (Janas *et al.* 2014). The species come from the Atlantic coast of North America (Howells *et al.* 1996). *R. cuneata* was recorded for the first time in European waters in the harbor of Antwerp (Belgium) in 2005. Shells of the new species are most similar to shells of *M. balthica*. However, the prominent umbo curved anteriorly is visible in both young and adult individuals of *R. cuneata* and it can be easily distinguished from *M. balthica.* The individuals of *R. cuneata* were identified using the identification key (Verween *et al.* 2006). The valves are thick and heavy, with a pale brown periostracum.

Acipenser gueldenstaedtii Brandt & Ratzeburg, 1833 (Pisces, Acipenseridae) was reported for the first time in the Puck Bay (three specimens) and in fishing grounds on the western Polish Baltic coast (two specimens) (Skóra and Arciszewski 2013). The specimens found along the Polish coast were caught in October and November 2011, fishes from the Puck Bay were caught in 1968 and in 2000′s. The Russian sturgeon *A. gueldenstaedtii* is a Ponto-Caspian species (Vlasenko *et al.* 1989). The occurrence of this species in the Baltic Sea is the result of escape from fish farms or deliberate releases by anglers and aquarists (Arndt *et al.* 2002). According to Grabowska *et al.* (2010) the species has been farmed in Poland since 1985.

Acipenser baerii Brandt 1868 (Pisces, Acipenseridae) was reported for the first time in the Reda River (Baltic Sea basin) (Skóra 2012). 12 specimens of the Siberian sturgeon were caught in June and July 2006. This is the first report of Siberian sturgeon in Polish Pomeranian rivers. It is hypothesized that the sturgeon originated from one of the hatcheries located on the banks of the Reda River.

The Siberian sturgeon was the most common among the non-indigenous sturgeon reported in Polish Baltic coastal waters in the 1980s and 1990s (Gessner *et al.* 1999). According to Arndt *et al.* (2002) the origin of this species in the sea may be accidental escape from fish farms and deliberate release by anglers and aquarists.

Ballerus sapa (Pallas, 1811) (Pisces, Acipenseridae) was reported for the first time in the Reda River, a tributary to the Baltic Sea (Skóra and Skóra 2013). A total of 13 specimens of *B. sapa* were caught between June 2005 and July 2007 in the Reda River. The native range of the white-eyed bream *B. sapa* is the Ponto-Caspian region: large rivers of the Black, Azov, Caspian and Aral seas (Terlecki 2000, Kottelat and Freyhof 2007).

Range extension of this species to the Vistula River basin was possible via the Pripyat-Bug Canal (Terlecki 1990), to central migration corridor of Ponto-Caspian aquatic species to Europe (Bij de Vaate *et al.* 2002). According to Skóra and Skóra (2013) its occurrence in the Reda River suggests that in future it may colonize by self-dispersal other rivers and lagoons flowing into the Baltic Sea.

Cercopagis pengoi (Ostroumov, 1891) (Crustacea, Cladocera) has been investigated seven years after the first records. In June-August 2006 *C. pengoi* was observed for the first time in a broad range of the water temperature and salinity (Bielecka *et al.* 2014). The Ponto-Caspian cladoceran, *C. pengoi,* has successfully colonized new areas. This Ponto-Caspian cladoceran, *C. pengoi*, is one of those that have successfully colonized new areas, expanded its range and significantly affected newly inhabited ecosystems (Leppäkoski and Olenin 2000, Laxson *et al.* 2003, Ojaveer *et al.* 2004, Põllumäe and Kotta 2007). For this reason, *C. pengoi* is being placed by the International Union for the Conservation of Nature and Natural Resources (IUCN) on its list of the 100 most invasive. According to Bielecka *et al.* (2014) *C. pengoi*, was observed in 2006 at 13 stations located in the inner part of the Gulf of Gdańsk and at 4 situated in the open waters of the Southern Baltic. The results confirm ecological plasticity of the species: in the Polish Baltic the species was observed in a broad range of temperature (the difference between the maximum and minimum values was ca. 21° C) and salinity (the species was noted in more than 11 PSU).

The concentration of *C. pengoi* found in the study was very similar to those in the Gulf of Finland (max. 305 ind. m^{-3}), four years after the first appeareance (Krylov *et al.* 1999).

The authors suggest that colonization of the species in the region is still at an early stage, although ecological conditions seem to be suitable for settlement.

Gammarus tigrinus Sexton, 1939 (Crustacea, Gammaridea) - one of the latest newcomers to the southern Baltic, was the most widely distributed and most numerous alien species in the whole of the inner Puck Bay (Janas and Kendzierska 2014). This species was first recorded in Puck Bay in 2001 (Gruszka 2002), and by 2007 its frequency of occurrence has increased (Janas and Kendzierska 2014).

Rhithropanopeus harrisii (Gould, 1841) (Crustacean, Decapoda) was collected in the Gulf of Gdańsk each year between 2006 and 2010 (Hegele-Drywa & Normant 2014 a, b). In the Gulf of Gdańsk this species was first noted in the 1960s, but since the early 2000s a reproducing population with max abundances 19 indiv./100 m2 (in the Puck Bay) has become established there (Hegele-Drywa & Normant 2014 a). Its negative influence on native species has been not reported (Hegele-Drywa & Normant 2014 a).

Neogobius melanostomus (Pisces, Gobiidae) invasion success in the Gulf of Gdańsk (Southern Baltic Sea) was confirmed by Sapota *et al.* (2014).

Invasion by the round goby (*Neogobius melanostomus*), a Ponto-Caspian fish, has been observed in the Gulf of Gdańsk since 1990 (Skóra and Stolarski 1993, 1996). After a few years, the round goby had invaded all suitable areas in the west part of the Gulf of Gdańsk. The research was conducted from May till September over three consecutive years, i.e. from 2006 through 2008. Places suitable for round goby nesting were monitored in the Puck Bay, the innermost part of the Gulf of Gdańsk. Actually, the round goby is one of the dominant fish species in the shallow, inshore waters of the area (Corkum *et al.* 2004, Sapota 2004, Sapota and Skóra 2005, Wandzel 2000).

In the case of the round goby invasion in the Gulf of Gdańsk, the most important factors were: lack of predators in the shallow water zone, which helps the population to settle and then grow without a significant external regulating factor and the presence of a hard substrate in the generally sandy bottom of shallow waters of the Gulf of Gdańsk. All solid elements on the bottom are utilized by round gobies as nest substrates and refuges; a food supply rich in bivalves (mostly blue mussels), favorable to the typically bivalvevorous round goby (Corkum *et al.* 2004, Sapota 2004, Sapota and Skóra 2005).

According to Sapota *et al.* (2014) the general conclusions about the round goby nest-guarding behavior and the possibilities of successful colonization of new areas can be drawn: any solid elements on the bottom may be used as a nest substrate; in the case of a limited nesting area, distances between nests may decrease noticeably; shallow water areas with almost any type of bottom might be invaded by the round goby.

4. Pathogens

There are no alien species.

5. Meetings

Past year

7th International sturgeon conference "Sturgeon world in one place", 26th November 2014 Warsaw, Poland

The subjects of this conference were world trends, both in production and the market of sturgeon farming and caviar production is a business, where national borders do not exist.

The idea to organize the International Sturgeon Conference was to get a broader view of the sturgeon world as well as to bring home practical knowledge. The conference was designed both for practitioners and scientists, so everyone can benefit from each other's knowledge.

The conference was organized for sturgeon farmers, producers, scientists and organizational representatives from all over the world gather in one place during International Sturgeon Conference.

The event gives a unique opportunity to meet, talk and solve problems concerning the sturgeon production sector.

Problems of sturgeon farmers were the main issues discussed during the conference program.

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Portugal

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Overview

A list of 139 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems, 9 of which were new additions to the 2014 report. The inventory of NIS was restructured to include fish species but freshwater species and cryptogenic species are not included. Portugal has a law on introduction of non-indigenous species, published in 1999, which is currently under revision (since 2009). Although the current law does not include a list of marine species the revision document included marine species and refers to IMO and ICES criteria for ballast water management. Concerning the implementation of the Marine Strategy Framework Directive the initial assessment reports for the Azores and Madeira islands (Macaronesia sub-region) were delivered, and both the monitoring programme and the programme of measures were submitted to the European Commission.

1. Regulations: An update on new regulations and policies (including, aquaculture and vector management)

There are no new regulations.

The initial assessment reports for the implementation of the Marine Strategy Framework Directive in the Azores and Madeira islands (Macaronesia sub-region) were delivered, and both the monitoring programme and the programme of measures for Portugal were submitted to the European Commission.

2. Intentional introductions

Information available for introductions in Portuguese estuarine and coastal waters is insufficient to separate between intentional and unintentional introductions.

3. Unintentional introductions

A list of 139 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems. New additions to the 2014 report are listed in Table 1. New additions for Portuguese mainland and Azores and Madeira islands were considered separately. Possible introduction vectors were indicated based on the life cycle of the introduced species and the presence of known introduction vectors at locations where it was registered. The inventory of NIS was reformulated to include fish species but freshwater species and cryptogenic species are not included. A first national comprehensive list of NIS for Portuguese coastal areas, including the Iberian coast and Macaronesia islands was accepted for publication (Chainho *et al.*, accepted). New records were registered mainly for the Madeira and Azores islands as a result of comprehensive literature reviews and recent surveys carried out in the islands (e.g. Micael *et al.*, 2014; Ramalhosa *et al.*, 2014; Ávila *et al.*, 2015). The gilthead seabream *Sparus aurata* was listed for the Madeira islands because several specimens were observed during a underwater visual sensus. Escape from a recent open sea aquaculture unit in the area is the most likely explanation for its occurrence (Alves & Alves, 2002). The mummichog *Fundulus heteroclitus* was initially confused by *Valencia hispanica* in the Guadiana estuary, being the first confirmed record in 1976 (Coelho *et al.*, 1976). In Portugal, the introduced range is restricted only to the salt marshes of the Guadiana, being widespread eastwards into Spanish territory. No apparent reason of *F. heteroclitus* introduction is known (Almaça 1995). The Portuguese oyster, *Crassostrea angulata*, was added to the NIS list, although there is an ongoing discussion on considering two species (*Crassostrea gigas* and *C. angulata*) or a single species (*C. angulata*=*C. gigas*). Although the Portuguese oyster *C. angulata* was initially described by Lamarck to be native of southwestern Europe while the Pacific oyster or Japanese oyster *C. gigas* is presumed to be native to the North West Pacific region, recent genetic studies indicate that both species were introduced from Asia (Boudry *et al.*, 2003, Batista *et al.*, 2005). Sampling surveys carried out during 2014 confirmed that the Manila clam population continues to occur with high densities in the Tagus estuary in spite of the massive harvesting of that species along the last 5 years. Continuous surveys conducted on the jellyfish *Blackfordia virginica* have also shown that the population registered at the Mira estuary is successfully established (Marques *et al.*, accepted). Recent developments have shown that this species has a high feeding plasticity, including not only metazooplankton in its diet, but also ciliates and phytoplankton (Morais *et al.*, accepted). Those authors also showed that the medusa might be able to maintain a good nutritional condition during periods of lower availability of metazooplanktonic preys, basing their diet on particulate organic matter sources.

Table 1. List of new NIS registered in Portuguese waters in 2014–2015.

Taxa	Year of first record	Location of first record	Possible introduction vector	Invasion Status	References
Aglaothamnion cordatum (Børgesen) Feldmann-Mazoyer	2005–2007	Azores (Pico)	Fouling	Not Established	Wallenstein, 2011
Branchiomma bairdi McIntosh, 1885	2013	Madeira	Fouling	Established	Ramalhosa *et al.*, 2014
Caprella scaura Templeton, 1836	2013	Madeira	Fouling	Unknown	Ramalhosa & Canning-Clode, *in press*
Crassostrea angulata (Lamark, 1819)	<1700	Sado estuary	Ballast water; Aquaculture	Established	Batista *et al.*, 2005

Fundulus heteroclitus (Linnaeus, 1758)	1976	Guadiana estuary	Unknown	Established	Coelho *et al.*, 1976
Hypnea flagelliformis Greville ex J. Agardh	2005–2007	Azores (São Miguel, Pico)	Fouling	Not Established	Wallenstein, 2011
Phorcus sauciatus (Koch, 1845)	2013	Azores (Santa Maria)	Unknown	Established	Ávila *et al.*, 2015
Schizoporella errata (Waters, 1878)	2013	Azores (São Miguel)	Fouling	Unknown	Micael *et al.*, 2014
Sparus aurata (Linnaeus, 1758)	2002	Madeira	Aquaculture	Unknown	Alves & Alves, 2002

5. Meetings and projects

Meetings

2014. Angélico, M.M., F. Marques, P. Chainho, I. Domingos, A. Teodósio & J.L. Costa. Potential impacts of the occurrence of blooms of *Blackfordia virginica* in the Mira estuary, SW Portugal. ICES Annual Science Conference 2014, Coruña, Spain.

2015. Bettencourt, A., J. Micael, A.M.L. Seca, M.C. Barreto & A.C. Costa. Biological activities and secondary metabolites from marine alien species from the Azores. Seminar Marine Non-Indigenous Species – 18th February, University of the Azores, Ponta Delgada, Portugal.

2015. Canning-Clode, J., T. Marques, P. Chainho, P. Fofonoff, L. McCann, J.T. Carlton, G.M. Ruiz & R.S. Santos. 2015. Spatial and temporal patterns in marine invasions in the offshore islands of Macaronesia. International Workshop on Marine Bioinvasions of Tropical Island Ecosystems. Puerto Ayora, Galápagos, Ecuador, February 24–27, 2015.

2014. Chainho, P., A. Amorim, S.P. Ávila, J. Canning-Clode, J. Castro, A. Costa, J.L. Costa, T. Cruz, A. Fernandes, S. Gollasch,C. Grazziotin-Soares, R. Melo, J. Micael, M. Parente, J. Semedo, T. Silva, D. Sobral, M. Sousa, P. Torres, V. Veloso & M.J. Costa. Are Portuguese estuaries and coastal areas less invaded by non-indigenous species? ECSA 54 Symposium, Sesimbra, Portugal.

2015. Chainho, P., A. Amorim, S.P. Ávila, J. Canning-Clode, J. Castro, F. Coelho, A. Costa, J.L. Costa, T. Cruz, A. Fernandes, L. Garaulet, S. Gollasch, C. Grazziotin-Soares,F. Marques, R. Melo, J. Micael, M. Parente, P. Presado, J. Semedo, T. Silva, D. Sobral, M. Sousa, P. Torres, V. Veloso & M.J. Costa. Non-indigenous species in Portuguese coastal areas, coastal lagoons, estuaries, and islands. Seminar Marine non-indigenous species, 18th February 2015, Ponta Delgada, Azores, Portugal.

2014. Costa, J.L., A. Amorim, S.P. Ávila, J. Canning-Clode, J. Castro, P. Chainho, A. Costa, M.J. Costa, T. Cruz, A. Fernandes, S. Gollasch, C. Grazziotin-Soares, R. Melo, J. Micael, M. Parente, J. Semedo, T. Silva, D. Sobral, M. Sousa, P. Torres & V. Veloso. Exotic species in marine and estuarine environment in Portugal with special reference to the Tagus estuary: current status and future perspectives. Forum Change Life, Lisboa, Portugal.

2015. Costa, A.C. & J. Micael. Açores: Stop-over for Marine Aliens Species? Seminar Marine Non-Indigenous Species – 18th February, University of the Azores, Ponta Delgada, Portugal.

2015. Jardim, N., J. Micael & A.C. Costa. Management response to a non-indigenous species *Bugula neritina* Linnaeus, 1758. Seminar Marine Non-Indigenous Species – 18th February, University of the Azores, Ponta Delgada, Portugal.

2014. Marques, F., P. Chainho, J.L. Costa, I. Domingos, & M.M. Angélico. Potential impacts of the non-native jellyfish *Blackfordia virginica* in the Mira estuary. ECSA 54 Symposium, Sesimbra, Portugal.

2014. Marques, F., P. Chainho, I. Domingos, J.L. Costa & M.M. Angélico. Distribution and abundance of the non-indigenous jellyfish *Blackfordia virginica* in the Mira estuary: which environmental conditions favor its occurrence? ECSA 54 Symposium, Sesimbra, Portugal. – poster communication.

2014. Micael, J., C. Núñez & A.C. Costa. Entry pathways for Non-Indigenous Marine Species in the Azores Islands. Science for the new regulation: One day BENELUX conference on Invasive species' April 2nd Ghent University, Belgium.

2014. Micael, J., C. Núñez & A.C. Costa. Bryozoa diversity from different marinas of the Azores archipelago. Mares Conference on Marine Ecosystems Health and Conservation, 17th - 21st November 2014, Olhão, Portugal.

2014. Micael, J., R.A. Sonsona & A.C. Costa. Fishing-bait as entry vector for non-indigenous species in the Azores. Mares Conference on Marine Ecosystems Health and Conservation, 17th - 21st November 2014, Olhão, Portugal. – poster communication

2014. Micael, J., M.I. Parente, D. Gabriel & A.C. Costa. Re-visiting Vila do Porto marina (Santa Maria, Azores archipelago) Science for the new regulation: One day BENELUX conference on Invasive species' April 2nd Ghent University, Belgium. – poster communication.

2015. Micael, J., R. Sonsona & A.C. Costa. Live-bait as an entry pathway for Marine Non-Indigenous Species in the Azores Islands. Seminar Marine Non-Indigenous Species – 18th February, University of the Azores, Ponta Delgada, Portugal.

2015. Parente, M.I., J. Micael & A.C Costa. Macroalgae NIS in the Azores: a growing concern? Seminar Marine Non-Indigenous Species – 8th February, University of the Azores, Ponta Delgada, Portugal.

2014. Parra, M., R. Marques, P. Chainho, M. Angélico, J. Cruz, P. Morais & M.A Chícharo Teodósio. What are jellyfish really eating? ICES Annual Science Conference 2014, Coruña, Spain.

2014. Ramajal, J., L. Garaulet, J.L. Costa, D. Picard, M. Gaspar, M.J. Costa & P. Chainho. Shifting fishing activities in the Tagus estuary, Portugal caused by the introduction of the Manila clam. ECSA 54 Symposium, Sesimbra, Portugal. – poster communication.

2014. Sá, E., C. Azeda, G. Silva, J.P. Medeiros, L. Garaulet, M. Gaspar, P. Chainho, M.J. Costa, I. Caçador & J.L. Costa. The benthic invertebrate community structure of a Portuguese estuary highly invaded by the Manila clam (*Ruditapes philippinarum*). ECSA 54 Symposium, Sesimbra, Portugal.

Projects:

- 2014–2015. Manila clam – Current state of the Tagus estuary population, impacts and fishing management.. Funded by PROMAR. PI: Paula Chainho (CO-FCUL).
- Current status of the Portuguese oyster (*Crassostrea angulata*) in the Sado estuary, threats and opportunities for its commercial exploitation – CRASSOSADO. Funded by PORTUCEL, S.A.

- 2014–2015. Alive bait – Polychaets used as alive bait in Portugal: harvesting management, importation and culture. Funded by the Fisheries Program PROMAR.
- 2013–2015. The Madeira Monitoring Marine Invasive Species Program (Mad_MOMIS)

Future Projects:

- National Monitoring Program **–** A national monitoring program on non-indigenous species is currently under preparation, aiming at contributing to implementation of the Marine Strategy Framework Directive in mainland Portugal. The program will be submitted for funding to the national authority coordinating the implementation of the MSFD.

6. Publications

Ávila, S.P., P. Madeira, A.C. Rebelo, C. Melo, A. Hipólito, J. Pombo, A.Z. Botelho & R. Cordeiro, 2015. *Phorcus sauciatus* (Koch, 1845) (Mollusca: Gastropoda) in the Archipelago of the Azores (NE Atlantic Ocean): the onset of a biological invasion. Journal of Molluscan Studies (in press).

Chainho, P., A. Fernandes, A. Amorim, S.P. Ávila, J. Canning-Clode, J. Castro, A. Costa, J.L. Costa, T. Cruz, S. Gollasch, C. Grazziotin-Soares, R. Melo, J. Micael, M. Parente, J. Semedo, T. Silva, D. Sobral, M. Sousa, P. Torres, V. Veloso & M.J. Costa (accepted). Non-indigenous species in Portuguese coastal areas, coastal lagoons, estuaries, and islands. Estuarine, Coastal & Shelf Science.

Gestoso, I., F. Arenas & C. Olabarria. 2014. Biotic resistance and facilitation of a nonindigenous mussel vary with environmental context. Marine Ecology Progress Series, 506: 163–173.

Micael, J., J. Marina, A.C. Costa, A. Occhipinti-Ambrogi. 2014. The non-indigenous *Schizoporella errata* (Bryozoa: Cheilostomatida) introduced into the Azores Archipelago. Marine Biodiversity Records doi: http://dx.doi.org/10.1017/S1755267214001298.

Marques, F., P. Chainho, J.L. Costa, I. Domingos, & M.M. Angélico (accepted). Abundance, seasonal patterns and diet of the non-native jellyfish *Blackfordia virginica* in a portuguese estuary. Estuarine, Coastal & Shelf Science.

Morais, P., M.P. Parra, R. Marques, J. Cruz, M.M. Angélico, P. Chainho, J.L. Costa, A.B. Barbosa & M.A. Teodósio (accepted). What are jellyfish really eating to support high ecophysiological condition? Journal of Plankton Research.

Ramalhosa P., K. Camacho-Cruz, R.J. Bastida-Zavala & J. Canning-Clode. 2014. First record of *Branchiomma bairdi* McIntosh, 1885 (Annelida: Sabellidae) from Madeira island, Portugal, (northeastern Atlantic ocean). BioInvasions Records 3(4): 235–239.

Ramalhosa, P. & J. Canning-Clode (*in press*). The invasive caprellid *Caprella scaura* Templeton, 1836 (Crustacea: Amphipoda: Caprellidae) arrives on Madeira Island, Portugal. BioInvasions Records.

Vaz-Pinto, F., I.F. Rodil, F. Mineur, C. Olabarria & F. Arenas. 2014. Understanding Biological Invasions by Seaweeds. In Marine Algae: Biodiversity, Taxonomy, Environmental Assessment, and Biotechnology. Edited by Leonel Pereira, Joao Magalhaes Neto, CRC Press., ISBN: ISBN 9781466581678.

7. References and bibliography

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Alves, F. & C. Alves. 2002. Two new records of seabreams (Pisces:Sparidae) from the Madeira Archipelago. Arquipélago. Ciências Biológicas e Marinhas 19A: 107–109.

Ávila, S.P., P. Madeira, A.C. Rebelo, C. Melo, A. Hipólito, J. Pombo, A.Z. Botelho & R. Cordeiro, 2015. *Phorcus sauciatus* (Koch, 1845) (Mollusca: Gastropoda) in the Archipelago of the Azores (NE Atlantic Ocean): the onset of a biological invasion. Journal of Molluscan Studies (in press).

Batista F., A. Leitao, A. Huvet, S. Lapegue, S. Heurtebise & P. Boudry. 2005. The taxonomic status and origin of the Portuguese oyster *Crassostea angulata* (Lamark, 1819). International Oyster Symposium. http://archimer.ifremer.fr/doc/00000/3433/.

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Coelho, M., J. Gomes & P.B. Ré 1976. *Valencia hispanica*, a new fish to Portugal. Arquivos do Museu Bocage 6, 1–3.

León-Cisneros, K., I. Tittley, M.R. Terra, E.M. Nogueira & A.I. Neto 2012. The marine algal (seaweed) flora of the Azores: 4, further additions. Arquipelago. Life and Marine Sciences 29: 25–32.

Leitão A., R. Chaves, S. Santos, Guedes-Pinto & P. Boudry. 2007, Interspecific hybridization in oysters: Restriction Enzyme Digestion Chromosome Banding confirms *Crassostrea angulata*×*Crassostrea gigas* F1 hybrids. J. Exp. Mar. Biol. Ecol. 343, 253–260.

Micael, J., M.I. Parente & A.C. Costa. 2014. Tracking macroalgae introductions in North Atlantic Oceanic islands. Helgoland Marine Research, 68: 209–219.

Ramalhosa, P. & J. Canning-Clode (in press). The invasive caprellid *Caprella scaura* Templeton, 1836 (Crustacea: Amphipoda: Caprellidae) arrives on Madeira Island, Portugal. BioInvasions Records.

Wallenstein, F.M. 2011. Rocky Shore Macroalgae Communities of the Azores (Portugal) and the British Isles: a Comparison for the Development of Ecological Quality Assessment Tools. PhD Thesis Heriot Watt University.

Spain

Prepared by Gemma Quilez-Badia, WWF Mediterranean Programme Office

Overview

Three new ship-mediated species are reported for Spain: i) the potentially ichthyotoxic marine microalgae *Fibrocapsa japonica* Toriumi & Takano (Raphidophyceae), which was reported offshore in the Eastern Alboran Sea for the first time in autumn of 2006; ii) the marine nemertean *Cephalothrix cf. simula* AM-2013, which can affect natural populations by competitive exclusion, was reported for the first time in several locations along the Spanish coasts (i.e. in the North Atlantic coast of Spain in Galicia, Asturias and Cantabria, and in the Mediterranean coast in Catalonia) in a recent survey of nemertean diversity along the Iberian Peninsula coasts; and iii) the caprellid amphipod *Caprella mutica* Schurin, 1935, which has the potential impact of this species on native ecosystems and marine aquaculture first reported in October 2012 in Illa d'Arousa (42.56135º N 8.95594º W) and then during 2012 and 2013 in other sites of Ria d'Arousa, Galicia, NW Spain, Atlantic coast.

In addition, on the 31st of July 2014, an individual of the Indo-Pacific silver-cheeked toadfish, *Lagocephalus sceleratus*, was captured by deep bottom trawling in the Ibiza channel (approx. 39.06666º N, 0.31666º E), NW Mediterranean. This lessepsian species is worrisome due to its potential impact on local fisheries resources and to the tetrodotoxine present in its liver.

Moreover, the first occurrence of the yellow tang *Zebrasoma flavescens* and the clown triggerfish *Balistoides conspicillum* in the Western Mediterranean were reported. These tropical fishes were photographed in October 2008 off Sitges (Costa Daurada, NE Spain: 41°13′27.09″ N; 1°47′22.35″ E) and in July 2012 in front of Palamós (Costa Brava, NE Spain: 41°50′56.19″ N; 3°8′26.29″ E), respectively. Because of their importance as ornamental aquarium species, it is likely that these tropical fishes had been released from private aquaria.

The subcrenate ark shell *Anadara kagoshimensis*, previously reported from Spain (Ría de Vigo – Galicia, NW Spain -, Bay of Biscay – N Spain - and Catalonia – NE Spain), was reported for the first time in the Ría de Arousa (42o 37.260′ N 8o 46.790′ W), Galicia, NW Spain, in May 2013. The haemolymph of *A. kagoshimensis* contains nucleated erythrocytes packed with haemoglobin, which enables this clam to bind oxygen in oxygen-deficient conditions, and haematin, which is involved in the removal of sulphides. *Anadara kagoshimensis* is listed among the hundred worst invasive species in the Mediterranean Sea and can displace autochthonous bivalves. Aquaculture seems to be the most probable hypothesis to explain the presence of *A. kagoshimensis* in Galician waters.

1. **Regulations**:

At the end of 2014, 21 additional species were included in the Spanish Catalogue of Invasive Alien Species, but none is an aquatic species.

2. Intentional:

3. Unintentional:

<u>New Sightings</u>

1) *Fibrocapsa japonica* Toriumi & Takano (Raphidophyceae)

Reported from Eastern Alboran Sea (SW Mediterranean).

<u>General Information</u>:

Fibrocapsa japonica Toriumi & Takano (Raphidophyceae) is a potentially ichthyotoxic marine microalga first reported in Japan, where it was associated with mass fish mortality events. The exact mechanism of icthyotoxicity in Raphidophyceae is unknown, but it has been linked to several different processes: an abundant production of mucous that clogs fish gills, production of reactive oxygen species (ROS) that asphyxiate the fish and the production of haemolytic compounds and/or brevetoxins. The presence of brevetoxins in *F. japonica* was recently debated, and thus the overall toxicity of this species is likely due to a combination of the above-mentioned factors acting together (de Boer *et al.*, 2012 and references therein).

Experiments conducted on *F. japonica* have shown that it has low nutrient uptake efficiency, and its growth should therefore be favored in high-nutrient conditions, which are frequently encountered in the stratified shallow coastal and brackish waters (Riegman *et al.*, 1996; Handy *et al.*, 2005; Cucchiari *et al.*, 2008) where Raphidophyceae are typically detected.

F. japonica is known to bloom in temperate and tropical coastal waters worldwide, including the Pacific and Atlantic American coasts, Korean and Chinese waters, the Arabian Sea, southern Australia and New Zealand. *F. japonica* has been reported in coastal European waters as well: in the French Atlantic, in the North Sea and Baltic Sea waters, as well as in the Mediterranean Sea, along both the Tyrrhenian Sea and the Adriatic Sea coasts (Cucchiari *et al.*, 2008; Fani *et al.*, 2014 and references therein). Kooistra *et al.* (2001) detected a high degree of polymorphisms among the nuclear ribosomal DNA ITS regions from different *F. japonica* strains, likely due to hybridization mechanisms, and suggested that the exchange of discharged ship ballast waters and/or aquaculture may have induced the expansion of F. japonica's disjointed distribution range.

Kooistra *et al.* (2001) detected a high degree of polymorphisms among the nuclear ribosomal DNA ITS regions from different F. japonica strains, likely due to hybridization mechanisms, and suggested that the exchange of discharged ship ballast waters and/or aquaculture may have induced the expansion of *F. japonica*'s disjointed distribution range.

The presence of *F. japonica* was reported offshore in the Eastern Alboran Sea for the first time in autumn of 2006 (Fani *et al.*, 2014).

2) The nemertean *Cephalothrix cf. simula* AM-2013

Reported from:

San Vicente do Mar, O Grove, Galicia, NW Spain. 42º 27′ N, 8º 55′ W (Atlantic coast).

Las Represas beach, Tapia de Casariego, Asturias, N Spain. 43º 34′ N, 6º 56′ W (Atlantic coast).

Los Chalanos beach, Muros de Nalón, Asturias, N Spain. 43º 23′ N, 6º 06′ W (Atlantic coast).

Aramar beach, Luanco, Asturias, N Spain. 43º 36′ N, 5º 46′ W (Atlantic coast).

Islares beach, Castro-Urdiales, Cantabria, N Spain. 43º 24′ N, 3º 17′ W (Atlantic coast).

Colera harbor, Cap de Creus, Catalonia, NE Spain. 42º 24′ N, 3º 09′ E (Mediterranean coast).

L'illot del Faradell, Cap de Creus, Catalonia, NE Spain. 42º 20′ 16″ N, 3º 16′ 49″ E (Mediterranean coast).

General Information:

In a recent survey of nemertean diversity along the Iberian Peninsula coasts, some morphospecies of *Cephalothrix* that had not been previously reported in this area were found (Fernández-Álvarez, unpublished data). A case of a marine nemertean alien invasion, which was confirmed by DNA barcoding studies is reported (Fernández-Álvarez and Machordom, 2013). The authors consider *C. simula* to be an alien invader whose larvae could have been introduced to their allochthonous distribution area in the ballast waters of ships. Moreover, it is possible that environmental changes produced by climate change are currently facilitating the settlement of this species. The presence of developed gonads in one specimen and the presence of juvenile individuals reveal that reproduction is occurring in the invaded areas (Fernández-Álvarez and Machordom, 2013).

Species of the genus *Cephalothrix* have predatory habits (Wu and Sun 2006), and their introduction into new environments can affect natural populations by competitive exclusion. The invasion in the Iberian Peninsula has been happening cryptically, and thus, it is possible that it has had several effects on the natural environment (Fernández-Álvarez and Machordom, 2013). The lack of quantitative data along the Iberian coasts for the majority of nemertean species makes it impossible to evaluate whether competitive exclusion is operating on autochthonous *Cephalothrix* species (Fernández-Álvarez and Machordom, 2013).

The report of *C. simula* along the Iberian coasts is the first record for this species in this local fauna (Fernández-Álvarez and Machordom, 2013).

3) *Caprella mutica* Schurin, 1935

Reported from Ría d'Arousa, Galicia (NW Spain) in these 6 sites:

42.56135º N 8.95594º W in October 2012

42.55390º N 8.95940º W in May 2013

42.58292º N 8.91915º W in May 2013

42.57520º N 8.94003º W in May 2013

42.56020º N 8.88870º W in June 2013

42.56295º N 8.98830º W in July 2013

General Information:

The caprellid amphipod, *Caprella mutica*, is a well-known invasive species, originating in the Sea of Japan, which has been rapidly expanding along the coasts of North America, Europe and Oceania for the last forty years. *Caprella mutica* is frequently associated with man-made structures, especially those dedicated to aquaculture activities, where it can reach high densities of up to 300,000 ind./m2. In addition, *C. mutica* has a high reproductive capability, which combined with a wide tolerance to salinity and temperature and a great adaptability to food, allows the species to colonize new places efficiently (Almón *et al.*, 2014).

In October 2012, *C. mutica* was seen for the first time in Illa de Arousa (42.56135º N 8.95594º W) (Galicia, north-west Spain), established around bateas, floating structures intended for shellfish farming. This was the first record of this species in the Iberian Peninsula, establishing a new southernmost limit of distribution in the European Atlantic waters and confirming the continuity of the colonization southwards. Between 2012 and 2013 a well-established population was found by SCUBA-divers in Galician waters (north-west Spain) at 6 different man-made floating structures along Ría de Arousa (Almón *et al.*, 2014).

The vector used by *C. mutica* to colonize new areas is not well understood, although it is suspected that it is more likely to be via commercial and recreational shipping, rather than by the stock movement of cultured species (Cook *et al.*, 2007). It has also been suggested that both, artificial buoyant (buoys, ropes and garbage) and natural materials (seaweed) may facilitate the dispersal of the species (Thiel *et al.*, 2003).

From a socio-economic point of view, one of the most important issues is the potential impact of this species on native ecosystems and marine aquaculture, limiting the growth of the mussel *Mytilus* spp. on spat collectors (Daneliya & Laakkonen 2012). The reduced size of these mussels when coexisting with *C. mutica* could be explained by interspecific competition for common food (phytoplankton), in which caprellids benefit from their positioning over mussels; or by the trampling done by caprellids, which would cause the mussels to close, hence interrupting their feeding (Turcotte 2010 within Almón *et al.*, 2014). The fact that each structure is an ideal niche for the establishment of new colonies may have dramatic consequences in a region with 3337 mussel bateas and a production of *Mytilus galloprovincialis* of over 200,000 tonnes yearly (Almón *et al.*, 2014).

The appearance of this species in Ría de Arousa strongly suggests that it may already be present in other Galician localities, since the environmental conditions are similar as are the type of structures on which they were found. In any case, the fact that *C. mutica* was not present in previous surveys suggests that colonization of the species may be relatively recent (Almón *et al.*, 2014).

4) The clown triggerfish *Balistoides conspicillum* (Bloch & Schneider, 1801)

Reported from Palamós (Costa Brava, NE Spain, 41°50′56.19″ N; 3°8′26.29″ E).

General Information:

The clown triggerfish is a tropical fish belonging to the family of Balistidae, and is widespread in the tropical Indo-West Pacific. The species is naturally distributed from East Africa through Indonesia to Samoa, and from southern Japan to New Caledonia. They feed on sea urchins, crabs and other crustaceans, mollusks, and tunicates and are popular aquarium fish with a minor importance to fisheries (Golani & Bogorodsky, 2010 and references therein).

In July 2012, a clown triggerfish, *B. conspicillum*, was encountered at a depth of 3 metres, in Cala Margarida, in front of Palamós (Costa Brava, NE Spain, 41°50′56.19″ N; 3°8′26.29″ E) by a recreational scuba diver (Weitzmann *et al.*, 2015).

The present finding from the Catalan Sea is the first documented occurrence of *B. conspicillum* in the Mediterranean the first Mediterranean occurrence (Weitzmann *et al.*, 2015).

Balistoides cospicillum is a commonly traded ornamental fish and one of the most highly prized aquarium species because of its attractive pigmentation (Reksodihardjo-Lilley & Lilley, 2007).

Considering that *B. cospicillum* is not reported to occur in the Red Sea (Golani & Bogorodsky, 2010), Lessepsian migration cannot be invoked as a suitable pathway of introduction for this species. Because of its importance as ornamental aquarium species, it is likely that this tropical fish had been released from private aquaria (Weitzmann *et al.*, 2015).

5) The silver-cheeked toadfish *Lagocephalus sceleratus* (Gmelin, 1789)

Reported from the Ibiza channel (approx. 39.06666° N, 0.31666° E).

General Information:

On the 31st of July 2014, an individual of the Indo-Pacific species *Lagocephalus sceleratus* was captured by deep bottom trawling in the North-western Mediterranean over muddy bottoms in the Ibiza channel (approx. 39.06666° N, 0.31666° E) between 350–400 m depth (A. Izquierdo-Muñoz and D. Izquierdo-Gomez, 2014).

Within the boundaries of the Mediterranean Sea, *L. sceleratus* was first recorded in February 2003 in Gökova Bay (Turkey). Subsequently, the species spread quickly along the Levantine Basin to the Adriatic Sea. Near the transition zone, between the Eastern and Western Mediterranean basins, two individuals caught in September 2011 and 2012 were reported in the region of Bizerte (Tunisia) (Ben Souissi *et al.*, 2014 and references therein). Nowadays, *L. sceleratus* and *Fistularia commersonii* are the only lessepsian fish species reported in Spanish Mediterranean waters, both demonstrating to be very fast colonizers as only eleven and seven years were needed to cross the Western Mediterranean after their first citation in the Eastern basin (A. Izquierdo-Muñoz and D. Izquierdo-Gomez, 2014). Consistently, both are considered two of the 100 "worst invasives" in the Mediterranean

(Streftaris & Zenetos, 2006), and there are concerns about potential impacts on local fisheries resources. Tetrodotoxine is present in the liver of *L. sceleratus* and special attention should be paid in order to prevent intoxication and protect public health (Ben Souissi *et al.*, 2014 and references therein).

6) The yellow tang *Zebrasoma flavescens* (Bennett, 1828)

Reported from Sitges (Costa Daurada, NE Spain, 41°13'27.09"N, 1°47'22.35"E).

<u>General Information</u>:

The yellow tang is a small tropical reef fish belonging to the family of Acanthuridae. It is a northern hemisphere Pacific species distributed from Hawaii (where it is abundant) to the Ryukyu Islands, including the Marshall Islands, Wake, Minami Tori Shima (Marcus Island), Mariana Islands, and Ogasawara Islands. They may occur singly or in groups of up to a few hundred individuals and they feed mainly on algae during the day (Weitzmann *et al.*, 2015 and references therein).

In October 2008, a yellow tang *Z. flavescens* was observed at a depth of 6 metres in front of the town of Sitges (Costa Daurada, NE Spain, 41°13'27.09"N, 1°47'22.35"E) (Weitzmann *et al.*, 2015).

The present finding from the Catalan Sea is the first documented occurrence of *Z. flavescens* in the Mediterranean (Weitzmann *et al.*, 2015).

According to Wabnitz *et al.* (2003, within Weitzmann *et al.*, 2015), *Z. flavescens* is one of the ten most traded species of ornamental fishes worldwide, and the number of specimens imported between 1997 and 2002 has been estimated to exceed 38,000 in the European Union. Considering that *Z. flavescens* is not reported to occur in the Red Sea (Golani & Bogorodsky, 2010), Lessepsian migration cannot be invoked as a suitable pathway of introduction for this species. Because of its importance as ornamental aquarium species, it is likely that this tropical fish had been released from private aquaria (Weitzmann *et al.*, 2015).

7) The hyperiid *Platyscelus armatus* (Claus, 1879)

Reported from El Hierro (27º 39.0'N, 18º 03.421'W) and Tenerife (28º 05.681'N 16º 50.305'W and 28º 04.670'N, 16º 49.440'W) in the Canary Islands.

<u>General Information</u>:

Platyscelus armatus is widely distributed in the Pacific (Australia, Indonesia, China Sea, Chile, Perú, Colombia (Gorgona Island) and Hawaii Islands), Indian and Atlantic Oceans, the Lesser Antilles, Venezuela (Isla Trinidad) and even the Falkland Islands. In the eastern Atlantic this species was previously unknown (Mingorance *et al.*, 2014 and references therein).

In April 2012, the oceanographic vessel 'Cornide de Saavedra' trawled three specimens of *P. armatus*, while conducting a mesopelagic survey, capturing one specimen from the south-western slope of El Hierro (27º 39.0′N, 18º 03.421′W) and two specimens from similar slopes of Tenerife (28º 05.681′N, 16º 50.305′W and 28º 04.670′N, 16º 49.440′W), Canary Islands (Mingorance *et al.*, 2014).

Previous Sightings

The subcrenate ark shell *Anadara kagoshimensis* (Tokunaga, 1906)

Reported from Ría de Arousa (42º 37.260′N, 8º 46.790′W), Galicia, NW Spain, in May 2013 (Bañón *et al.*, 2015).

Previous sightings are from:

First record was from the Eo estuary (43º 28′N, 7º 03′W) (between Galicia and Asturias), Bay of Biscay (N Spain), in 1993–1994 (Cigarría and Valdés 1996, within Bañón *et al.*, 2015).

Ría de Vigo, Galicia, NW Spain, before 2003 (Pérez, 2003 within Bañón *et al.*, 2015).

Catalonia (40º 26′N, 0º 41′E), NE Spain, in 2002–2004 (Sánchez *et al.*, 2007).

General Information:

The native distribution of *A. kagoshimensis* includes the coasts of the central Indian Ocean and the western Pacific, from India, Sri Lanka, Indonesia, Korea, China, Japan and northern Australia. The invasive process of *A. kagoshimensis* began in the Mediterranean Sea where it was introduced accidentally, most likely by shipping. It was first reported as *Scapharca* cf. *cornea* off Ravenna (Adriatic Sea, Italy) in 1969 and invaded the Venice Lagoon in the mid-1970s. The present distribution includes the western and eastern Mediterranean, the Catalan, Adriatic, Aegean, Marmara and Azov Seas, as well as along the coasts of Bulgaria, Romania, Ukraine, Russia, Georgia and Turkey in the Black Sea. In the Atlantic European waters, it was first reported in the Eo estuary (north of Spain) in 1993–1994 and in 2003 in St. Philibert (Morbihan, West France). Previously, in grey literature, the presence of *A. kagoshimensis*, as *Anadara inaequivalvis* (Bruguière, 1789), had been reported in Galician waters among the European flat oyster *Ostrea edulis* cultured on floating platforms in the Ría de Vigo, together with specimens of *A. transversa* (Say, 1822) reported as *A. demiri* (Bañón *et al.*, 2015 and references therein).

Anadara kagoshimensis is listed among the hundred worst invasive species in the Mediterranean Sea (Streftaris & Zenetos, 2006). The haemolymph of *A. kagoshimensis* contains nucleated erythrocytes packed with haemoglobin, which enables this clam to bind oxygen in oxygen-deficient conditions, and haematin, which is involved in the removal of sulphides (Morello *et al.*, 2004). Due to the presence of haemoglobin in its tissues, this species is capable of long-term existence under the hypoxic conditions in the near-bottom layer of water, when other mollusks die (Shiganova, 2008, within Bañón *et al.*, 2015). Moreover, a further competitive advantage of this mollusk could be its ability to attach itself to all types of hard substrata by means of a byssus, acting indistinctly as an epifaunal or infaunal species. In the Adriatic and Black Seas, enormous proliferations of *A. kagoshimensis* have ousted autochthonous bivalves such as *Chamelea gallina* (Linnaeus, 1758), *Mya arenaria* (Linnaeus, 1758) and *Cerastoderma glaucum* (Bruguière, 1789) from their habitats (Streftaris & Zenetos, 2006; Kolyuchkina & Miljutin, 2013).

The occurrence of the alien species *Anadara kagoshimensis* was reported for the first time in the Ría de Arousa (42º 37.260′ N 8º 46.790′ W), Galicia, NW Spain, in May 2013 (Bañón *et al.*, 2015).

Aquaculture seems to be the most probable hypothesis to explain the presence of *A. kagoshimensis* in Galician waters, introduced accidentally as clam spat together with *R. philippinarum* from the Italian Adriatic, where *A. kagoshimensis* is a well-established invasive species (Crocetta *et al.*, 2013).

Not Seen Species Yet

4. Pathogens

5. Meetings

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Sweden

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Overview

Two new crustacean species have been recorded in the Swedish part of the Baltic Sea, the amphipod *Grandidierella japonica* and the mud crab *Rhithropanopeus harrisii*. Occurence oft he polychaeta *Ficopomatus enigmaticus* have also been discovered in the Baltic Sea. There have been several new reports of American lobster *Homarus americanus* in Kattegat/Skagerrak including egg bearing females and the round goby *Neogobius melanostomus* has expanded its range significantly in the Baltic Sea. A new herpesvirus (OsHV-1 μvar) caused massive mortality in Japanese Oyster, *(Crassostrea gigas).*

1. Regulations and policies:

Several new actions especially towards *Homarus americanus* has been undertaken by the Swedish Agency of Marine and Water Management (SWAM):

- Information campaign targeting companies (restaurants and fishmonger) selling living American lobsters.
- Start with a revision of the national regulation for fish stocking (FIFS 2011:13) and the strategy for stocking of fish (Fiskeriverket 2001).
- A revision of the national strategy for invasive species and implementation of the new EU regulation (1143/2014/EG) was commission by the government in 2014 and developed by SEPA in cooperation with SWAM, Jordbruksverket and SVA (Anon 2014).
- A new suggestion for monitoring, including alien species, within the Marine Strategy Framework Directive was put forward (Havs och Vattenmyndigheten 2014).
- A national Classification method for risk assessment of invasive species was developed, coordinated by Swedish Species information Center, SLU and ordered by SEPA, SWAM, SJV, SKS (Aronsson *et al.* 2014).
- A new action program for MSFD developed by SWAM is under review during the first half of 2015 (Erland Lettevall SWAM, pers. comm).

2. Intentional:

No information

3. Unintentional:

New Sightings

The amphipod *Grandidierella japonica* Stephenson, 1938 was first observed in Sweden in the Oresund Strait in 2014 (approximate location 55.5 N 12.9E WGS84DD, Berggren 2015). It is native to the Pacific Ocean and has probably spread to the Baltic Sea with the aid of ballast water and biofouling (Berggren 2015, Jourde *et al.* 2013). The species lack a pelagic larva stage and hence it spreads either by adult movement or attached to drifting objects. In North America the spreading is associated to ship traffic (Pilgrim *et al.* 2013). It is sensitive to heavy metals and is used as screening species in toxicity tests (Nippon *et al.* 1998, Lee *et al.* 2005). There is little evidence for its impact but it might have negative impact by competition with native amphipods http://www.nature.nps.gov/water/marineinvasives/assets/PDFs/Grandidierella_japonica.pdf).

The mud crab *Rhithropanopeus harrisii* (Gould 1841), was discovered in Sweden in 2014. One juvenile specimen was found in Oxelösund in the central Baltic Sea in September 2014 (approximate location 58.6 N 17.1E WGS84DD, Berggren 2015). This originally north western Atlantic brackish water dwarf crab has probably spread by ships traffic, either ballast water or biofouling. It is possible that it is a secondary spread from other invaded sites in the Baltic Sea (Fowler *et al.* 2013).

The polychaetae *Ficopomatus enigmaticus* was first discovered in Sweden in 2013 in Oresund, close to the city of Malmö. The discovery was made in the science project CHANGE, Changing antifouling practices for leisure boats in the Baltic Sea (ICES WGBOSV report 2015).

Previous Sightings

In 2014 the ctenophore *Mnemiopsis leidyi* had the highest densities since its first occurrence in a monitoring program in the Gullmar fjord in Skagerrak (Lene Friis Möller, pers comm). And it has also been observed in high quantities in the Oresund strait in 2014 (Peter Göransson, PAG. pers comm). There is still no confirmation if the parasitic Sea anemone *Edwardsiella lineata* is the one parasitizing *Mnemiopsis leidyi* or if it is the native Sea anemon *E. carnea* (Nellbrink 2014 fact sheet on www.frammandearter.se, Lene Friis Möller, pers comm.)

Massive numbers of dead *Crassostera gigas* were found on the coasts of Skagerrak in September 2014 (see section on pathogens below), however recruitment of new oysters seem to have been very high the last summer (Jansson *et al.* in press; Lena Kautsky pers. comm http://tangbloggen.com/2014/10/31/ryktet-om-massdod-av-japanska-jatteostron-forhastat/) so the effect of this possible mass extinction on the population is unknown.

Callinectes sapidus has not been observed in Sweden. The record from Kattegat 1951 in AquaNIS and HELCOM (Heyer 2014) probably is a misunderstanding of the cited literature which reveals: "A single specimen was recorded from Øresund, Denmark in 1951, and the next Danish record is from 2007 near Skagen, the northernmost point of Denmark (Tendal & Flintegaard, 2007). Hence it is considered non-established in these two countries…". This refers to Denmark–Germany, not Sweden–Denmark. It is unlikely that this species could be introduce in Swedish waters but likely in the OSPAR area from the Netherlands and Belgium southwards, possibly in the German Bight (Jensen 2010).

The combjelly *Mertensia ovum* have been removed from the Swedish list of alien species at www,.frammandeater.se since it is now considered a glacial relict (Sture Nellbring and Cathy Hill pers comm, county board of Stockholm)

Range expansions

The Japanese shore crab *Hemigrapsus sanguineus* (De Haan 1835), was first observed in Sweden in 2012 close to Gothenburg in the border between Kattegat and Skagerrak (Berggren 2013). On the 5th of September in 2014 a second individual of this Asian crab was found. This time in Ustö, Kattegat, 50km south of the first location (Jansson *et al.* in press, http://www.artportalen.se/Sighting/16900218,). All sightings in the Gothenburg area probably result from ballast water of ships entering the harbour of Gothenburg. However, if and when the species will be sighted further north on the coast, around the Smögen area, it will probably be a case of secondary spread by water currents from France/Belgium/Holland where the species is established. At Helgoland in the German Bight, that is even closer and in the start of the Jutland current, ovigerous females have been caught.

The shrimp *Palaemon elegans*, is native on the Swedish west coast, so previous sightings of the genetic variant from the Mediterranean Sea spread by ballast water in the Baltic Sea has probably been overlooked. New information suggests it might have been present in the Hanö Bay (Bight?) already in 1999 (Nellbring 2014 fact sheet on www. frammandearter.se) and is confirmed as far north as the Trosa Archipelago south of Stockholm (Eriksson *et al.* 2011).

During summer and autumn 2014, 17 American lobsters, *Homarus americanus,* whereof 4 egg bearing females were found in the Gullmar fjord in Skagerrak (Nellbring 2014 fact sheet on www.frammandearter.se). An updated figure reveals that 21 lobsters found in 2014/2015 have been confirmed by genetic analysis to be *Homarus americanus* ; 19 in the Gullmar fjord, 2 south of Lysekil and 1 in Marstrand (11 March 2015, Vidar Öresland pers comm). This means that in total 26 American lobsters have been verified in Sweden. Their origin is probably escapees from the food industry holding live specimens.

Round Goby, *Neogobius melanostomus,* is rapidly expanding its range in the Baltic Sea (Fig 1). In 2014 it was reported from several locations in the sound between the island of Öland and the Swedish east coast. In addition, an inventory of harbors in Gotland by the county board found three previous unknown occurrences of the species (Andersson 2015t). The increased frequency of reports in the Gothenburg harbor area suggests an increasing abundance in the area. Occurrences are logged in the citizen science database www.artportalen.se and also presented at www.slu.se/svartmunnadsmorbult.

No new species are recorded from the Gulf of Bothnia and previously recorded species *Marenzelleria spp, Potamopyrgus antipodarium and Cercopagis pengoii* show no recent changes in distribution and abundance (Jan Albertson, pers comm. Umeå Marine Science Centre, Kristin Dahlgren, county of Västerbotten and Information central for the Gulf of Bothnia)

Marenzelleria cf *viridis* occurs regularly in Kungsbackafjorden, outside Helsingborg and on the Swedish south coast (Göransson 2014).

4. Pathogens

Herpes virus in Japanese Oyster, (Crassostrea gigas)

In the autumn of 2014, several cases with high mortality among Pacific oyster (*Crassostrea gigas*) were observed along the Swedish west coast. Acute mass mortality was also seen in a farm with juvenile stages of Japanese oyster. No other species of bivalve animals seemed to be affected but *C. gigas*. University of Gothenburg immediately implemented field sample collection in collaboration with the oyster farm to examine the extent of damage. The university has followed the establishment of this new species along the Swedish coast for several years. In Norway, observations of high mortality in wild stocks of Japanese oyster have been made on several occasions north of the Swedish border up to the Oslo Fjord. The first mortality observed in Sweden coincided with the changed direction of currents, and a longer period of bottom water upward flow changed to currents with more southernly direction. Brackish water was carried along the Swedish coast and salinity decreased rapidly from over 30 down to 24 per thousand, which may have induced stress in the oyster population. International studies have shown that Japanese oysters are very susceptible to a new variant of oyster herpes virus (OsHV-1 μvar), first demonstrated in France in 2008. Presence of the same virus in the collected Swedish samples was confirmed with PCR at National Veterinary Institute, SVA in November. How many of the total population of Japanese oysters that have been eliminated is still unknown since no inventory has yet been made. However, in one affected oyster farm near the islands of Koster, over 10 million oyster larvae died (Areskog & Alfjorden 2014).

Confirmation of previous findings

During the health screening of Baltic salmon in the national conservation program 2011, large granulomas in the kidney and liver were found in one returning salmon. The fish were sampled negative for viral and BKD-infections. Histological examination showed fungal infection and further analysis isolated an *Ochroconis spp.* –like fungal organism. On agar the isolate where seen as dark brown and "hairy" colonies (PG-1 and marine agar plates). These results have now been verified as *Ochroconis globalis* (new species), which means that this is the first finding of the disease in fish in Sweden and Europe (Areskog & Alfjorden 2014). The natural habitat for this newly described species is not known (Samipitak *et al.* 2015) and hence it is unknown if it is introduced by humans or not.

5. Meetings

Swedish University of Agricultural Sciences was co-organising the workshop on 'Round goby – need for collaborative science and management in Nordic and Baltic countries', held on 4th -5th September 2014 in DTU-Aqua Charlottenlund, Denmark together with DTU Aqua, SYKE and UT-EMI. The workshop was co-funded by BONUS BIO-C3 and NORDEN. Scientists from all Baltic countries were invited and attended. Key-note lecture was given by Dr. D. Heath, Canada. In addition to scientists, various stakeholder representatives participated. These include: Baltic Sea RAC, ICES, the Danish Ministry of Environment, GEMBA Seafood Consulting, Ministry of Food, Agriculture and Fisheries of Denmark. The meeting was attended around 50 participants.

On behalf of Sweden, the following oral presentations were given:

Charlotta Kvarnemo (Gothenburg University): Sperm, salinity and geographical distribution

Magnus Thorlacius (Umeå University): Importance of behavioral types during species invasions Gustav Hellström (Umeå University): Connection invasion dynamics and goby behavior: Methods and approaches

Ann-Britt Florin (SLU Aqua): Invasion history of round goby in Sweden and the shortcomings of environmental monitoring programs

Joint HELCOM/OSPAR Task Group on Ballast Water Management Convention Exemptions (Helcom/Ospar TG BALLAST) 4th meeting Copenhagen May 2014, 5th meeting Madrid 2015

Joint HELCOM Coreset/OSPAR ICG-COBAM workshop Gothenburg 30 September 2014.

6. Other

SWAM have taken over the drift of the webportal www.frammandearter.se, commisioned Informationscentralen to update the factsheets and will develop it to also cover freshwater.

An impact analysis of invasive species performed by the county board of Västerbotten according to the county board classification scheme resulted in the conclusion that 7 coastal water districts in the Bothnian Bay were in danger due to invasive species. *Potamopyrgus antipodarum* and *Elodea sinensis* were the species judged as invasive in the area. *Amphibalanus improvisus* and *Eriocheir sinensis* were also assessed but not found to be occurring in such a density to be a risk (Kristin Dahlgren, county of Västerbotten and Information central for the Gulf of Bothnia pers. comm. www.viss.lansstyrelsen.se).

Two scientific projects coordinated by AquaBiota Water Research and financed by the Swedish Environmental Protection Agency (SEPA) and the Swedish Agency for Marine and Water Management (SWAM) with an impact on non-indigenous species were conducted in 2014: NISSES and VALUES (Johan Näslund AquaBiota, Erland Lettevall SWAM, pers. comm).The project Non-Indigenous Species in Swedish seas (NISSSES) 2014–2016 aims to development indicators for good environmental status regarding marine non-indigenous species in Sweden. In VALUES a case study of the effects of *Marenzelleria* spp on the link between benthic and pelagic ecosystem and the possible consequences of the species on the flow of phosphorus to the water is included (Johan Näslund AquaBiota, Erland Lettevall SWAM, pers. comm.)

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United Kingdom

Compiled by Gordon H. Copp (Centre for Environment, Fisheries & Aquaculture Science – Lowestoft), Lyndsay Brown (Marine Scotland–Science and Paul Stebbing (Cefas–Weymouth), with contributions from: Jenni Kakkonen (Orkney Islands Council Marine Services), Tracy McCollin (Marine Scotland); Robert Packham (Cefas– Weymouth); Eoina Rodgers (Scottish Natural Heritage) and Rachel Shuck-smith (NAFC Marine Centre)

Overview

Various monitoring programmes and biosecurity projects have been completed during 2014 by institutes throughout the UK. These include a biosecurity Plan for the Shetland Isles developed and published which provides supplemtary guideance to the Shetland Islands' Marine Spatial Plan. Guidance for preparing a non-native species biosecurity plan for sites/operations has been published by Scottish Natural Hetitage. The Environmental Research Institute has published results from a rapid assessment of marinas and harbours for marine non-native species and a study on biofouling of commercial vessels has been published. The Marine Biological Association have conducted a number of studies assessing the distribution of non-native species in English and Welsh marinas using rapid assessments. Data gathered have been compared to previous similar studies to assess spread.

Cefas is progressing work that examines the potential use of molecular tools in monitoring for non-native species from environmental DNA (eDNA) that is shed into the water column (in freshwater environments) and from scrape, sediment and water samples (in marine environments). Cefas and the University of Leeds have conducted a number of studies examining the use of hotwater as a biosecurity tools in the freshwater environment, with a range of invasive plant and inverterbrate species tested. Additionally a fact finding exercise was undertaken in New Zealand to examine how the awareness and uptake of the biosecurity programme 'Check, Clean, Dry' has been matained for over a decade. Cefas has undertaken preliminary assessments of chemical control agents deliverd through a spiked-bait feeding station system in the control of signal crayfish (*Pacifastacus leniusculus*) and killer shrimp (*Dikerogammarus villosus*). Cefas has co-ordinated the Marine Pathways Project on behalf of Natural Resource Wales and Defra. The project has had contributions from a number of organisations from across the UK and Republic of Ireland. Work conducted by the project has included the assessment of high risk location of introduction, the development of biosecurity advise for stakeholders, the development of monitoring and surveillance programmes and tools, including assessing the distribution of certain marine non-native species, in addition to examining control meaures for certain marine invasive species. The Marine Pathways Project is due to end March 2015, but the group will continue to provide advice to Defra and devolved administrations. Cefas has continued to investigate methods of controlling invasive species of crayfish, with a 2.5 year trapping study due to end in March 2015, and to develop risk analysis tools, with new aquatic invasive species screening tool (Aquatic Species Invasiness Screening Kit (AS-ISK) due to be released in March 2015.

Other projects nearing completion include a Scottish Pacific oyster survey, an invasive non-native species early warning system project, a genetic study of UK populations of

Didenmum vexillum and the 2014 marina surveys in Orkney. A sighting of a Chinese mitten crab was reported from Norfolk while a moult was reported from the River Clyde. The Asian shore crab was reported from two locations in Wales in Kent and the quagga mussel has been identified from two nearby locations in the south east of the UK.

Regulations

No new regulations were introduced in 2014.

Intentional introductions

Fish

Summaries of imports of salmonid eggs into the UK can be found in Finfish News for England and Wales (www.cefas.co.uk/publications/finfish-news.aspx) and Marine Scotland Science publications for Scotland (www.scotland.gov.uk/Topics/marine/science/Publications/publicationslatest/FishFarmProductionSurveys). UK export statistics are also presented in these publications.

Invertebrates

Summaries of the imports of Pacific oysters can be found for England and Wales in Finfish News (http://www.cefas.co.uk/publications/finfish-news.aspx) and Marine Scotland Science publications for Scotland (www.scotland.gov.uk/Topics/marine/science/Publications/publicationslatest/FishFarmProductionSurveys). Deliberate releases of Pacific oysters for cultivation, mainly from UK hatcheries, continue at a similar level to that in previous years. Oyster consignments for growing on have been imported from Guernsey and France. Movement restrictions to prevent the spread of a new and highly pathogenic strain of oyster herpes virus (OsHV-1 μvar) remain in place.

Imports of non-native species of live bivalve molluscs and crustaceans for human consumption continue. There were further reports of North American lobsters being captured in pots set in the wild.

There are continued low-level attempts to introduce non-native crayfishes, which are illegal to keep in the UK under national legislation, through the aquarium trade.

Unintentional introductions

New sightings

In September 2014, a Chinese mitten crab (*Eriocheir sinensis*) was reported to have been found in the River Glaven, County of Norfolk. This is the first report of the species in this river catchment and indeed in this part of England.

A moult of a female *E. sinensis* was also reported from the River Clyde (Scottish west coast) in September 2014 (verified by Dr Paul Clark of the Natural History Museum). This is the first record for the species in Scotland, however no live animals have been observed to date. A report has been prepared (Yeomans & Clark, 2014; in press). A survey of the surrounding area will be conducted to monitor for any additional crabs. This work will be coordinated by Scottish Natural Heritage (SNH), Scottish Environment Protection Agency (SEPA) and Marine Scotland Science (MSS).

In May 2014, Asian shore crab *Hemigrapsus sanguineus* was reported for two locations, Glamorgan (Wales) and Herne Bay (Kent), the first such recordings in the UK. In October 2014, the quagga mussel (*Dreissena rostriformis bugensis*), was discovered in the south east of the UK, reported by the UK Environment Agency teams during routine water quality testing on the River Wraysbury and subsequently in the nearby Wraysbury reservoir. The identifications were confirmed by Dr David Aldridge of Cambridge University.

Previous sightings

Invertebrates

Fish

Species not yet reported or observed

A target species list for monitoring and surveillance in the marine environment is currently being developed by Cefas. This will include high priority species currently present and those that are considered likely to arrive in the near future.

Pathogens

Sightings/records

Oyster herpes virus (OHV-1) was found in the River Crouch in Essex after a mortality event was reported to the Fish Health Inspectorate at Cefas.

The parasite *Haplosporidium nelsoni* was discovered in stocks of *Crassostrea gigas* on the River Dart in Devon following reports of increased mortalities. This was the first time that this parasite has been identified in England.

Prolonged high temperatures during the summer months of 2014 resulted in an elevated number of cases of koi herpes virus (KHV) disease, with 23 new designations having been made; this increase in mortality is believed to have resulted from the prolonged high temperatures and mild winter of 2013/14.

General information

The Marine Scotland Science (MSS) study 'Native and non-native marine biofouling species present on commercial vessels using Scottish dry docks and harbours' has now been published in *Management of Biological Invasions* (2014) vol. 5, pp. 85–96. For further information contact Lyndsay Brown (Lyndsay.brown@scotland.gsi.gov.uk)

An MSS study of UK *Didemnum* populations is now complete, and a manuscript has been submitted to *Aquatic Invasions* for publication. For further information contact Lyndsay Brown (Lyndsay.brown@scotland.gsi.gov.uk).

Current collaborations/projects involving the Scottish Association for Marine Science include:

1. Firth of Clyde Forum and Scottish Natural Heritage:

Marine Biosecurity Planning – A review and guidance for preparing a non-native species biosecurity plan for sites/operations. The final report for this project has now been published and is available at:

www.snh.gov.uk/docs/A1294630.pdf

2. Scottish Natural Heritage and Marine Scotland:

The Invasive Non-Native Species Early Warning System project) report is nearing completion and will soon undergo QA. This work included comparing the effectiveness of early warning systems for the detection of marine invasive non-native species in Scottish waters. The methods looked at included rapid assessment survey, settlement panels, scrape samples, in-situ and settlement panel photographs. For further information contact Elizabeth Cook (Elizabeth.cook@sams.ac.uk) or Eoina Rodgers (Eoina.rodgers@snh.gov.uk).

3. Scottish Aquaculture Research Forum and Scottish Natural Heritage:

A Scottish Pacific oyster survey has been completed and results are expected shortly. Sixty sites have been surveyed and results will provide baseline data on the prevalence and scale of 'wild' Pacific oysters in Scotland. For further information contact Elizabeth Cook (Elizabeth.cook@sams.ac.uk) or Eoina Rodgers (Eoina.rodgers@snh.gov.uk).

4. Environmental Research Institute (University of the Highlands and Islands): A comprehensive survey of marine non-native species was undertaken across a number of harbours/ marinas in northern Scotland, July/ August 2012. Large-scale development of wave and tidal energy farms is planned in the Pentland Firth and Orkney waters, northern Scotland and this survey provides the first dataset of presence and distribution of non-native species in the area, and can be used as a baseline to monitor the potential for this development to facilitate the introduction and spread of non-native species. This work has now been pubished in *Aquatic Invasions* (2015) 10: 107–121. For further information contact Chris Nall (chris.nall@uhi.ac.uk)

Cefas has been conducting work in collaboration with the University of Leeds (Alison Dunn) to help underpin the "Check, Clean, Dry" campaign. This has included examining the effectiveness of hot water as a bio-security measure on a range of species including zebra mussels *Dressena polymorpha*, signal crayfish *Pacifastacus leniusculus*, killer shrimp *Dikerogammarus villosus*, floating pennywort *Hydrocotyle ranunculoides*, and curly water weed *Lagarosiphon major*. This work has now be finalised and is due to be published in the near future (Biological Invasions). Other work has included a fact-finding mission to New Zealand to gather information on the sustainable implementation of effective biosecuirty campaigns; a manuscript on this work has been submitted to the *Journal of Environmental Management*. Reports from this work are available, for copies of the reports or further information contact Paul Stebbing (paul.stebbing@cefas.co.uk).

Work is being conducted by Cefas examining methods of controlling invasive species of crayfish started in 2012. There are several different strands to this work looking at different forms of control including: male sterilisation, biocidal control and physical removal. The male sterilisation work has been completed as has the biocidal work, the trapping work is due to finish March 2015. For further information contact Paul Stebbing (paul.stebbing@cefas.co.uk).

An application of the Fish Invasiveness Screening Kit (FISK v2), a decision support tool (www.cefas.defra.gov.uk/4200.aspx), to Turkey was published in 2014 (Tarkan *et al.* 2014). Also published on early view in 2014 were a summary of ENSARS, the European Non-native Species in Aquaculture Risk Assessment Scheme (Copp *et al.* 2014a) and a paper in which ENSARS was applied to species listed on Annex IV of the EU Alien Species Regulation (Copp *et al.* 2014b). A new aquatic invasive species screening tool (AS-ISK) is currently being developed and due to be finalised March 2015. For further information contact Gordon H. Copp (gordon.copp@cefas.co.uk).

The Marine Pathways Project, which began in 2013, aims to reduce the risk associated with pathways by which marine invasive non-native species may be introduced into the British Isles. The main objectives of the project are the:

- Assessment of the presence and distrbution of existing marine INNS.
- Development of monitoring programmes to detect the introduction of invasive non native species.
- Assessment of high risk regions/pathways for marine invasive non native species introduction
- Raising awareness of marine INNS with stakeholders and developing codes of practise to reduce the risk of introduction and spread.
- Research and trialling of strategies for the control and eradication of marine INNS to increase preparedness in the event of their introduction.

The project is a collaborative programme of work including input from Department of Environment, Food and Rural Affairs (Defra), Natural England, Natural Resources Wales - Cyfoeth Naturiol Cymru, Scottish Natural Heritage, Marine Scotland, Irish Sea Fisheries Board - Bord Iascaigh Mhara, Centre for Environment, Fisheries and Aquaculture Science (Cefas), Bangor University, Marine Biological Association and Cornish Wildlife Trust. The project is being co-ordinated by Cefas and funded by Defra and Natural Resource Wales. Much of the work conducted will assist in the implementation of the Marine Strategy Framework Directive. There have been a number of outputs from the project, some of which are still in the process of being finalised. The project is due to end in March 2015, but the group will continue to function and provide advice to Defra and devolved administrations. Published reports, papers and other output are currently available, along with additional information on the project can be found at the projects website, further outputs will be placed on the website as they become available:
(www.nonnativespecies.org/index.cfm?sectionid=105)
For further information contact Hannah Tidbury (Hannah.tidbury@cefas.co.uk) or Paul Stebbing (paul.stebbing@cefas.co.uk).

Work continues at Cefas on the use of molecular tools, in particular environmental DNA (e-DNA) in monitoring for non-native marine and freshwater species – the so-called "e-DNA detection" of non-native species. Tools are being developed to assess rapidly the presence of certain non-native species that are difficult to identify using standard taxonomic techniques. Molecular tests have been developed and are currently being tested against known positive field samples. Work is due to be finalised March 2015 for the marine element of this work area, and the current research contract on the detection of non-native freshwater fishes is due to be completed in March 2016. For further information on the detection of marine species, contact Paul Stebbing (paul.stebbing@cefas.co.uk) and for freshwater and diadromous fishes contact Gordon H. Copp (gordon.copp@cefas.co.uk).

Orkney Islands Council is continuing with identification of samples collected during the 2014 marina surveys. A first sighting of *Asterocarpa humilis* was made in Kirkwall marina in September 2014 during a rapid assessment. This has been reported to the GB Non-Native Species Secretariat. For further information contact Jenni Kakkonen (jenni.kakkonen@orkney.gsi.gov.uk)

A pilot Pentland Firth and Orkney Waters Marine Spatial Plan is being developed by a working group consisting of Marine Scotland, Orkney Islands Council and Highland Council to pilot the process of regional marine planning in Scotland. The pilot Plan is non statutory and sets out an integrated planning policy framework to guide marine development, activities and management decisions, whilst ensuring the quality of the marine environment is protected. One of the general policies within the Plan will deal with invasive non-native species. For further information contact Tracy McCollin (tracy.mccollin@scotland.gsi.gov.uk).

Shetland's Biosecurity Plan developed by the NAFC Marine Centre has been approved and forms supplementary information to the Shetland Islands' Marine Spatial Plan. It is available at: www.nafc.uhi.ac.uk/departments/marine-science-and-technology/biosecurity-planning.

New species recorded in Shetland include *Corella eumyota*, *Dasysiphonia japonica* and *Bugula simplex*. For furher information contact Rachel Shucksmith (Rachel.shucksmith@uhi.ac.uk).

Meetings

Past year (2014)

The following meetings are either focused on non-native species or had non-native species sessions as part of their programme:

Canadian Conference for Fisheries Research (Yellowknife, Canada; 3–5 January 2014)(www.uwindsor.ca/glier/ccffr/).

25th USDA Interagency Research Forum on Invasive Species (Annapolis, Maryland, USA; 7–10 January 2014).

Invasives 2014: Invasive Species Council of British Columbia Public Forum & AGM (Richmond, British Columbia, Canada; 21–22 January 2014).

Invasive Species Educational Forum (Richmond, British Columbia, Canada; 22–24 January 2014).

International Conference on Marine Invasive Species:b Management of Ballast Water and Other Vectors (Muscat, Sultanate of Oman; 17–19 February 2014).

Marine Alliance for Science and Technology Scotand (MASTS) Invasive species workshop (Heriot Watt University, 5 September 2014).

Defra Marine and Freshwater Invasive Non-native Species Workshop (London, 9 July 2014; www.nonnativespecies.org/index.cfm?sectionid=127).

Non-native species in Europe workshop (Norwich, 25 September 2014).

Neobiota 2014 – 8th European Conference on Biological Invasions: "Biological Invasion, from understanding to action" (Anatalya, Turkey, 3–8 November 2014).

Meetings in 2015

The following meetings are either focused on non-native species or have non-native species sessions as part of their programme:

Canadian Conference for Fisheries Research (Ottawa, Canada; 8–11 January 2014)(www.uwindsor.ca/glier/ccffr/).

26th USDA Interagency Research Forum on Invasive Species (Annapolis, Maryland, USA; 13–16 January 2015).

Invasives 2015 – Invasive Species Council of British Columbia (Richmond, Canada; 20–21 January 2015).

Aquatic Invasive Species Summit – Boat Design and Construction in Consideration of AIS (Las Vegas, Nevada, USA; 27–28 January 2015).

Marine Pathways Project conference (Cardiff 25 February 2015) (www.nonnativespecies.org/index.cfm?sectionid=105).

Aquatic Invasive Species and Conservation Workshop (Ligonier, Pennsylvania, USA; 21 March 2015).

XV European Congress of Ichthyology, which will include a session on the ecology, conservation and invasive species (Porto, Portugal; 7–11 September 2015).

North American Invasive Species Management Association Annual Conference (Vancouver, Canada; 18–21 October 2015).

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United States

Submitted by Judith Pederson, MIT Sea Grant College Program and Paul Fofonoff, Smithsonian Environmental Research Center

Highlights

Two new species of algae were reported in the Northwest Atlantic. A green alga *Ulva laetevirens*, from New Zealand was found in Connecticut and a red alga, *Laurencia caduciramulosa,* has invaded Key Biscayne, Florida. The polychaete, *Hediste* (=*Nereis*) *diversicolor*, long thought to be native in New England and Canada (Scituate, Massachusetts to the Minas Basin, Canada) originated in estuaries from the Baltic to Morocco, and the Mediterranean and Black Seas. A few species are expanding their range in the East coast. One species of fish, *Pterois miles/volitans* is a summer migrant that can be found in Long Island Sound, but has established populations throughout most of the southeastern US to North Carolina. Only one carapace of a female Chinese mitten crab, *Eriochier sinensis* was found in 2014 in the Mianus River, Long Island Sound.

1. Regulations:

An update on new regulations and policies (including, aquaculture and vector management)

For regulations on the National Ocean Atmospheric Administration's aquaculture provides federal regulations as of 2013. visit http://www.nmfs.noaa.gov/aquaculture/policy/24_regulating_aquaculture.html for more information including other federal regulations on aquaculture.

Note that all states may have more stringent regulations than federal regulations.

Vector regulations are under the purview of the U.S. Coast Guard and the Environmental Protection Agency. No new additions to existing regulations were disseminated this year. Note that to some extent, state may be more stringent, but recent regulations allow the federal regulations to supercede state regulations.

2. Intentional:

Synthesis of introductions

The NOAA Fisheries, Fisheries Statistics Division has automated data summary programs that anyone can use to rapidly and easily summarize U.S. commercial fisheries landings. It also manages the U.S. foreign trade data which for 2011, 2012 and 2013 have been updated to reflect U.S. Census Bureau revisions published on 6/4/2014.

The Fisheries Statistics Division of the National Marine Fisheries Service (NMFS) has maintained a foreign trade data base for many years. We have developed a series of programs that can be used to summarize U.S. foreign trade in fishery products for the years 1975 to present. You can summarize the kilos and dollar value by your choice of years, products, countries, and the type of trade.

The data from the Foreign Trade Division of the U.S. Census Bureau that compiles the information submitted by importers and exporters to the U.S. Customs and Border Protection. The data are normally scheduled for release to the public 43 days after the close of the statistical month.

Importers and exporters submit their transactions to the U.S. Bureau of Customs and Border Protection using the international Harmonized Commodity Description and Coding System (HS). The HS is the system for classifying goods in international trade which has been developed under the auspices of the World Customs Organization (WCO), located in Brussels. The WCO is an international organization consisting of representatives of about 161 countries. The U.S. is represented in the WCO by the U.S. Bureau of Customs and Border Protection. The International Trade Commission maintains the *Harmonized Tariff Schedule of the United States* used by importers to classify their goods. Exporters use the *Schedule B* maintained by the U.S. Census Bureau.

Data are available at: http://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/.

3. Unintentional:

New Sightings

Ulva laetevirens (Areschoug 1854) (Chlorophyta), Holly Pond, Stamford, Connecticut, Long Island Sound (6/21/2011); 41°2′57.87′′N, 73°29′ 55.66′′, molecular identification, established population (Mao *et al.* 2014). This green alga was described from Australia, and later found in New Zealand and the Mediterranean Sea. This is the second record from North America. It was previously collected in Kouchibouguac National Park, New Brunswick, on the Gulf of St. Lawrence (Kirkendale *et al.* 2013). Possible vectors include hull fouling and ballast water. Populations in all these locations show little genetic divergence (Kirkendale *et al.* 2013; Mao *et al.* 2014).

Laurencia caduciramulosa (Masuda & Kawaguchi 1997) (Rhodophyta) Key Biscayne, Florida, Atlantic Ocean (8/13/13, 25°43'29.18"N, 80°08'41.78" W, (Collado-Vides *et al.* 2013), growing on *Thalassia testudinum* blades). This red alga was described from Vietnam, and later found in the Mediterranean, the Canary Islands, Brazil, and Cuba. This red seaweed is expanding its range around in tropical and subtropical world, probably due to transport by shipping.

Previous Sightings *Hediste* (=*Nereis*) *diversicolor*

Hediste (=*Nereis*) *diversicolor* (O. F. Műller 1776) is a long-established polychaete in the northwest Atlantic, in the Gulfs of Maine and St. Lawrence, but recent molecular analysis indicates that it is a historical introduction to the East Coast of North America (Einfeldt *et al.* 2014). The nominal species is actually a complex of many cryptic species distributed from the Baltic to Morocco, and in the Mediterranean and Black Seas, frequently in brackish estuaries. Northwest Atlantic populations represent three of these cryptic species, but their genetic diversity is greatly reduced, relative to European populations (Einfeldt *et al.* 2014). The earliest record, of which we're aware, in North American waters, is from the Shubencadie River, Nova Scotia, in the Bay of Fundy (1922, Berkeley and Berkeley 1956**)**. The earliest US record is from Durham, New Hampshire, on the Great Bay (5/7/1953, MCZ IZ 35699, Museum of Comparative Zoology 2014). The known range in the Gulf of Maine is from Scituate, Massachusetts, north to Kingsport, Nova Scotia on the Minas Basin (Pettibone 1963). Populations in the Gulf of St. Lawrence are genetically distinct and represent a separate introduction from different European populations (Breton *et al.* 2003; Audzijonyte *et al.* 2008; Einfeldt *et al.* 2014). This polychaete has direct development, and lacks a planktonic larvae or pelagic spawning forms. Early introductions by solid ballast are the most probable vector (Einfeldt *et al.* 2014), although juveniles swim to a limited extent (Scaps 2002).

Range Expansions

Red Alga

The red alga, *Heterosiphonia japonica*, appears to be expanding its range and increasing in areas where it is found. The subtidal alga is difficult to identify in the field and on beaches, making definitive identification by divers and quantification a challenge.

Crustaceans-Barnacles

Megabalanus coccopoma (Titan Acorn Barnacle) This tropical Eastern Pacific barnacle was first reported in US waters as dead specimens collected in 2001 in Texas, Florida, and Louisiana, but was found to be established in Florida by 2005. Established populations were collected as far north as Rodanthe, North Carolina, just north of Cape Hatteras. In experiments, the animals ceased responding at 4.7 ◦C, and died at 2.3 ◦C. Larval development was completed to settlement at temperatures as low as 16 ◦C. Crickenberger (2014) predicted that reproducing populations could occur as far north as South

Bristol, Maine (43.85 °N, 69.54 °W). However, the larvae of the existing populations near Cape Hatteras had sufficient metabolic reserves for natural dispersal only as far as Virginia Beach VA. During the severe winter of 2010, the population retracted southward to just north of Cape Canaveral, and then recolonized its earlier range by 2012. Adult functional tolerance appears to be the major factor limiting poleward range extension in this barnacle (Crickenberger 2014).

Shrimp

Palaemon elegans (rock shrimp) and *P. macrodactylus* (Oriental shrimp) Two shrimp species were first reported in 2010 in the East Coast of the U.S.; *Palaemon macrodactylus* was first reported in New York City area and is moving northward whereas *P. elegans* was first observed in Salem, Massachusetts. Ongoing studies to determine the extent of the species distribution and abundance was initiated last summer (J. Carlton, Williams-Mystic Marine Program, pers. comm., 2015).

Crabs

Eriocheir sinensis (Chinese mitten crab) Only one report of a Chinese Mitten Crab was received in 2014. This crab was an adult female (55 mm carapace width), collected on October 20, 2014 from the Mianus Pond fishway in Greenwich, Connecticut, on the Mianus River, a Long Island Sound tributary. A juvenile crab was collected here in 2012 (Matthew Goclowski, Darrick Sparks, personal communications, USGS Nonindigenous Aquatic Species Program 2014). We have received no other reports of mitten crabs form the East Coast of the United States.

Although the European green crab, *Carcinus maenas* has been in North America for over 200 years, the recent invasion (reported in 2007) of a northern haplotype was anecdotally correlated with increased populations to the south. The increased crab populations are a concern for shellfishermen. A recent unpublished study by Larissa Williams from Bates College and colleagues suggests that the northern haplotype is restricted to Penobscot Bay, Maine and north. The increased crab populations reported in areas south of Penobscot, Maine may be due to warming sea temperatures, but even in cold winters, the population sizes appear to increase in many areas. It is unclear if this is a climate change phenomenon or the result of other factors that are favorable for green crabs. Several groups are monitoring populations.

Bryozoans

Tricellaria inopinata As previously reported, this Pacific Ocean bryozoan was first reported from Woods Hole, Massachusetts, in 2010 (Johnson *et al.*, 2012), and later expanded its range south to Newport, Rhode Island, and north to Hampton New Hampshire (Wells *et al.* 2013). A genetic examination of 4 populations (Woods Hole, Boston, Marblehead, and Gloucester, Massachusetts) found that the Marblehead and Gloucester populations had a separate origin from the Woods Hole population, indicating at least two separate introductions (Johnson and Woolacott 2014).

Ascidians

Clavelina lepidiformis, the lamp bulb sea squirt has become established at three locations in Connecticut, but has not been observed in outside of the localized area 2014 (N. Balcom, CT Sea Grant College Program, pers. comm.).

Fishes

Pterois miles/volitans spp. Lionfish (probably mostly *P. volitans*, Red Lionfish) are now extensively distributed from Cape Hatteras to the Texas-Mexico border (USGS Nonindigenous Aquatic Species Program 2015). Within that range, Lionfish have been found utilizing the Loxahatchee River estuary in Florida, and can be expected to be found in other southeastern US estuaries. Lionfish were found to survive and feed at salinities as low as 5 PSU in aquaria, and in the field, entered lower salinities briefly while pursuing prey. Fish, caged in a downstream location in the estuary, tolerated tidal salinity fluctuations between 7 and 35 PSU, but fish caged at locations further upstream did not survive when salinities dropped below 5 PSU (Jud *et al.* 2014). Predation by these caged lionfish had significant effects on benthic organisms, reducing numbers of Grass Shrimps (*Palaemon* spp.) by ~90% (Layman *et al.* 2014). Moving offshore, the Gulf of Mexico, a Remotely Operated Vehicle (ROV) survey found numerous lionfishes in deep mesophotic continental shelf communities, at 50–175 m depth, with an apparent increase in abundance from 2011 to 2013. These communities, dominated by coralline algae, sponges, and soft corals, are considered ecologically sensitive habitats (Nuttall *et al.* 2014). A genetic study of lionfish in Puerto Rico found that only *P. volitans* was present in Puerto Rico, and that there was an apparent decrease in genetic diversity, from North Carolina to Puerto Rico and Colombia, suggestive of a founder effect, resulting from gradual dispersal from source populations in Florida (Toledo-Hernandez *et al.* 2014).

In 2014, a single specimen of *Acanthurus pyroferus* (Chocolate Surgeonfish) was caught near Palm Beach, Florida. This was the only non-established, exotic marine fish reported in US waters in 2014, according to the USGS Nonindigenous Aquatic Species Database. At least 32 species of tropical marine fishes, mostly single specimens of Indo-Pacific species have been released in Florida waters since 1990 (USGS Nonindigenous Aquatic Species Program 2015).

General Comments

Two documents have been released for public review. The Draft National Invasive Lionfish Prevention and Management Plan was placed in the Federal Register for a public comment period (http://www.anstaskforce.gov/default.php) and will be revised prior to release as a final plan. The Aquatic Nuisance Specie Task Force and the National Invasive Species Council has released a Bioinvasions in a Changing World: A Resource on Invasive Species-Climate Change Interactions for Conservation and Natural Resource Management is available at http://www.anstaskforce.gov/default.php.

Species Not Yet Observed.

There are several species that have invaded areas to the south of New England that have not been reported north of New York City or Long Island Sound. These species include a mollusk, *Rapa venosa* (present in the Chesapeake); a tunicate, *Styela plicata*, seen in southern areas of the U.S. east coast; and the isopod, *Synidotea laevidorsalis* observed as far north as New York City. Several species have been observed as "summer" vagrants, a barnacle *Amphibalanus amphitrite* was observed near a warm water outfall pipe in Massachusetts but did not survive the winter; the bryozoan *Zoobotryon verticullatum*, has been found both in Connecticut and Massachusetts but does not survive the winter, the amphipod, *Melita palmata*, was found in Massachusetts and the lionfish *Pterois miles/volitans* spp. has been observed in Long Island Sound.

Two crustacean species are present in Europe but have not been reported in the U.S. The barnacle *Austrominius* (=*Elminius*) *modestus* has been in Western Europe since World War II where it outcompetes native barnacles. Despite the success of the introduced *Hemigrapsus sanguineus* in the U.S., the shore crab *Hemigrapsus takanoi,* abundant in Western Europe has not been reported in the northwest Atlantic. Two tunicate species *Corella eumyota* and *Perophora japonica* are fouling organisms in Western Europe and are candidates for invasion to the U.S.

4. Pathogens

No new pathogens reported.

5. Meetings

International Conference on Marine Bioinvasions, Sydney Australia, January 19–21, 2016. www.marinebioinvasions.info

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Annex 4: Information on new invasions and range expansions of non-indigenous species as reported by Canada

Region	Date of Record	Genus	Species	Location name	latitude	longitude	Population status	Region of 1st record	date of 1st record	Likely vector	References
Canada, Nova Scotia	31–10–2012	*Ascidiella*	*aspersa*	Lunenburg Harbour; Railway wharf	N 44.37525	W 64.30687	Observed	south shore Nova Scotia, Lunenburg harbour	2012	unknown	
Canada, Nova Scotia	30–11–2013	*Ascidiella*	*aspersa*	Lunenburg Harbour; Railway wharf	N 44.37525	W 64.30687	Established			unknown	
Canada, Nova Scotia	30–11–2013	*Ascidiella*	*aspersa*	Corkum's Island	N 44.36113	W 64.33362	Established			unknown	
Canada, Nova Scotia	30–11–2013	*Ascidiella*	*aspersa*	Lunenburg Harbour, Fisheries Museum wharf	N 44.3754	W 64.3105	Established			unknown	
Canada, Nova Scotia	31–10–2014	*Ascidiella*	*aspersa*	Lunenburg Harbour, Fisheries Museum wharf	N 44.3754	W 64.3105	Established			unknown	
Canada, Newfoundland	23.10.2007	*Botrylloides*	*violaceus*	Belleoram	N 47.527194	W 55.409167	First record, established, expanding	Lunenburg and Mahone Bay area of N.S.	2001 (Carver, Mallet & Vercaemer, 2006b)	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	McKenzie *et al.*, 2010; Deibel *et al.*, 2014
Canada, Newfoundland	17.11.2013	*Botrylloides*	*violaceus*	Codroy	N 47.8812	W 59.398233	One specimen, species awaiting confirmation	Lunenburg and Mahone Bay area of N.S.	2001 (Carver, Mallet & Vercaemer, 2006b)	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	S. Caines, pers comm

Canada, Prince Edward Island	2004	*Botrylloides*	*violaceus*	Borden	N 46.24993	W 63.7031	Established	Borden (within Gulf Region)	2004 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, New Brunswick	2006–10–00	*Botrylloides*	*violaceus*	Cape Tormentine	N 46.13179	W 63.77321	Established	Borden (within Gulf Region)	2004 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	DFO tunicate diving survey, station 2-southwestern breakwater; Botrylloides violaceus of medium density, well established in rock crevasses of low water areas
Canada, New Brunswick	01–11–2013	*Botrylloides*	*violaceus*	St. Andrews Biological Station	N 45.0823	W 67.0847	Established and spreading			unknown	
Canada, Nova Scotia	2013–09–18	*Botrylloides*	*violaceus*	Chance Harbour	N 45.67947	W 62.58035	Reported	Borden (within Gulf Region)	2004 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	DFO AIS monitoring program
Canada, Nova Scotia	2001	*Botrylloides*	*violaceus*	Lunenburg and Mahone Bays			First report	South shore, Nova Scotia	2001	unknown	
Canada, Nova Scotia	30–11–2013	*Botrylloides*	*violaceus*	Dingwall	N 46.9032	W 60.4604	Established			unknown	
Canada, Nova Scotia	30–11–2013	*Botrylloides*	*violaceus*	West Head	N 43.45813	W 65.6546	Established			unknown	
Canada, Nova Scotia	31–10–2014	*Botrylloides*	*violaceus*	Big Bras d'Or	N 46.28117	W 60.425	Reported	North east entrance of Bras d'Or Lake, Cape Breton		unknown	

Canada, Nova Scotia	31–10–2014	*Botrylloides*	*violaceus*	Bras d'Or	N 46.25304	W 60.2999	Reported	North east entrance of Bras d'Or Lake, Cape Breton		unknown	
Canada, Nova Scotia	31–10–2014	*Botrylloides*	*violaceus*	New Harris	N 46.239	W 60.5	Reported	North east entrance of Bras d'Or Lake, Cape Breton		unknown	
Canada, Nova Scotia	31–10–2014	*Botrylloides*	*violaceus*	Port Hawkesbury	N 45.6136	W 61.3656	Established				
Canada, Québec	12–10–2010	*Botrylloides*	*violaceus*	Havre-Aubert	N 47.23599	W 61.8344	First report	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2011	*Botrylloides*	*violaceus*	Havre-Aubert	N 47.23599	W 61.8344	Established	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2012	*Botrylloides*	*violaceus*	Havre-Aubert	N 47.23599	W 61.8344	Established and spreading	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2013	*Botrylloides*	*violaceus*	Havre-Aubert	N 47.23599	W 61.8344	Established and spreading	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Botrylloides*	*violaceus*	Havre-Aubert	N 47.23599	W 61.8344	Established and spreading	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2010	*Botrylloides*	*violaceus*	Cap-aux-Meules	N 47.376883	W 61.851667	First report	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2011	*Botrylloides*	*violaceus*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2012	*Botrylloides*	*violaceus*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2013	*Botrylloides*	*violaceus*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Botrylloides*	*violaceus*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2012	*Botrylloides*	*violaceus*	Havre-aux-Maisons	N 47.40535	W 61.83514	First report	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2013	*Botrylloides*	*violaceus*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Botrylloides*	*violaceus*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2013	*Botrylloides*	*violaceus*	Grande-Entrée	N 47.55677	W 61.55755	First report	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Botrylloides*	*violaceus*	Grande-Entrée	N 47.55677	W 61.55755	Established	Magdalen Islands	2010	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	17–05–2012	*Botrylloides*	*violaceus*	NW Anticosti	N 50.13785	W 63.9030	First report	Northern Gulf of St. Lawrence	2012	Unknown	

Canada, Québec	20–05–2012	*Botrylloides*	*violaceus*	NW Anticosti	N 50.1042	W 63.8787	First report	Northern Gulf of St. Lawrence	2012	Unknown	
Canada, Québec	26–08–2013	*Botrylloides*	*violaceus*	NE Anticosti	N 49.84933	W 61.79033	First report	Northern Gulf of St. Lawrence	2012	Unknown	
Canada, Québec	27–08–2014	*Botrylloides*	*violaceus*	NW Anticosti	N 49.91883	W 64.72883	Reported	Northern Gulf of St. Lawrence	2012	Unknown	
Canada, Québec	28–08–2014	*Botrylloides*	*violaceus*	NW Anticosti	N 49.84933	W 61.79033	Reported	Northern Gulf of St. Lawrence	2012	Unknown	
Canada, Québec	08–08–2014	*Botrylloides*	*violaceus*	Belle Isle Strait	N 50.9835	W 57.37333	First report	Belle Isle Strait	2014	Unknown	
Canada, Newfoundland	1940's	*Botryllus*	*schlosseri*	Argentia	N 47.292	W 53.990417	First record	Quebec	1900 (Carver, Mallet & Vercaemer, 2006b)	Anthropogenic	US Navy, 1951; Callahan *et al.*, 2010; Ma, 2010; McKenzie *et al.*, 2010
Canada, Newfoundland	1975	*Botryllus*	*schlosseri*	St Pauls Inlet	N 49.847821	W 57.781275	Unknown	Quebec	1900 (Carver, Mallet & Vercaemer, 2006b)	Anthropogenic	Hooper, 1975
Canada, Newfoundland	10.10.2013	*Botryllus*	*schlosseri*	Foxtrap	N 47.5129	W 52.9986	Established, expanding	Quebec	1900 (Carver, Mallet & Vercaemer, 2006b)	Anthropogenic, Shipping Traffic, Movement of Fishing Gear	Carver, Mallet & Vercaemer, 2006b; Deibel *et al.*, 2014

Canada, Newfoundland	17.11.2013	*Botryllus*	*schlosseri*	Codroy	N 47.8812	W 59.398233	Single specimen observed	Quebec	1900 (Carver, Mallet & Vercaemer, 2006b)	Anthropogenic, Shipping Traffic, Movement of Fishing Gear	S. Caines, pers comm
Canada, Newfoundland	1.09.2014	*Botryllus*	*schlosseri*	Port aux Basques	N 47.57427	W 59.13878	Established	Quebec	1900 (Carver, Mallet & Vercaemer, 2006b)	Anthropogenic, Shipping Traffic, Movement of Fishing Gear	S. Caines, pers comm
Canada, Prince Edward Island	2001	*Botryllus*	*schlosseri*	St. Peters Bay	N 46.42989	W 62.698	Established	St. Peters Bay (within Gulf Region)	2001 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Prince Edward Island	2013	*Botryllus*	*schlosseri*	North Lake	N 46.46613	W 62.07199	Established	St. Peters Bay (within Gulf Region)	2001 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Prince Edward Island	2013	*Botryllus*	*schlosseri*	Conway Narrows	N 46.65518	W 63.91164	Established	St. Peters Bay (within Gulf Region)	2001 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, New Brunswick	1970's	*Botryllus*	*schlosseri*	Lower Bay of Fundy			First report	Lower Bay of Fundy, New Brunswick	1970's	unknown	
Canada, New Brunswick	01–11–2013	*Botryllus*	*schlosseri*	St. Andrews Biological Station	N 45.0823	W 67.0847	Established			unknown	
Canada, Nova Scotia	1980's	*Botryllus*	*schlosseri*	Atlantic Coast and Bras D'Or lake			First report	Atlantic Coast and Bras D'Or lake	1980's	unknown	

Canada, Nova Scotia	30–11–2013	*Botryllus*	*schlosseri*	Dingwall	N 46.9032	W 60.4604	Established			unknown	
Canada, Nova Scotia	30–11–2013	*Botryllus*	*schlosseri*	West Head	N 43.45813	W 65.6546	Established			unknown	
Canada, Nova Scotia	30–11–2014	*Botryllus*	*schlosseri*	Port Hawkesbury	N 45.6136	W 61.3656	Established				
Canada, Québec	01–07–2006	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	First report	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2007	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2008	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2009	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2010	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2011	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2012	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2013	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Botryllus*	*schlosseri*	Havre-Aubert	N 47.23606	W 61.83416	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2007	*Botryllus*	*schlosseri*	Cap-aux-Meules	N 47.376883	W 61.851667	First report	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2008	*Botryllus*	*schlosseri*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2009	*Botryllus*	*schlosseri*	Cap-aux-Meules	N 47.376883	W 61.851667	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2010	*Botryllus*	*schlosseri*	Cap-aux-Meules	N 47.376883	W 61.851667	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2011	*Botryllus*	*schlosseri*	Cap-aux-Meules	N 47.376883	W 61.851667	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2012	*Botryllus*	*schlosseri*	Cap-aux-Meules	N 47.376883	W 61.851667	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2013	*Botryllus*	*schlosseri*	Cap-aux-Meules	N 47.376883	W61.851667	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Botryllus*	*schlosseri*	Cap-aux-Meules	N 47.376883	W 61.851667	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	01–07–2006	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	First report	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2007	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2008	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2009	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2010	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2011	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2012	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2013	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Botryllus*	*schlosseri*	Havre-aux-Maisons	N 47.40535	W 61.83514	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2007	*Botryllus*	*schlosseri*	Grande-Entrée	N 47.55677	W 61.55755	First report	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2008	*Botryllus*	*schlosseri*	Grande-Entrée	N 47.55677	W 61.55755	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2009	*Botryllus*	*schlosseri*	Grande-Entrée	N 47.55677	W 61.55755	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2010	*Botryllus*	*schlosseri*	Grande-Entrée	N 47.55677	W 61.55755	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2011	*Botryllus*	*schlosseri*	Grande-Entrée	N 47.55677	W 61.55755	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2012	*Botryllus*	*schlosseri*	Grande-Entrée	N 47.55677	W 61.55755	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2013	*Botryllus*	*schlosseri*	Grande-Entrée	N 47.55677	W 61.55755	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Botryllus*	*schlosseri*	Grande-Entrée	N 47.55677	W 61.55755	Established and spreading	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2008	*Botryllus*	*schlosseri*	Pointe-Bassse	N 48.34489	W 64.66974	First report	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	25–09–2012	*Botryllus*	*schlosseri*	Chandler	N 48.3449	W 64.6697	First report	Baie des Chaleurs	2012	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	07–08–2011	*Botryllus*	*schlosseri*	Belle Isle Strait (N)	N 51.6853	W 56.2456	First report	Belle Isle Strait	2011	unknown	
Canada, Québec	20–05–2012	*Botryllus*	*schlosseri*	NW Anticosti	N 50.13751	W 63.8783	First report	Northern Gulf of St. Lawrence	2012	unknown	
Canada, Québec	17–05–2012	*Botryllus*	*schlosseri*	NW Anticosti	N 50.13783	W 63.9039	First report	Northern Gulf of St. Lawrence	2012	unknown	
Canada, Newfoundland	2.11.2006	*Caprella*	*mutica*	Presque Harbour	N 47.411717	W 54.498250	First record	Prince Edward Island	1998 (Turcotte & Sainte-Marie, 2009)	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	Turcotte & Sainte-Marie, 2009; McKenzie *et al.*, 2010

Canada, Newfoundland	11.09.2013	*Caprella*	*mutica*	Burin	N 47.030889	W 55.174333	Unknown	Prince Edward Island	1998 (Turcotte & Sainte-Marie, 2009)	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	P. Sargent, pers comm
Canada, Nova Scotia	30–11–2013	*Caprella*	*mutica*	Dingwall	N 46.9032	W 60.4604	Established			unknown	
Canada, Nova Scotia	30–11–2013	*Caprella*	*mutica*	Ship Harbour	N 44.8124	W 62.872	Established			unknown	
Canada, New Brunswick	2003	*Caprella*	*mutica*	Passamaquoddy Bay			First report	Lower Bay of Fundy, New Brunswick	2003	unknown	
Canada, New Brunswick	01–11–2013	*Caprella*	*mutica*	St. Andrews Biological Station	N 45.0823	W 67.0847	Established			unknown	
Canada, Nova Scotia	31–10–2014	*Caprella*	*mutica*	Sydney; Dobson Yacht Club	N 46.13722	W 60.2044	Established	Cape Breton		unknown	
Canada, Nova Scotia	31–10–2014	*Caprella*	*mutica*	Port Hawkesbury	N 45.6136	W 61.3656	Established				
Canada, Québec	2003	*Caprella*	*mutica*	Cascapedia Bay	N 48.11035	W 66.01706	First report	Baie des Chaleurs	2003	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2008	*Caprella*	*mutica*	Chandler	N 48.34489	W 64.66974	Established and spreading	Baie des Chaleurs	2003	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2013	*Caprella*	*mutica*	Tracadigache Bay	N 48.07291	W 66.19844	Established and spreading	Baie des Chaleurs	2003	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2013	*Caprella*	*mutica*	Newport	N 48.286416	W 64.721305	Established and spreading	Baie des Chaleurs	2003	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2013	*Caprella*	*mutica*	Cascapedia Bay	N 48.11035	W 66.01706	Established and spreading	Baie des Chaleurs	2003	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2014	*Caprella*	*mutica*	Tracadigache Bay	N 48.072918	W 66.1984433	Established and spreading	Baie des Chaleurs	2003	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2010	*Caprella*	*mutica*	Baie de Gaspé	N 48.84721	W 64.46855	First report	Baie de Gaspé	2008	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2004	*Caprella*	*mutica*	Baie de plaisance	N 47.35805	W 61.75972	First report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2007	*Caprella*	*mutica*	Magdalen Islands	N 47.43366	W 61.807709	First report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	

Canada, Québec	2010	*Caprella*	*mutica*	Magdalen Islands	N 47.43366	W 61.807709	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2013	*Caprella*	*mutica*	Magdalen Islands	N 47.43366	W 61.807709	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Québec	2014	*Caprella*	*mutica*	Magdalen Islands	N 47.43366	W 61.807709	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Newfoundland	28.08.2007	*Carcinus*	*maenas*	North Harbour	N 47.85486	W 54.10026	First record	Digdeguash River, Passamaquoddy Bay	1951 (Klassen & Locke, 2007)	Anthropogenic, Shipping Traffic, Ballast Release	Klassen & Locke, 2007; Blakeslee *et al.*, 2010; McKenzie *et al.*, 2010

Canada, Newfoundland	7.07.2013	*Carcinus*	*maenas*	Port Saunders	N 50.647042	W 57.276222	Established, expanding	Digdeguash River, Passamaquoddy Bay	1951 (Klassen & Locke, 2007)	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Newfoundland	12.08.2013	*Carcinus*	*maenas*	Pools Cove	N 47.68209	W 55.430145	Established, expanding	Digdeguash River, Passamaquoddy Bay	1951 (Klassen & Locke, 2007)	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Newfoundland	2014	*Carcinus*	*maenas*	Harbour Breton	N 47.479	W 55.811806	Established	Digdeguash River, Passamaquoddy Bay	1951 (Klassen & Locke, 2007)	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Prince Edward Island	1996–00–00	*Carcinus*	*maenas*	Georgetown	N 46.167	W 62.533	Established	Auld's Cove, NS (within Gulf Region)	1994 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, New Brunswick	1951	*Carcinus*	*maenas*	Passamaquoddy Bay				Lower Bay of Fundy, New Brunswick		unknown	
Canada, New Brunswick	01–11–2013	*Carcinus*	*maenas*	Mary's Point	N 45.7102	W 64.6677				unknown	
Canada, Nova Scotia	1953	*Carcinus*	*maenas*	Minas Basin and St. Mary's Bay			First Report	Bay of Fundy shores	1953		
Canada, Nova Scotia	27–07–2013	*Carcinus*	*maenas*	Ingonish, MacLeods Point	N 46.68	W 60.35	Established				
Canada, Nova Scotia	04–07–2013	*Carcinus*	*maenas*	Wedgeport	N 43.71468	W 65.9696	Established				

Canada, Québec	2004	*Carcinus*	*maenas*	Bassin aux Huîtres	N 47.5587	W 61.50563	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2008	*Carcinus*	*maenas*	Bassin aux Huîtres	N 47.5587	W 61.50563	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Carcinus*	*maenas*	Bassin aux Huîtres	N 47.5587	W 61.50563	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2004	*Carcinus*	*maenas*	Baie Old Harry	N 47.57587	W 61.48357	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2006	*Carcinus*	*maenas*	Baie du Bassin	N 47.22806	W 61.90243	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2008	*Carcinus*	*maenas*	Baie du Bassin	N 47.22806	W 61.90243	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Carcinus*	*maenas*	Baie du Bassin	N 47.22806	W 61.90243	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2014	*Carcinus*	*maenas*	Baie du Bassin	N 47.22806	W 61.90243	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	

Canada, Québec	2006	*Carcinus*	*maenas*	Baie du Havre aux Basques	N 47.26373	W 61.97483	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2008	*Carcinus*	*maenas*	Baie du Havre aux Basques	N 47.26373	W 61.97483	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Carcinus*	*maenas*	Baie du Havre aux Basques	N 47.26373	W 61.97483	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2014	*Carcinus*	*maenas*	Baie du Havre aux Basques	N 47.26373	W 61.97483	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2009	*Carcinus*	*maenas*	Havre du Havre Aubert	N 47.23075	W 61.83345	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2010	*Carcinus*	*maenas*	Havre du Havre Aubert	N 47.23075	W 61.83345	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Carcinus*	*maenas*	Havre du Havre Aubert	N 47.23075	W 61.83345	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2009	*Carcinus*	*maenas*	Étang-du-Nord	N 47.36512	W 61.95978	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	

Canada, Québec	2010	*Carcinus*	*maenas*	Étang-du-Nord	N 47.36512	W 61.95978	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Carcinus*	*maenas*	Étang-du-Nord	N 47.36512	W 61.95978	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2014	*Carcinus*	*maenas*	Étang-du-Nord	N 47.36512	W 61.95978	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2010	*Carcinus*	*maenas*	Havre de la Grande Entrée	N 47.55498	W 61.5509	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2011	*Carcinus*	*maenas*	Havre de la Grande Entrée	N 47.55498	W 61.5509	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Carcinus*	*maenas*	Havre de la Grande Entrée	N 47.55498	W 61.5509	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2014	*Carcinus*	*maenas*	Havre de la Grande Entrée	N 47.55498	W 61.5509	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2008	*Carcinus*	*maenas*	Havre-aux-Maisons	N 47.39859	W 61.84635	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	

Canada, Québec	2009	*Carcinus*	*maenas*	Havre-aux-Maisons	N 47.39859	W 61.84635	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Carcinus*	*maenas*	Havre-aux-Maisons	N 47.39859	W 61.84635	Established and spreading	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2014	*Carcinus*	*maenas*	Havre-aux-Maisons	N 47.39859	W 61.84635	Established	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2010	*Carcinus*	*maenas*	Cap-aux-Meules	N 47.37856	W 61.84635	First Report	Magdalen Islands	2004	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2011	*Carcinus*	*maenas*	Chandler	N 48.34489	W 64.66974	First Report	Baie des Chaleurs	2011	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2012	*Carcinus*	*maenas*	Chandler	N 48.34489	W 64.66974	Reported	Baie des Chaleurs	2011	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2011	*Carcinus*	*maenas*	Grande Rivière	N 48.3941	W 64.49459	First Report	Baie des Chaleurs	2011	Anthropogenic, Shipping Traffic, Ballast Release	

Canada, Newfoundland	19.09.2012	*Ciona*	*intestinalis*	Burin	N 47.031	W 55.172936	First record	Grand Manan Island	Stimpson, 1852	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	Carver, Mallet & Vercaemer, 2006a; Sargent *et al.*, 2013
Canada, Newfoundland	10.09.2013	*Ciona*	*intestinalis*	Marystown	N 47.167	W 55.015194	Established	Grand Manan Island	Stimpson, 1852	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Newfoundland	1.10.2013	*Ciona*	*intestinalis*	Little Bay	N 47.163	W 55.112194	Established	Grand Manan Island	Stimpson, 1852	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Prince Edward Island	22.09.2005	*Ciona*	*intestinalis*	St. Mary's Bay	46.14695	W 62.52	Established	St. Mary's Bay, PEI (within Gulf Region)	2005 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	DFO Stewartship monitoring; Ciona confirmed at Souris marina on 22 Sept.
Canada, Nova Scotia	1997	*Ciona*	*intestinalis*	Lunenburg Bay			First Report	South shore, Nova Scotia	1997	unknown	
Canada, Nova Scotia	30–11–2013	*Ciona*	*intestinalis*	Dingwall	46.9032	W 60.4604	Established			unknown	
Canada, Nova Scotia	30–11–2013	*Ciona*	*intestinalis*	Clark's Harbour	43.4447	W 65.6351	Established			unknown	

Canada, New Brunswick	1850	*Ciona*	*intestinalis*	Bay of Fundy			First report	Lower Bay of Fundy, New Brunswick		unknown	
Canada, New Brunswick	01–11–2013	*Ciona*	*intestinalis*	St. Andrews Biological Station	45.082300	W 67.0847	Established			unknown	
Canada, Nova Scotia	3.Oct.14	*Ciona*	*intestinalis*	Caribou	45.64824	W 61.4353	Reported	Lower Bay of Fundy, New Brunswick	year 1850	unknown	Collected on PVC monitoring collector (Gulf Region)
Canada, Nova Scotia	31–10–2014	*Ciona*	*intestinalis*	Bras d'Or	46.253040	W 60.2999	Reported	North east entrance of Bras d'Or Lake, Cape Breton		unknown	
Canada, Nova Scotia	31–10–2014	*Ciona*	*intestinalis*	Sydney; Dobson Yacht Club	46.137220	W 60.2044	Established	Cape Breton		unknown	
Canada, Nova Scotia	31–10–2014	*Ciona*	*intestinalis*	Port Hawkesbury	45.6136	W 61.3656	Established				
Canada, Québec	2006	*Ciona*	*intestinalis*	Cap-aux-Meules	N 47.376883	W 61.851667	First report	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2010	*Ciona*	*intestinalis*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Ballast Release	

Canada, Québec	2011	*Ciona*	*intestinalis*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2012	*Ciona*	*intestinalis*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Ciona*	*intestinalis*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2014	*Ciona*	*intestinalis*	Cap-aux-Meules	N 47.376883	W 61.851667	Established	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2008	*Ciona*	*intestinalis*	Havre-aux-Maisons	N 47.43366	W 61.807709	First report	Magdalen Islands	2006	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Newfoundland	22.08.2012	*Codium*	*fragile*	Spanish Room	N 47.195	W 55.075	First record, single specimen collected	Mahone Bay, NS	1989–1991 (Bird,1993)	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	Matheson *et al.*, 2014

Canada, Newfoundland	30.08.2013	*Codium*	*fragile*	Arnolds Cove	N 47.756	W 53.988	Established	Mahone Bay, NS	1989–1991 (Bird,1993)	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Newfoundland	23.09.2013	*Codium*	*fragile*	Pilley's Island	N 49.477	W 55.725	Established	Mahone Bay, NS	1989–1991 (Bird,1993)	Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear	
Canada, Prince Edward Island	2005	*Codium*	*fragile*	Brudenell	N 46.172776	W 62.547863	Reported	Caribou (within Gulf Region)	2002 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	DFO CAMP station 2, Aitken Pt. (June)
Canada, Nova Scotia	2013–06–19	*Codium*	*fragile*	Tatamagouche	N 45.76097	W 63.1882	Reported	Caribou (within Gulf Region)	2002 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	DFO CAMP
Canada, Nova Scotia	1989	*Codium*	*fragile*	Mahone Bay			First report	South shore, Nova Scotia	2012	unknown	
Canada, Québec	2003	*Codium*	*fragile*	Grande-Entree	N 47.587888	W 61.509722	First report	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	

Canada, Québec	2004	*Codium*	*fragile*	Havre de la Grande-Entree	N 47.5897	W 61.576826	Established and spreading	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2008	*Codium*	*fragile*	Magdalen Islands	N 47.433661	W 61.807709	Established and spreading	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2009	*Codium*	*fragile*	Magdalen Islands	N 47.433661	W 61.807709	Established and spreading	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2010	*Codium*	*fragile*	Magdalen Islands	N 47.433661	W 61.807709	Established and spreading	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2011	*Codium*	*fragile*	Magdalen Islands	N 47.433661	W 61.807709	Established and spreading	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2012	*Codium*	*fragile*	Magdalen Islands	N 47.433661	W 61.807709	Established and spreading	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2013	*Codium*	*fragile*	Magdalen Islands	N 47.433661	W 61.807709	Established and spreading	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	
Canada, Québec	2014	*Codium*	*fragile*	Magdalen Islands	N 47.433661	W 61.807709	Established and spreading	Magdalen Islands	2003	Anthropogenic, Shipping Traffic, Ballast Release	

Canada, Nova Scotia	29-Nov-2013	*Didemnum*	*vexillum*	Minas Basin	n/a	n/a	First report	Minas Basin	2013	unknown	
Canada, Nova Scotia	31–10–2014	*Didemnum*	*vexillum*	Minas Basin	N 45.3704	W 64.2798	Established	Minas Basin, off Parrsborro	2013	unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Minas Basin	N 45.3672	W 64.2291	First Report	Minas Basin		unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Minas Basin	N 45.3687	W 64.2228	First Report	Minas Basin		unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Minas Basin	N 45.3654	W 64.2009	First Report	Minas Basin		unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Minas Basin	N 45.3744	W 64.3707	First Report	Minas Basin		unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Minas Basin	N 45.3624	W 64.2915	First Report	Minas Basin		unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Minas Basin	N 45.3698	W 64.2531	First Report	Minas Basin		unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Scots Bay, Bay of Fundy	N 45.2335	W 64.5522	First Report	Minas Basin		unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Scots Bay, Bay of Fundy	N 45.2295	W 64.5775	First Report	Minas Basin		unknown	
Canada, Nova Scotia	30–04–2014	*Didemnum*	*vexillum*	Greville Bay, Bay of Fundy	N 45.3241	W 64.6942	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Greville Bay, Bay of Fundy	N 45.3472	W 64.664	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Greville Bay, Bay of Fundy	N 45.3585	W 64.664	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Greville Bay, Bay of Fundy	N 45.3838	W 64.6451	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Scots Bay, Bay of Fundy	N 45.293	W 64.5242	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Scots Bay, Bay of Fundy	N 45.3005	W 64.5072	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Scots Bay, Bay of Fundy	N 45.2518	W 64.5112	First Report	Minas Basin		unknown	

Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Advocate Bay, Bay of Fundy	N 45.3047	W 64.9519	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Bay of Fundy, off Digby	N 44.7252	W 64.8684	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–08–2014	*Didemnum*	*vexillum*	Bay of Fundy, off Yarmouth	N 43.9404	W 66.3546	First Report	Minas Basin		unknown	
Canada, Nova Scotia	31–10–2013	*Diplosoma*	*listerianum*	Lunenburg Harbour, Fisheries Museum wharf	N 44.3754	W 64.3105	First report	south shore Nova Scotia, Lunenburg harbour	2012	unknown	
Canada, Québec	21.06.2008	*Diplosoma*	*Listerianum*	Havre-Aubert	N 47.23606	W 61.83416	First report	Magdalen Islands	2008		
Canada, Québec	2010	*Diplosoma*	*Listerianum*	Havre-Aubert	N 47.23606	W 61.83416	Reported	Magdalen Islands	2008		
Canada, Québec	2011	*Diplosoma*	*Listerianum*	Havre-Aubert	N 47.23606	W 61.83416	Reported	Magdalen Islands	2008		
Canada, Québec	2011	*Diplosoma*	*Listerianum*	Cap-aux-Meules	N 47.376883	W 61.851667	Reported	Magdalen Islands	2008		
Canada, Nova Scotia	2013	*Heterospiphonia*	*japaonica*	Lunenburg			First report	South shore, Nova Scotia	2012	unknown	
Canada, Newfoundland	2002	*Membranipora*	*membranacea*	Bonne Bay	N 49.50576	W 57.91666	First report	Nova Scotia	1990's (Burridge, 2012)	Unknown/Natural Dispersal/Rafting	R Hooper, pers comm; McKenzie *et al.*, 2010
Canada, Newfoundland	18.10.2012	*Membranipora*	*membranacea*	Little St Lawrence	N 46.922131	W 055.360794	Established, Widespread	Nova Scotia	1990's (Burridge, 2012)	Unknown/Natural Dispersal/Rafting	

Canada, Nova Scotia	1992	*Membranipora*	*membranacea*	Mahone and St. Margaret's Bays			First Report	South shore, Nova Scotia	1992	unknown	
Canada, Nova Scotia	30–11–2013	*Membranipora*	*membranacea*	Venus Cove	N 45.6153	W 61.3901	Established			unknown	
Canada, Nova Scotia	30–11–2013	*Membranipora*	*membranacea*	Clark's Harbour	N 43.4447	W 65.6351	Established			unknown	
Canada, New Brunswick	01–11–2013	*Membranipora*	*membranacea*	St. Andrews Biological Station	N 45.0823	W 67.0847	Established			unknown	
Canada, Prince Edward Island	23.Sep.14	*Membranipora*	*membranacea*	Souris	N 46.34711	W 62.24821	Established	Mahone and St. Margaret's Bays, NS	1992	unknown	Found on Laminaria and Ulva hanging from marina floating docks
Canada, Nova Scotia	31–10–2014	*Membranipora*	*membranacea*	Sydney; Dobson Yacht Club	N 46.13722	W 60.2044	Established			unknown	
Canada, Nova Scotia	31–10–2014	*Membranipora*	*membranacea*	Port Hawkesbury	N 45.6136	W 61.3656	Established				
Canada, Québec	2003	*Membranipora*	*membranacea*	Port-Daniel	N 48.1816	W 64.9525	First Report	Baie des Chaleurs	2003		
Canada, Québec	2008	*Membranipora*	*membranacea*	Cascapedia Bay	N 48.1101	W 66.0188	First Report	Baie des Chaleurs	2003		
Canada, Québec	2010	*Membranipora*	*membranacea*	Cascapedia Bay	N 48.1101	W 66.0188	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2011	*Membranipora*	*membranacea*	Cascapedia Bay	N 48.1101	W 66.0188	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2012	*Membranipora*	*membranacea*	Cascapedia Bay	N 48.1101	W 66.0188	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2014	*Membranipora*	*membranacea*	Cascapedia Bay	N 48.1101	W 66.0188	Established and spreading	Baie des Chaleurs	2003		

Canada, Québec	2009	*Membranipora*	*membranacea*	Grande-Rivière	N 48.39397	W 64.49467	First Report	Baie des Chaleurs	2003		
Canada, Québec	2012	*Membranipora*	*membranacea*	Grande-Rivière	N 48.39397	W 64.49467	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2013	*Membranipora*	*membranacea*	Grande-Rivière	N 48.39397	W 64.49467	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2014	*Membranipora*	*membranacea*	Grande-Rivière	N 48.39397	W 64.49467	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2009	*Membranipora*	*membranacea*	Paspébiac	N 48.020305	W 65.25658	First Report	Baie des Chaleurs	2003		
Canada, Québec	2010	*Membranipora*	*membranacea*	Tracadigache Bay	N 48.072918	W 66.1984433	First Report	Baie des Chaleurs	2003		
Canada, Québec	2012	*Membranipora*	*membranacea*	Tracadigache Bay	N 48.072918	W 66.1984433	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2014	*Membranipora*	*membranacea*	Tracadigache Bay	N 48.072918	W 66.1984433	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2011	*Membranipora*	*membranacea*	Newport	N 48.286416	W 64.721305	First Report	Baie des Chaleurs	2003		
Canada, Québec	2012	*Membranipora*	*membranacea*	Newport	N 48.286416	W 64.721305	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2013	*Membranipora*	*membranacea*	Newport	N 48.286416	W 64.721305	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2014	*Membranipora*	*membranacea*	Newport	N 48.286416	W 64.721305	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2011	*Membranipora*	*membranacea*	Chandler	N 48.34489	W 64.66974	First Report	Baie des Chaleurs	2003		
Canada, Québec	2012	*Membranipora*	*membranacea*	Chandler	N 48.34489	W 64.66974	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2013	*Membranipora*	*membranacea*	Chandler	N 48.34489	W 64.66974	Established and spreading	Baie des Chaleurs	2003		

Canada, Québec	2014	*Membranipo ra*	*membranacea*	Chandler	N 48.34489	W 64.66974	Established and spreading	Baie des Chaleurs	2003		
Canada, Québec	2009	*Membranipo ra*	*membranacea*	Baie de Gaspé	N 48.84721	W 64.46855	First Report	Baie de Gaspé	2003		
Canada, Québec	2010	*Membranipo ra*	*membranacea*	Baie de Gaspé	N 48.84721	W 64.46855	Established and spreading	Baie de Gaspé	2003		
Canada, Québec	2011	*Membranipo ra*	*membranacea*	Baie de Gaspé	N 48.84721	W 64.46855	Established and spreading	Baie de Gaspé	2003		
Canada, Québec	2012	*Membranipo ra*	*membranacea*	Baie de Gaspé	N 48.84721	W 64.46855	Established and spreading	Baie de Gaspé	2003		
Canada, Québec	2011	*Membranipo ra*	*membranacea*	Sainte-Anne-des-Monts	N 49.13286	W 66.48776	First report	St. Lawrence Estuary	2003		
Canada, Québec	2014	*Membranipo ra*	*membranacea*	Sainte-Anne-des-Monts	N 49.13286	W 66.48776	Established and spreading	St. Lawrence Estuary	2003		
Canada, Québec	2003	*Membranipo ra*	*membranacea*	Iles-de-la-Madeleine	N 47.4336	W 61.8077	First Report	Magdalen Islands	2003		
Canada, Québec	2008	*Membranipo ra*	*membranacea*	Iles-de-la-Madeleine	N 47.4336	W 61.8077	Established and spreading	Magdalen Islands	2003		
Canada, Québec	2009	*Membranipo ra*	*membranacea*	Iles-de-la-Madeleine	N 47.4336	W 61.8077	Established and spreading	Magdalen Islands	2003		
Canada, Québec	2010	*Membranipo ra*	*membranacea*	Iles-de-la-Madeleine	N 47.4336	W 61.8077	Established and spreading	Magdalen Islands	2003		
Canada, Québec	2011	*Membranipo ra*	*membranacea*	Iles-de-la-Madeleine	N 47.4336	W 61.8077	Established and spreading	Magdalen Islands	2003		
Canada, Québec	2012	*Membranipo ra*	*membranacea*	Iles-de-la-Madeleine	N 47.4336	W 61.8077	Established and spreading	Magdalen Islands	2003		
Canada, Québec	2013	*Membranipo ra*	*membranacea*	Iles-de-la-Madeleine	N 47.4336	W 61.8077	Established and spreading	Magdalen Islands	2003		

Canada, Québec	2014	*Membranipora*	*membranacea*	Iles-de-la-Madeleine	N 47.4336	W 61.8077	Established and spreading	Magdalen Islands	2003		
Canada, Prince Edward Island	1998	*Styela*	*clava*	Montague/Brudenell	N 46.17488	W 62.5786	Established	Montague/Brudenell (within Gulf Region)	1998 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	PEI DFARD
Canada, Prince Edward Island	15.11.2013	*Styela*	*clava*	Egmont Bay	N 46.557	W 64.083	Reported	Montague/Brudenell (within Gulf Region)	1998 (within Gulf Region)	Anthropogenic, Shipping Traffic, Ballast Release	PEI DFARD
Canada, Nova Scotia	31.okt.12	*Styela*	*clava*	Halifax Harbour; BIO Jetty	N 44.68187	W 63.61187	First report	Halifax Harbour	2012	unknown	
Canada, Nova Scotia	31.okt.12	*Styela*	*clava*	Lunenburg Harbour, Fisheries Museum wharf	N 44.3754	W 64.3105	First report			unknown	
Canada, Nova Scotia	01–11–2013	*Styela*	*clava*	Venus Cove	N 45.6153	W 61.3901	Established			unknown	
Canada, Nova Scotia	31–10–2014	*Styela*	*clava*	Port Hawkesbury	N 45.6136	W 61.3656	Established			unknown	
Canada, Nova Scotia	November 2013	*Diadumene*	*lineata*	BIO Jetty	N 44.681	W 63.6101	First report	Halifax Harbour	November 2013	unknown	Moore *et al.* 2014

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Annex 5: Comments and edits to draft OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition

JAMP Eutrophication Monitoring Guidelines:

Phytoplankton Species Composition

1. Introduction

Phytoplankton species composition serves as an indicator of the effects of eutrophication. Nutrient enrichment/eutrophication may give rise to shifts in phytoplankton species composition (*e.g.* from diatoms to flagellates, some of which are nuisance or toxic) and an increase in the frequency and/or magnitude and/or duration of phytoplankton blooms and/or of nuisance/potentially toxic blooms. Invasive non-indigenous species of phytoplankton also have the potential to cause shifts in local species compositions through competition, and/or bloom formation and/or toxic events. These guidelines are intended to support the minimum monitoring requirements of the Nutrient Monitoring Programme[4].

Regulations including the Water Framework Directive (WFD), Marine Strategy Framework Directive (MSFD) and EU Regulation on the prevention and management of introduction and spread of invasive alien species (1143/2014) require assessment, monitoring and recording of invasive alien species by Member States. As such, these phytoplankton species should also be recorded during routine phytoplankton analysis.

2. Purposes

The measurement of phytoplankton species composition is carried out for, *inter alia*, the following purposes:

1. to establish the spatial distribution and frequency of phytoplankton blooms;
2. to establish temporal trends, over periods of several years, in phytoplankton species composition and their relative abundance;
3. to identify key phytoplankton species.
4. to identify non-indigenous phytoplankton species.

3. Quantitative objectives

[Secretariat note: in addition to the general purpose of the programme, an explicit quantified statistically formulated objective for temporal trend and spatial distribution monitoring requires development.]

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4 The Nutrient Monitoring Programme as adopted by OSPAR 1995 (OSPAR 95/15/1, Annex 12).

4. Sampling strategy

An understanding of the complexity of the hydrography of estuarine or coastal seas is necessary before starting to survey or sample the phytoplankton. Thus, there is a need for routine hydrographic observations at the same time as the surveys/sampling. Apart from the influence of water column structure on phytoplankton dynamics there is a need to consider horizontal (spatial) and temporal variability in order to establish the frequency and location of sampling. Sample sites should be further apart than the horizontal tidal amplitude but sufficiently close to resolve the presence of strong gradients. Sampling frequency should take account of seasonal variability in the relative abundance of the species of interest.

The abundance of "key species" should be examined. The "key species" are dominant and/or nuisance and/or potentially toxic and/or non-indigenous species. Examples of taxa~~species~~ which are dominant and/or nuisance and/or potentially toxic and/or non-indigenous are: *Alexandrium* spp. (*Gonyaulax*), *Ceratium* spp., *Chrysochromulina polylepis, Corymbellus aureus, Coscindiscus wailesii, Dinophysis acuminata, Gymnodinium catenatum, Gyrodinium aureolum, Lepidodinium viride, Noctiluca scintillans, Phaeocystis* spp., *Prorocentrum balticum, Prorocentrum minimum, Prymnesium parvum, Pseudochattonella verruculosa* and *Pseudonitzschia* spp. ~~Attempts should be made to establish the overall species composition.~~ An overall species composition should be established. The presence of non-indigenous species should be recorded as part of a full community analysis. The IOC-UNESCO Taxonomic Reference List of Harmful Micro Algae (http://www.marinespecies.org/hab/index.php) contains up-to-date information on the status of harmful species.

Particulate organic carbon, total organic carbon, particulate organic nitrogen, light (PAR/Secchi depth), chlorophyll fluorescence, temperature and salinity should be measured as supporting/interpretation parameters.

Aerial surveillance (for example under the Bonn Agreement) will help to identify annual and interannual variability in phytoplankton bloom development and will also help target specific sampling in relation to phytoplankton bloom events. Short synoptic surveys may be useful for following the dynamics of phytoplankton blooms within a growth season, *e.g.* by helicopter. Complementary crowdsourcing of phytoplankton bloom reports eg. NOAA's Phytoplankton Monitoring Network or www.phenomer.org may also extend the areas under observation for phytoplankton blooms.

5. Sampling equipment

Techniques for sampling are various. Nets are limited in that they do not retain all phytoplankton but can concentrate from a large volume and are helpful for determining the species composition. Nets are semi-quantitative if used with a flow meter attached. Water bottles sample discrete and smaller volumes but retain all organisms and are thus necessary for quantitative studies. A brief outline of various sampling devices can be found in Karlson *et al.* (2010) and Franks and Keafer (2004) provide a detailed overview on the different types of sampling strategies that can be incorporated into a phytoplankton monitoring programme.

6. Storage and pre-treatment of samples

In general, samples are preserved with a suitable fixative such as lugol or formalin[5]. Many small, naked flagellates are destroyed by fixatives and can only be identified live. In the event of an algal bloom a live sample should be collected from the area. For preservation of microflagellates, 20 % paraformaleyhde (final volume 2%) can be added to samples which should then be snap-frozen and stored at -80 ºC until analysis.

7. Analytical procedures

Microscopic analysis allows direct identification of phytoplankton species and quantification in terms of cell numbers. Many small (<5 µm) cells will be very difficult to identify by light microscopy (LM) and may have to be recorded as unidentified. ~~The counting procedure should be based on the proposals of ICES (1996).~~ The latest IOC guidance for quantitative phytoplankton analysis should be referred to (Karlson *et al.*, 2010), as should Standards EN 15204: 2006 and EN 15972: 2011. Given the rapid development of flow cytometry and the large number of small fluorescent cells present in samples, these are best determined by fluorescence microscopy or flow cytometry. A combination of flow cytometry and immuno-labelling may in the near future enable the rapid and conclusive identification and counting of toxic species if sufficient immuno-labels are available. New methods may offer the opportunity for fast-automated analysis of phytoplankton species samples. In order to record non-indigenous phytoplankton speices that may be present, a full LM phytoplankton community analysis should be performed. The presence of a non-indigenous species may be missed if only analysing for toxic and/or harmful species.

Molecular tools can be more sensitive for the early detection of non-indigenous and/or small (<5 µm) phytoplankton species, and are also useful for the identification of early and/or cyst stages likely to be introduced via ballast water, rare taxa or badly conserved specimens. Molecular methods do not need strong taxonomic expertise and follow standard procedures. New techniques are now emerging for global assessments such as e-DNA and metabarcoding. While more effort is needed to build up reference databases, these are very promising analytical tools.

8. Analytical quality assurance[6]

The quality assurance programme should ensure that the data are fit for the purpose for which they have been collected, *i.e.* that they satisfy the objectives of the monitoring programme. Emphasis should be placed on the intercalibration of species identification on a regular basis. A phytoplankton checklist must be compiled during intercalibration exer-

[5] Recommendation on the fixative to be used should be updated on the basis of the outcome of a suitable calibration exercise.

[6] A joint ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements related to eutrophication parameters was established in 1997 in order to coordinate the development of quality assurance procedures, the implementation of quality assurance activities (*e.g.*, the conduct of workshops and intercomparison exercises) and the preparation of appropriate taxonomic lists of species. This work will cover phytoplankton species and is a fairly long-term programme of about five years. Good cooperation will be ensured with the ICES/HELCOM steering group on Quality Assurance of Biological Measurements in the Baltic Sea.

cises. Participation in quality assurance/quality control (QA/QC) schemes such as the annual BEQUALM phytoplaknton ring test, run under the auspcies of the National Marine Biological Analytical Quality Control (NMBAQC) scheme BEQUALM is required for ensuring data quality. Organisations can also aquire certification through national, European or international accreditation schemes eg. Good Laboratory Practice (GLP) and the United Kingdom Accreditation Service (UKAS).

9. Reporting requirements

~~[Secretariat note: reporting procedures require development. As a component of the 1997 ICES Work Programme, the Oslo and Paris Commissions have formally requested ICES to establish a databank for phytoplankton species. The work will include the development of a reporting format and a species code list. The reporting procedures should include a national report containing information on methods used and any other comments or information relevant to an ultimate assessment of the data. In order to establish the acceptability of the data, they should be reported together with the dates and results of participation in intercalibration exercises.]~~ [This is now HAEDAT – so this note can be deleted].

All harmful algae events are recorded onto the Harmful Algae Events Database (HAEDAT). Non-indigenous phytoplankton species identified during routine phytoplankton community analyses should be reported to national authorities. Publically available database(s), such as AquaNIS (http://www.corpi.ku.lt/databases/index.php/aquanis) should be used for reporting and data storage for non-indigenous species. A Harmful Algal Information System (HAIS) is being developed in cooperation with WoRMS, ICES, PICES and ISSHA and can be accessed here http://haedat.iode.org//

10. References

~~ICES (1996). Report of the ICES/HELCOM Second workshop on quality assurance of biological measurements in the Baltic Sea, Warnemünde, Germany, 16–20 September 1995. ICES CM 1996/E:1.~~ [should be deleted as out of date]

Franks, P.J.S. and Keafer, B.A. (2004). Sampling techniques and startegies for coastal phytoplankton blooms. In: G.M. Hallegraeff., D.M. Anderson and A.D. Cembella (eds), *Manual on Harmful Marine Microalgae*, UNESCO Publishing. Pp 51–76.

Karlson, B., Cusack, C. & Bresnan, E. (Eds) (2010). Microscopic and molecular methods for quantitative phytoplankton analysis. Intergovernmental Oceanographic Commission of UNESCO, Paris. IOC Manuals and Guides, no. 55. IOC/2010/MG/55, 110 pp.

Annex 6: Draft Terms of Reference for 2016

Working Group on Introductions and Transfers of Marine Organisms (WGITMO), chaired by Henn Ojaveer, Estonia, will meet in Olbia, Italy, 16–18 March 2016, back-to-back with the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV) to:

a) Summarize information provided in national reports and through the AquaNIS information system. Develop annual summaries of new occurrences/introductions of aquatic non-indigenous species (NIS);

b) Continue addressing EU MSFD D2 on further developing and evaluating NIS indicators and screening and identification of species of concern;

c) Continue identification and evaluation of climate change impacts on the establishment and spread of NIS. Finalise global review on salinity change effects on non-indigenous species;

d) Continue investigating NIS associated with biofouling, incl. those on artificial hard structures in the marine environment and recreational boating;

e) Finalise draft of the alien species alert report for ICES CRR on *Didemnum vexillum*.

f) Evaluate the role/importance of different bioinvasion vectors and pathways globally

WGITMO will report by 10 April 2016 (via SSGEPI) for the attention of SCICOM.

Supporting Information

Priority:	The work of the Group forms scientific basis for developing options to minimise the risk of future unintentional movements of invasive and/or deleterious aquatic species including disease agents and parasites with the legitimate trade in species required for aquaculture, table market, ornamental trade, fishing and other purposes and to assess the potential of species moved intentionally to become a nuisance in the area of introduction. The work of this Group supports the core role of ICES in relation to planned introductions and transfers of organisms.
Scientific justification and relation to action plan:	WGITMO work contributes to the following objectives of EPI: *Estimate long-term trends of human impacts on marine ecosystems:* Develop historical baselines of population and community structure and production to be used as the basis for population and system level reference points *Understand, quantify and mitigate multiple impacts of human activity on populations and ecosystems:* Develop methods to quantify multiple direct and indirect impacts, particularly from fisheries, as well as mineral extraction, energy generation, aquaculture practices and others, and estimate the vul-nerability of marine ecosystems to these impacts. Develop indicators of pressure on populations and ecosystems from human threats such as eutrophication, contaminant and litter release, introduction of invasive species and generation of underwater noise. *Provide evidence in support of the sustainable management of ecosystem goods and services:* Quantify and map biological, ecological and environmental value, optimise

	ecosystem use and minimise environmental impact, in relation to a dynamic ecosystem carrying capacity. Develop science in support of advisory needs on sustainable marine aquaculture systems, minimising environmental impacts and inte-grating other marine sectors.
Resource requirements:	None required other than those provided by ICES Secretariat and national members
Participants:	WGITMO nominated members and invited experts from, e.g. PICES and CIESM countries.
Secretariat facilities:	Meeting room providen by the host
Financial:	None required
Linkages to advisory committees:	ACOM
Linkages to other committees or groups:	WGHABD, WGBOSV, WGBIODIV, WGAQUA, WGIMT, WGPDMO, WGBE, WGZE
Linkages to other organizations:	WGITMO urges ICES to encourage and support a continued dialogue with PICES, CIESM, IMO, HELCOM, OSPAR and EIFAC.

Annex 7: Technical minutes from RGJAMP

Review of ICES Working Group on Introductions and Transfer of Marine Organisms (WGITMO), 18–20 March 2015, regarding Section 4.9 (Term of Reference i) OSPAR 1/2015 request: Review of draft OSPAR JAMP Eutrophication Guidelines on phyto-plankton species composition)

28 May 2015

Reviewers: Harri Kuosa, Finland (chair) and Donald Boesch, USA

WGITMO Chair: Henn Ojaveer, Estonia

ICES Secretariat: Sebastian Valanko

WGITMO provides a short commentary on JAMP Eutrophication Guidelines. The comments have already been streamlined with those of WGBOSV and given in Annex, which is identical to that of WGBOSV comments.

Regarding non-indigenous species the observations are correct. The first observation that consistent terminology is required is important for all users of Guidelines.

Though additions/modifications on the JAMP Guidelines have been proposed, it is not clear from the reports how systematic the consideration of non-indigenous phytoplankton species were. The Guidelines are in many aspects very general, and it could be considered if the normal sampling programmes and identification procedures are valid in optimal monitoring of non-indigenous phytoplankton.

The general discussion included discussion on 'key species' and a specific checklist. This is an important aspect, and should be considered. As the WG notifies, all lists should be open for revisions.