# ICES WGITMO REPORT 2014

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

19–21 March 2014

Palanga, Lithuania

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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# Contents

## Executive summary

The 2014 meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was held in Palanga, Lithuania during 19-21. March with Sergej Olenin as host and Henn Ojaveer as chair. The meeting was attended by participants from 22 countries. The physical participants were from Belgium, Canada, Denmark, Estonia, Finland, France, Greece, Germany, Ireland, Italy, Lithuania, the Netherlands, Norway, Portugal, Russia, Sweden, Ukraine and United Kingdom while United States participated over Skype and Croatia, Israel, Poland and Spain contributed by correspondence. The meeting was also attended by the EU and CIESM representative. It was the 40$^{th}$ meeting of this expert group.

The objectives of the meeting were to update information and discuss several aspects related to the introduction of alien species. The meeting dealt in more details with the 'Information system on aquatic non-indigenous and cryptogenic species' (AquaNIS) and whether/how to use this platform to further reporting to WGITMO purposes, fouling of artificial structures by alien species, how to better address emerging ICES strategic topics (climate impacts, Arctic research) and cooperation with CIESM and PICES. Importantly, the group also dedicated time for addressing the MSFD D2 issues and finalized the species alert report on *Ensis directus*. As usual, sufficient time was devoted to presentations of national reports and exchange of knowledge and information (e.g. with the Mediterranean Sea and the Ponto-Caspian region).

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 bioinvasions in general. The meeting started as a full-day joint meeting with the Working Group on Ballast and Other Ship Vectors (WGBOSV) during which issues of common interest were addressed. For the next meeting, the joint meeting is also planned to last one full day.

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 Term of Reference by either completing the task or clearly identifying and agreeing on the intersessional activities required to finalize 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 AquaNIS to substitute the present data-reporting format (xls file) and to be used beginning 2015 as an online reporting platform for new species invasions and secondary spread of already existing invasions in ICES countries and elsewhere (e.g. CIESM and PICES regions).

# 1 Opening of the meeting

The meeting was opened at 09:00 on March 19th, 2014 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. Sergej Olenin, Lithuania, acted as host of the meeting. Sarah Bailey and Henn Ojaveer chaired the joint session. The joint session finished at 17:00 on March 19th and the WGITMO meeting started at 09:00 on March 20th.

## 2 Adoption of the agenda

The agenda was organized based on the Terms of Reference as given in ICES Resolution 2013/2/ACOM30 (see below). In addition, a few invited presentations on a specific topic and/or of generic interest, which, among others, might assist in defining ToR's for the coming years, were accommodated into the agenda which was adopted without changes (Annex 2).

# 3 WGITMO Terms of Reference

2013/2/ACOM30 The **ICES Working Group on Introduction and Transfers of Marine Organisms** (WGITMO), chaired by Henn Ojaveer, Estonia, will meet in Klaipeda, Lithuania, from 19–21 March 2014, with a back to back meeting with the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV) to:

a ) Synthesize and evaluate national reports using the adopted format for reporting and contributions to the database that includes species, locations (latitude and longitude), status of invasions as appropriate, region of origin, status of eradication efforts, and habitat, and develop an annual summary table of new occurrences/introductions of aquatic non-indigenous species.

b ) Continue verifying selected datasets of the newly developing database on marine and other aquatic organisms in European waters by making other components of the database available online, in addition to the Baltic Sea which is already available. This activity will mostly be carried out intersessionally and take several years.

c ) Continue addressing EU MSFD D2 on further developing alien species indicators, incl. evaluating of ecological impacts caused by alien species.

d ) Continue identification and evaluation of climate change impacts on the establishment and spread of non-indigenous species. Produce draft manuscript on temperature effects on non-indigenous species and develop further research agenda. This activity will mostly be carried out intersessionally and take several years.

e ) 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).

f ) Investigate and report on new developments in non-native species issues into and through the Arctic region (joint Term of Reference with WGBOSV).

g ) Collaborate with ICES Study Group on Integrated Morphological and Molecular Taxonomy (SGIMT) regarding identification, early detection and monitoring of non-native species, as appropriate (joint Term of Reference with WGBOSV).

h ) Finalize the draft alien species alert report on *Ensis directus*.

WGITMO will report by 14 April 2014 for the attention of ACOM.

**Supporting Information**

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| Priority: | The work of the Group is the basis for essential advice to prevent future unintentional movements of non-indigenous species. 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 ac- | We are routinely updating data and information on new introductions or expanding introductions.<br>The group will contribute to MSFD Descriptor 2 issues, incl. provid- |

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|---|---|
| tion plan: | ing guidance and generic suggestions for designing future alien species monitoring programs.<br><br>We are planning to actively contribute in verification of selected datasets of the newly developing database on marine and other aquatic organisms in European waters. This will be essentially important for WGITMO to contribute as a group into these database building.<br><br>We plan to identify and evaluate climate change impacts on the establishment and spread of alien species; this activity will result in scientific publication.<br><br>We'll investigate and report increasingly important issue of various artificial structures for alien species spread and invasions.<br><br>We'll initiate cooperation with Working Group on Integrated Morphological and Molecular taxonomy (WGIMT).<br><br>We'll produce next alien species alert report (on *Ensis directus*). |
| Resource requirements: | None required other than those provided by ICES Secretariat and national members |
| Participants: | WGITMO nominated members and invited experts from, e.g. Mediterranean Sea countries that are not members of ICES. |
| Secretariat facilities: | Meeting room providen by the host |
| Financial: | None required |
| Linkages to advisory committees: | WGITMO reports to ACOM |
| Linkages to other committees or groups: | WGHABD, WGEIM, WGBOSV, WGAGFM, WGMASC, WGBIODIV |
| 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 by each of the Term of Reference, amended by more important discussion items as well as relevant conclusions/suggestions as emerged from the group discussions.

## 4.1 Term of Reference a)

*Synthesize and evaluate national reports using the adopted format for reporting and contributions to the database that includes species, locations (latitude and longitude), status of invasions as appropriate, region of origin, status of eradication efforts, and habitat, and develop an annual summary table of new occurrences/introductions of aquatic non-indigenous species (ToR lead Henn Ojaveer).*

This Term of Reference was addressed by all meeting participants who provided information for their country according to the items of the reporting outline. This was done either via a short verbal report or in the form of more substantial presentation. In addition, several countries which were physically not represented at the meeting (Croatia, Denmark, Greece, Italy, Poland and Portugal) submitted their written contributions. The following subsections provide condensed highlights of all national reports received. For details please see Annex 3 (national reports) and Annex 4 (detailed summary information on new invasions and range expansions of already existing alien species as reported by countries).

### 4.1.1 Belgium

During 2013 the introduced sea spider *Ammothea hilgendorfi* has been found in the Hinder Banks area some 30 km offshore. 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 and is also revising the National Code on Introductions and Transfers of Aquatic Organisms. In 2013 a new species was discovered in Canada, *Didemnum vexillum*, Minas Basin, Bay of Fundy, Nova Scotia. Other species that have already invaded Canadian waters continue to spread, including European Green Crab, Vase Tunicate, *Codium fragile*, (oyster thief), Golden Star Tunicate, *Styela clava* (clubbed tunicate), *Diplosoma listerianum* and *Botrylloides violaceus*.

### 4.1.3 Croatia (by correspondence)

New sightings include *Paraleucilla magna, Oculina patagonica* and *Lagocephalus sceleratus*.

IPA CBC Adriatic project Ballast Water Management System for Adriatic Sea protection (BALMAS) which includes partner from all countries on Adriatic Sea will prepare a common Ballast Water Management (BWM) Plan for the Adriatic Sea area, and implement the BALMAS BWM decision support system (DSS) including compliance control and enforcement (CME), compliant with the International Convention for the Control and Management of Ship´s Ballast Water and Sediments (BWM Convention) considering local specifics.

### 4.1.4 Denmark

The occurrence of *Beroe ovata* in Danish waters has been confirmed by molecular methods. The largest oyster (*Crassostrea gigas*) in the world (35.5cm long) found in Danish Wadden Sea. The round goby, *Neogobius melanostomus*, is now a nuisance species in waters around the islands of Lolland and Falster (Baltic Sea coast).

### 4.1.5 Estonia

National alien species monitoring was continued in the scope and aims as in previous years. One of the aims is to monitor alien species in the high-risk areas of new invasions. Base on surveys in vicinity of the largest port in the country – Muuga harbour – no new alien species were identified in 2013. The new polychate species found in Pärnu Bay in 2012, belonging to the genus *Laonome*. The species was recently described as *Laonome armata* sp. nov. (Sabellida, Sabellidae) and by now has established a permanent population. The bloody-red shrimp *Hemimysis anomala* and the round goby *Neogobius melanostomus* expanded their distribution areas while the abundance of Chinese mitten crab *Eriocheir sinensis* continued to be low. The grass prawn *Palaemon elegans* was found across the whole Estonian coastal sea in 2013.

### 4.1.6 Finland

One new alien species was found in Finnish waters in 2014. It is at present an unknown gastropod species. The identification is underway with molecular analysis. The round goby, *Neogobius melanostomus*, is increasing in abundant and in the number of ports occupied. The mud crab *Rhithropanopeus harrisii* was found to still increase in abundance in the Archipelago Sea. Port monitoring was conducted according to HELCOM protocol in 3 Finnish ports in spring and late summer 2013. Finnish board on invasive species issues was set up and started its work in September 2013. The ratification of the IMO's BWM Convention by Finland was delayed and will take place during 2014.

### 4.1.7 France

This year was the discovery of the European green crab *Carcinus maenas* in the French overseas territory of St Pierre et Miquelon. In mainland France, several species identified in previous reports are showing range expansions, including the algae *Heterosiphonia japonica* and *Undaria pinnatifida,* the amphipod *Grandidierella japonica* and the crab *Hemigrapsus sanguineus*. Several molecular barcoding research projects studying non-native species are ongoing. Finally, it is worth noting that a tentative commercial exploitation of the slipper limpet *Crepidula fornicata* is underway in the vicinity of the Mont St Michel bay.

### 4.1.8 Germany

No new findings were reported since last year's meeting. 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. The impact of *Gracilaria vermiculophylla* on Fucus was studied in the Kiel Fjord and it was concluded that Gracilaria is able to influence *Fucus* in the Baltic Sea through direct competition for resources and by exposing it to higher grazer pressure (Hammann et al 2013). Floating *Sargassum muticum* are found since 1981/1982 and the first attached algae were found in 2011. Attached *S. muticum* seem to spread along the Lower Saxony coast (Island of Juist) (Markert & Wehrmann 2013). A species not yet known from Germany is *Didemnum vexillum*, but it is found in other European countries. 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.

### 4.1.9 Greece

In 2013 six marine alien species were reported for the first time from the Greek Seas. These include the polychaet *Dipolydora blakei* from the Ionian and Aegean Sea, the shrimps *Meliceros hathor* and *Farfantepenaeus aztecus* from south and north Aegean Sea respectively, the decapod crab *Xanthias lamarcki* from the Rhodes area (south Aegean); the barnacle *Megabalanus coccopoma* from Saronikos Gulf, and the hydrozoan *Sertularia marginata* from the Aegean Sea.

In addition, 40 alien species have expanded their distribution in Greek waters, some of them exhibiting invasive behaviour (*Callinectes sapidus, Lagocephalus sceleratus*).

### 4.1.10 Ireland

Ireland will have had a joint co-operative programme with Northern Ireland dealing with non-indigenous species 'invasive species Ireland'. The contracts for this joint work have terminated and much of the continued biodiversity is undertaken now by the biodiversity centre (http://www.biodiversityireland.ie/) part of this cross border cooperation will have involved a marina and shore survey of the north coast of Ireland and in Carlingford Lough (http://www.doeni.gov.uk/niea/marina_report_final.pdf). This last study has revealed two NIS not previously known in Ireland, *Undaria pinnatifida* and *Perophora japonica* and four further species to this part of the island of Ireland. The bryozoan *Bugula fulva*, was new to the Republic of Ireland and *Bugula neritina*, *Watersipora subtorquata* and the carpet tunicate *Didemnum vexillum* to Northern Ireland. There were thirty-five new range extensions since a survey in 2006.

### 4.1.11 Israel (by correspondence)

Eleven marine alien species were newly reported from the 180 kms long Mediterranean coast of Israel. These include 4 molluscs: *Elysia grandifolia*, *Pseudorhaphitoma iodolabiata*, *Monotygma watsoni*, *Cylichna villersii*; 4 decapod crustaceans: *Lucifer hanseni*, *Matuta victor*, *Saron marmoratus*, *Actaea savignii*; 3 fish: *Vanderhorstia mertensi*, *Gymnothorax reticularis*, *Parupeneus forsskali*. Eight of the species are new records for the Mediterranean Sea, undelining the need for closely monitoring the southeast Levantine Sea for incoming thermophilic Erythraean aliens. The population of *Cheilodipterus novemstriatus*, first recorded in 2010, is undergoing rapid expansion.

### 4.1.12 Italy

Three new species of algae and three invertebrates have been recorded in Italian marine waters. Information on already established alien species, including macroalgae, invertebrate and fish NIS is given.

### 4.1.13 Lithuania

No new intentional NIS introductions recorded in 2013. One new NIS species recorded, most probably spreading from the neighboring Kaliningrad area. Monitoring of marine NIS is included into a proposal for the renewed National Monitoring Program for the Marine Strategy Framework Directive.

#### 4.1.14 Netherlands

It was reported that Japanese oysters collected in Wadden Sea area in the summer of 2012 were infected with the oyster Herpesvirus OsHV-1 µvar. This virus appears to be responsible for an increased juvenile mortality on Japanese oysters. As Japanese oysters are an important species for aquaculture in the Netherlands further research on the effects caused by the virus could be important.

#### 4.1.15 Norway

i ) No new NIS to Norwegian waters has been reported. Several species have expanded range slightly, and some new sites have been discovered within the known range (*Styela clava, Crassostrea gigas);*

ii ) *Crassostrea gigas*: Rapid growth in 2012-2013. A reef has formed where cold winters have reduced the population previously;

iii ) *Chionoecetes opilio:* No final genetic clarification of the origin of the Snowcrab (It has previously been established that there is a significant genetic distance from the Canada/Greenland stock) (Dale et al., 2013). 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);

iv ) *Paralithodes camtschaticus:* King crab stock still smaller than the peak in 2008,

v ) (Hjelset et al., 2012), but the estimate for 2013 is slightly larger than for 2012 (0.98 mill ind.,vs.0.8 mill ind., respectively);

vi ) *Homarus americanus*: Six lobsters with suspicious phenotype have been analysed. Two of them were confirmed to be American lobster.

#### 4.1.16 Poland (by correspondence)

Reported in this work new sightings were published in 2013 and 2014, but were found earlier; only new parasites of the Eurasian otter *Lutra lutra* (Linnaeus, 1758) were found on May 2013, in northern Poland (the Elbląg River) (Rolbiecki & Izdebska 2014). These new parasites are: *Oswaldocruzia filiformis* (Goeze, 1782), the acanthocephalan *Acanthocephalus ranae* (Schrank, 1788) and the skin mite from the Demodecidae family. *Demodex sp.* is a new species to science, while *O. filiformis* and *A. ranae* are new parasites for the otter throughout the species range. The recorded helminths are typical parasites of amphibians and reptiles, and their occurrence in the Eurasian otter may result from postcyclic transmission from primary hosts.

#### 4.1.17 Portugal

A list of 130 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems, 33 of which were new additions to the 2013 report. The inventory of NIS did not include fish species and freshwater species. Portugal has a law on introduction of exotic 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. A first characterization report was delivered in the aim of the implementation of the Marine Strategy Framework Directive and monitoring programs are currently under development. The illegal fishing of

*Ruditapes philippinarum* is a major problem in the Tagus estuary and authorities want to develop specific regulation for this activity. Recent information suggests that the blue crab (*Callinectes sapidus*) has established a population in the Sado estuary but with low census size.

### 4.1.18 Russia

No new intentional NIS introductions were recorded in 2013. One new alien species was first reported in the Russian marine coastal waters - cyanobacteria *Planktolyngbya brevicellularis* (Curonian Lagoon, Baltic Sea) and one alien species, recorded earlier in the Baltic sea (Russian part of coastal Vistula Lagoon), clam *Rangia cuneata*, was marked for the first time in open Baltic waters; its appearance here could be regarded as further secondary dispersal by natural vectors. Two bivalve species were first marked in Russian Barentz Sea - *Abra prismatica* and *Gari fervensis*, but its NIS status is less probable than natural range expansion.

In 2013 an inventory of alien biota of Russian SE Baltic area discovered 37 established species. In recent years several NIS inventories for other Russian marine areas were done: Gulf of Finland (2008, 51 aliens), seas of Far East (2011, 66 aliens), Black Sea (2012, 171 aliens), invasion status is evident not for all listed species and is discussed in cited papers.

### 4.1.19 Spain (by correspondence)

Royal Decree 630/2013, of August 2, regulating the Spanish Catalog of alien invasive species is in place. Although the official Spanish Catalog of invasive alien species has been extended to 183 species, some species from the previous catalog have disappeared. Moreover, the List of 264 plants and animals considered as "potentially invasive species" in the previous decree has been removed.

Regarding new sightings, *Chiton cumingsii*, the Scaly chiton, was reported in Las Palmas Port (Gran Canaria, Canary Islands) in August 2012. The ployplacophoran *Tonicia atrata*, was identified from material taken in three locations of the Bay of Biscay (N Spain, Atlantic coast) in January 1978, July 1985 and May 2010. Specimens had been preserved and misidentified as *Ch. angulata*. This is the first record for both species (*C. cumingsii* and *T. atrata*) in European waters and the first evidence of their presence outside their native range. *Ensis directus*, the American razor clam, was recorded for the first time in the waters of the Iberian Peninsula in two locations of the southwest Bay of Biscay in 2011. Twenty-four living specimens of *Mercenaria mercenaria*, the hard clam or quahog, collected in Asturias (N Spain) in January 1978 were recently examined and identified as *M. mercenaria*; making this the first record of the species in the Iberian Peninsula. In January 2011, *M. mercenaria* was found again close to the 1978 location. *Theora lubrica*, the Asian semele, was recorded for the first time in the Atlantic Ocean, specifically in four sites in the Bay of Biscay, on 6 October 2010 and 21 May 2010.

With regards to previous sightings, the scleractinian coral *Oculina patagonica* it is now spread throughout all the Spanish Mediterranean coast, from Algeciras to Catalonia and Balearic Islands. The tropical hydroid *Sertularia marginata* was detected in the Chafarinas Islands (Alborán Sea, Western Mediterranean) in 2007 and in a shipwreck off Sancti Petri (Cádiz, Atlantic coast of the Strait of Gibraltar) in 2012. This species had previously been reported in the 1980's in the Canary Islands, in the north coast of the Iberian Peninsula, and in the Gulf of Cádiz. Specimens of the polychate *Branchiomma bairdi* were obtained from Mazarrón harbour (Murcia, Spain) and Las Palmas harbour (Gran Canaria, Canary Islands) in May 2012. But previous records (from 2006) of *B. boholense* reported from Mar Menor Lagoon (SE Spain), had been misidentified and were actually *B.bairdi*. Two specimens of the spionid *Paraprionospio coora* were identified from two stations in the SE Bay of Biscay, in 2010 and in 2012. *P. coora* had previosuly been reported in 1995 from Valencia (E Spain) as *P. pinnata*. The caprellid amphipod *Caprella scaura* was recorded for the first time in the Iberian Peninsula in July 2005 in Roses Bay (Girona, NE Spain). Now its extensive distribution along the Spanish Mediterranean coast (including the Balearic Islands) and the Strait of Gibraltar has been confirmed. *C. scaura* is also present in the Canary Islands. Two established populations of *Paracaprella pusilla* were found for the first time in the Mediterranean, in Mallorca and Ibiza, in 2011 and 2012, respectively. Previously, in 2010, and for the first time in European coastal waters, *P. pusilla* had been found in a marina in Cádiz (SW Spain).

### 4.1.20 Sweden

One specimen of the Japanese/Asian shore crab *Hemigrapsus sanguineus* was found on the Swedish west coast by a crab-fishing child in 2012 and confirmed in 2013, by photo identification. The round goby, *Neogobius melanostomus*, can now be considered established in several areas in Sweden. It has spread rapidly and is commonly found in areas where it was first recorded just a few years ago.

### 4.1.21 United Kingdom

Institutes throughout the UK are progressing with a number of monitoring programmes and biosecurity projects. These include the Cefas-led marine pathways project (Marine non-indigenous species monitoring and risk management) which is a collaboration between Defra, Natural England, Natural Resources Wales, Scottish Natural Heritage, Marine Scotland, Irish Sea Fisheries Board, Cefas, Bangor University, Marine Biological Association and Cornish Wildlife Trust. A monitoring and recording system for marine invasive non-native species in Orkney has been developed and the North Atlantic Fisheries College (NAFC) Marine Centre in Shetland has been undertaking invasive species monitoring at Shetland's ports, marinas and aquaculture sites since 2012. Biosecurity plans are being developed for Shetland which will provide supplementary guidance to that already contained in Shetland Islands' Marine Spatial Plan and the Scottish Association of Marine Science has collaborated with the Firth of Clyde Forum and Scottish Natural Heritage to produce guidance for biosecurity planning for sites and operations. Cefas as progressing with work examining the potential use of molecular tools in monitoring for non-native species from environmental DNA that is shed into the water column. Various projects examining methods of controlling non-native species have been progressing over the last year. These include control methods for *Dressena polymorpha*, *Pacifastacus leniusculus*, *Dikerogammarus villosus*, *Hydrocotyle ranunculoides*, *Lagarosiphon major* and *Dikerogammarus haemobaphes*. Measures investigated so far include hot water, chemical control, semiochemicals, biological control agents, male sterilisation and physical control and removal. Four species of macroalgae previously unrecorded in the UK have been identified during 2013. These are *Chrysymenia wrightii, Griffithsia schousboei, Dictyota cyanoloma* and *Gracilaria vermiculophylla*, which were all recorded from the south coast of England. A recording of the non-native bryozoan Bugula simplex in northern Scotland during summer 2012 constituted the most northern UK record to date. This record became available in 2013. A new version of the decision support tool, the Fish Invasiveness Scoring Kit (FISK), has been published online for free download. Defra continue to support negotiations on the forthcoming EU invasive alien species strategy.

#### 4.1.22 United States (by correspondence)

One new species, *Panulirus versicolor*, the Painted Spiny Lobster has been found in a single location in the state of Georgia as a single specimen. Several species have been shown to expand their ranges including, the red alga *Heterosiphonia japonica* northward to Maine, the brown alga *Colpomenia perigrina* (southward), the rhizocephalan barnacle (parasite) *Loxothylacus panopaei,* two shrimp *Palaemon elegans and P. macrodactylus,* the bryozoan *Tricellaria inopinata,* and the lion fish, *Pterois volitans/miles.* One transient, *Palaemon floridanus* was along with two warm water species *Melita palmata* and *Aiptasiogeton eruptaurantia* have been observed in New England waters, of which *M. palmata* and *A. eruptaurantia* may be established.

## 4.2 Term of Reference b)

*Continue verifying selected datasets of the newly developing database on marine and other aquatic organisms in European waters by making other components of the database available online, in addition to the Baltic Sea which is already available. This activity will mostly be carried out intersessionally and take several years (ToR lead Sergej Olenin).*

### AQUANIS DATABASE (Presentation and discussion led by Sergej Olenin)

At its 2013 meeting in Montreal, WGITMO suggested the newly established Information system on aquatic non-indigenous and cryptogenic species (AquaNIS) to be used not only in ICES whenever alien species information is required (e.g. for ecosystem overviews or regional ecosystem assessments), but also promote the database for stakeholders and policymakers, like OSPAR and HELCOM. AquaNIS is one of the products of the EU funded project VECTORS (Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors, FP7/2007-2013). AquaNIS Editorial Board seeks to ensure the long term maintenance and reliability of the database by continuous update and scientific validation of its data. At the 2014 meeting the progress in further development of AquaNIS functionality and content was presented. One of the major steps forward was elaboration of a module to accommodate data on natural and human-made habitats where non-indigenous species (NIS) have been recorded, e.g. open coast, lagoon, aquaculture sites, marinas, etc. Also new module "Ports" was considered in details. This module is aimed to assemble, store and disseminate comprehensive data on NIS found in ports and their vicinities. A concrete proposal was made on how to improve format of annual national data reports to WGITMO using AquaNIS. Such regular updates of key data will help to produce indicator fact sheets on newly registered NIS in the ICES area, NIS spreading and those impacting aquaculture, fishery and ecosystem functioning. In combination with information already accrued in AquaNIS (introduction histories, recipient regions, taxonomy, biological traits, impacts, environmental tolerance limits, etc.) the annual national data updates will provide opportunity for deeper analysis of NIS vectors of spread and their impacts on marine ecosystems and uses of the sea.

**Information system on aquatic non-indigenous and cryptogenic species: AquaNIS**

AquaNIS stores and disseminates information on NIS introduction histories, recipient regions, taxonomy, biological traits, environmental tolerance limits, impacts, and other relevant documented data. It is freely available online at www.corpi.ku.lt/databases/aquanis.

### New developments since 2013

Structure of AquaNIS, its data input and output functions as well as data acquisition and data quality control scheme were presented at large at the previous, 2013 meeting of the WGITMO. Further details could be found in a recent publication (Olenin et al. 2013). During the reporting period a major steps forward was elaboration of a module to accommodate data on natural and human-made habitats where non-indigenous species (NIS) have been recorded, e.g. open coast, lagoon, aquaculture sites, marinas, etc. Also a new module "Ports" was presented. This module is aimed to assemble, store and disseminate comprehensive data on NIS found in ports and their vicinities (Figure 1).

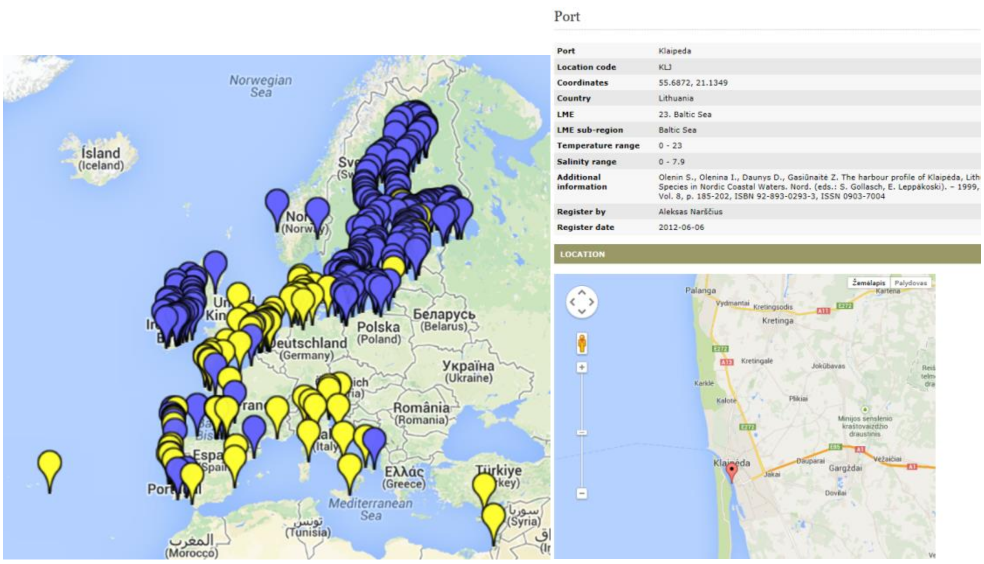


**Figure 1. Left: ports listed AquaNIS, "yellow" - ports with registered non-indigenous species, "blue" - ports for which data are not provided yet. Assessed at 2014-03-20.**

In total there are 296 ports catalogued in AquaNIS, of them for 76 ports data on presence on NIS and, in some cases, on salinity and water temperature range is entered.

### Recent data coverage and perspectives

By the WGITMO meeting (March 19-21, 2014) AquaNIS encompassed data on 1282 NIS and CS involved in 3736 introduction events in 50 recipient regions (i.e. a country coast within a Large Marine Ecosystem (LME), see WGITMO 2013 report and Olenin et al., 2013 for technical details and definitions). In addition to the Baltic Sea, data for LME 20 Barents Sea, LME 21 Norwegian Sea, LME 24 Celtic-Biscay Shelf – Ireland's waters, LME 59 Iceland Shelf, LME 60 Faroe Plateau was opened for public access during the reporting period. Moreover, data for the Black Sea countries is being entered to AquaNIS and will become accessible after publication of a review paper by the data providers (Aleksandrov et al., in prep.). AquaNIS is ready to accommodate data from the NW Atlantic ICES Member States (USA and Canada) including Atlantic coast of North America and Laurentian Great Lakes.

### Harmonizing national reporting formats for WGITMO with AquaNIS

Data on findings of new NIS is being reported to WGITMO using national data reporting format, an Excel spreadsheet which contains: Date of Record of a NIS, its Latin name, taxon it belongs to, location name and coordinates, population status, likely vector, etc. Few years ago introduction of such format to submit national data were a big step towards standardization of information reported by national representatives. However, experience gained since that time shows that the data presented in Excel spreadsheets cannot be used for the analysis directly after submission. Mechanical junction of data from all national reports requires a lot of additional efforts. For example, scientific names of species to check may be misspelled while entering data or because of using different synonyms; coordinates are being entered in several different formats; vectors involved are presented differently and without indicating the level of certainty. Insufficient standardization of data and human errors which are difficult to avoid while entering data manually, make it difficult the immediate use of the submitted data for producing indicators on new arrivals, spreading and impacting species, species which are expanding their range due to climate change, etc. due to prevents.

It is important that all fields used in the WGITMO national data reporting format are developed in AquaNIS. However, on the contrary to Excel spreadsheets, the entries are supported by explanations of terms and guidance is provided for data input throughout logically separated data attributes. Drop down and checkbox menus, designed to reduce possible human error, enable rapid data entry. For example, there are 11 pathways and 49 related vectors which a user may select from a drop down menu. The variety of pathways and vectors included in AquaNIS is based on extensive literature reviews. And it is also important, that it is required to indicate the level of certainty assigned to a particular pathway or vector.

### Online submission of national data reports to AquaNIS

Taking into account the above objective and subjective problems arising from using Excel spreadsheets it is proposed to use AquaNIS for online submission of national data reports. The reasons for that are:

- Historical data on NIS and CS recorded in marine environment of all ICES Member States (except USA and Canada, so far) up to 2013 is available in AquaNIS;
- New regions, e.g. Black Sea, are joining AquaNIS, which essentially enlarges possibilities for comparative analysis of data;
- AquaNIS provides a well-developed and user friendly system for entering data. Eventually, the online submission of data would take less time when entering the Excel spreadsheet forms.

Thus, an annual national report would include text (as usual) and the online update of the existing data for the reporting year. In addition, the national data reports may be extracted as Table and added to Appendix as pdf, Excel spreadsheets or text. All nominated national representatives will get access to AquaNIS (login, password). After entering, the data will be verified by the AquaNIS Editorial Board. On approval all data will be available for the analysis immediately.

AquaNIS seeks to ensure the long-term maintenance and reliability of the database by continuous update and scientific validation of its data, making it useful for research and practical for management. The Database developers and Editorial board believe that the content will be of value in relation to the management of the EU Water Framework Directive, The Marine Strategy Framework Directive, Risk Assessment measures for different pathways, especially shipping and aquaculture

### Data policy

The AquaNIS Development Team, which is responsible for the designing and maintaining of the system, agreed on the following:

- "In order to manage the information system effectively and to protect each contributor's right to use his/her data before it is generally released to the public, the contributors should comply with following conditions:
- each contributor is free to distribute (within and without AquaNIS) his/her own data;
- each group of contributors, responsible for a particular LME, may, on agreement, release their data for public use after notifying the Editorial Board;
- permission is required for use of data which belong to other contributors. Data are not to be used and released without written approval by the contributing author. If there is doubt about the actual contributor of the data then all the possible authors should be consulted."

Storage of national report data in AquaNIS may be further harmonized with the ICES data Centre.

### Literature

Olenin S., Narščius A., Minchin D., David M., Galil B., Gollasch S., Marchini A., Occhipinti-Ambrogi A., Ojaveer H., Zaiko A. 2013. Making non-indigenous species information systems practical for management and useful for research: an aquatic perspective. Biological Conservation. http://dx.doi.org/10.1016/j.biocon.2013.07.040

### European Alien Species Information Network EASIN (Presentation by Stelios Katsanevakis)

The European Alien Species Information Network (EASIN; http://easin.jrc.ec.europa.eu/; Katsanevakis et al. 2012) was presented to WGITMO. EASIN was officially launched in September 2012. It is an online platform that aims to facilitate the exploration of existing information on alien species from distributed resources and to assist the implementation of European policies on biological invasions, in particular the proposed (by the European Commission) new Regulation on Invasive Alien Species. Other highly related European policies include the Biodiversity Strategy (Target 5) and the Marine Strategy Framework Directive (Descriptor 2). EASIN covers all environments (marine, freshwater, terrestrial) and all European countries (for marine species, the entire Mediterranean basin is covered, i.e. also northern African and Near East marine areas).

EASIN harmonizes and integrates information (such as occurrence records) from many different sources and provides tools for their exploration. Specifically, EASIN:

- Provides an inventory of all reported alien species in Europe (EASIN Catalogue). The EASIN Catalogue was initially compiled by integrating information from 43 online database; taxonomic experts were then advised for validation and completion of missing information (for some terrestrial species this process is ongoing).

- Provides information on reported alien species (taxonomical classification, pathways of introduction, native range, country and year of first introduction etc)
- Provides links to other databases (e.g. DAISIE, NOBANIS, WoRMS, CABI, CIESM, Fishbase).
- Integrates spatial data from various data providers, currently from GBIF, GISIN, REABIC, CIESM, ELNAIS, HCMR-EEA, and published literature (EASIN-Lit; Trombetti et al. 2013).
- Provides flexible and interactive search and mapping tools and services: tailored selection of subgroups of species based on various criteria (e.g. environment, taxonomic classification, pathways) – creation and export in real time of distribution maps.

Ongoing developments include: the establishment of an Editorial Board and a supporting web platform for the continuous update and quality assurance of the EASIN catalogue; the development of a web platform for an Early Warning and Rapid Response system that will allow member states to automatically report and quickly distribute information on new detections of invasive alien species as well as information on management techniques and outcomes of management actions; the further enlargement of the EASIN network with new partners.

Especially for the latter, cooperation with ICES through the AQUANIS information system was proposed and discussed.

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Katsanevakis S, Bogucarskis K, Gatto F, Vandekerkhove J, Deriu I, Cardoso AC, 2012. Building the European Alien Species Information Network (EASIN): a novel approach for the exploration of distributed alien species data. BioInvasions Records 1: 235–245.

Trombetti M, Katsanevakis S, Deriu I, Cardoso AC, 2013. EASIN-Lit: a geo-database of published alien species records. Management of Biological Invasions 4(3): 261–264.

### Non-indigenous species in the Black Sea and the Sea of Azov (Presentation by Borys Aleksandrov)

According the activity of Advisory Group on Conservation of Biological Diversity of Secretariat of the Commission on the Protection of the Black Sea (BS) Against Pollution and 37 experts from all BS countries have been produced database of the BS non-indigenous species (NIS). This base contains information about the year and the area of the first registration of alien species in national waters of all BS countries, origine of alien species, success of their naturalization, source of information based on 179 local and international publications.

Biological diversity and total number of NIS correlate with salinity of the water. Total number of alien species in Mediterranean Sea ($S_{aver}$= 36-39‰) in recent time is 963 (Zenetos et al., 2012), in the BS ($S_{aver}$= 18-22,5‰) – 300 species, in the Sea of Azov ($S_{aver}$= 10,5-11,5‰) – 87 species (Zaitsev, Ozturk et al., 2001; Matishov, Boltachev et al., 2010; Demchenko&Demchenko, 2013).

The list of NIS consists of marine (261), brackish (39) and excludes species (58). The last group of organisms includes: 1) cryptogenic species, or the species that have been identified as the progress in systematic investigations (as the rule it is small organisms with not clear systematic position, or hardly identify); 2) native species for the BS, that first identify in their different areas; 3) occasionally registered (mostly plankton organisms, for example phytoplankton cysts and zooplankton species that appear with ballast water and not survive with time), some species with mistaken identification. Among marine alien species in BS have been specified: 10 species of marine fungi, 65 - phytoplankton, 35 - zooplankton; 5 - microphytobenthos, 50 - macroalgae, 65 - zoobenthos, 6 – parasites, 25 - fish. From 300 NIS (marine and brackish) registered in BS 21% is casual species, 33% are successfully naturalize (established) and 46% has questioner status. According to the list total number of alien species in different national waters of BS countries has distributed: 82 species in Bulgaria, 35 – in Georgia, 97 – in Romania, 50 – in Russia, 94 – in Turkey, 177 – in Ukraine. This distribution connected not only with position of different countries along the BS coast (length of shore line, or total square of the shelf area), but first of all from the number of experts involving to this work and total duration of hydrobiological invistigation in the countries. If consider the BS alien species from the point of view of their origin it is possible to receive following conclusions. More than 90% (from total number of registered species - 268) of aliens connected with the Atlantic Ocean and Mediterranean Sea, 18-27% - has the origin from Indian and Pacific Ocean, 16-25% - have originated from northern Atlantic inhabiting the coastal area of North Europe or America. About the preferential penetration NIS into BS with the Bosphorus current indicates percentage of common number of NIS in neighboring countries that correlate with direction of the Black Sea long shore currents movement.

A database on the Black Sea non-indigenous species has been compiled as the result of the dedicated effort of the experts from all six coastal countries during 2007-2013. According to the decision of the Advisory Group on Conservation of Biological Diversity of Secretariat of the Black Sea (BS) Commission the database will be opened for public use through AquaNIS (Information system on non-indigenous and cryptogenic species) only after publication of a joint review paper on biological invasions in the Black Sea (Aleksandrov et al., in prep.) involving six expert team leaders from all Black Sea countries as the coauthors.

### Non-native species invasions in the southern seas of Eurasia: pathways, vectors and risk assessment (Presentation by Tamara Shiganova)

In the latter half of the XX century rate of invasions accelerated during last 50 years in the southern seas of Eurasia caused anthropogenic and climatic shifts of ecosystems and construction of ballast tanks at the ship in 1980s. Increased shipping intensity and extension of routes, construction of canals which connected previously separated seas caused the Black Sea to become a recipient and donor area for marine and brackish water species of different origin. It serves as a hub for species that then spread further to the Sea of Azov and the Caspian Sea, and also to the Sea of Marmara and in some cases to the Mediterranean Sea and in some cases in areas of the Northern and southern Atlantic . As a result first of all these processes led to biotic homogenization of all the Ponto-Caspian Seas (the Black, Azov and Caspian), as the same non-native species became dominant numerically in communities and often in ecosystem functioning while native biodiversity decreased.

We compare native and non-native biodiversity in the Southern seas of Eurasia on the base of own and published data. Both numbers of native and non-native species decline with salinity decrease in the Seas of Eurasia: from species -rich Mediterranean Sea to lower-species Black Sea and to the species-poor Azov and Caspian seas. High biodiversity in the Mediterranean Sea might be explained diversity of environmental conditions, high salinity and temperature. From the Mediterranean to the Black Sea salinity drops at 21‰, the numbers of native and non-native species decrease both by factor of 3,5.

From the Black Sea to the Sea of Azov salinity drops at 7‰, numbers of native species decreased by factor of 3, 4, non-native species - by factor of 3, 3. The numbers of native species reduce by factor of 2, 5 in the Caspian Sea comparing with the Black Sea ones, numbers of non-native species reduce by factor of 2, 6. Thus, numbers of non-native species pro rata the numbers of native species in the Seas of Eurasia and the recognized theory that a rich many-component marine basin less invasible than poor diverse sea with many empty niches does not confirmed in the this case.

#### NIS monitoring program in the Madeira archipelago and invasions in offshore islands (Presentation by João Canning Clode)

While terrestrial introductions have been well documented on many island ecosystems and continue to be the focus of extensive work in invasion biology, studies on marine invasions on most of the world's islands have been poorly explored. Three island systems in the Pacific Ocean (New Zealand, Hawaiian Islands and Guam) and one in the Atlantic Ocean (Azores) are exceptions. To expand our understanding of the scale and diversity of fouling marine bioinvasions on insular systems, marine bioinvasions of Macaronesia were examined. This region consists of four archipelagos: Azores, Madeira, Canary Islands and Cape Verde. An extensive literature review of records of fouling NIS in Macaronesia was performed. 98 non-indigenous species in Macaronesia were recognized and these numbers were related with critical variables, including latitude, ship traffic, distance to mainland ports and anthropogenic activities. The Azores archipelago showed highest NIS diversity while Cape Verde the lowest, In addition, Azores, Madeira and the Canary islands share more NIS perhaps due to a closer shipping history. Caper Verde seems very distant from the remaining island systems both in terms of NIS diversity and composition. Search effort over the years may play a key role in shaping these patterns. Finally, as there are only two NIS inventories in Portugal, both in the islands. In order to complement this effort, a new NIS monitoring program was launched in Madeira in 2013. This program will be presented.

### 4.3 Term of Reference c)

*Continue addressing EU MSFD D2 on further developing alien species indicators, incl. evaluating of ecological impacts caused by alien species (ToR leads Sergej Olenin and Henn Ojaveer).*

#### MSFD D2: What we know vs. what is reported on MS IAs for the MSFD (Presentation by Argyro Zenetos)

Invasive alien species have been recently taken enough consideration in the European directives such as the Marine Strategy Framework Directive (MSFD) and the Biodiversity Strategy. On behalf of the European Environment Agency, MSFD Initial Assessment reports and accompanying report sheets delivered to EU by August 2013 were evaluated for Descriptor 2 (Non Indigenous Species).

The data recorded in the report sheets were analysed for number of species, level of pressure, activities responsible for the transfer of species (pathways) and impacted elements. The produced analyses were compared with data which is stored in the HCMR/EEA database retrieved from EASIN and reported in publications.

Compilation of the information on NIS reported by 19 EU countries surrounding European Seas, revealed that efforts for monitoring and reporting alien species vary among EU countries. A key issue was the lack of consistency of the information reported on non-indigenous-species. Among the discrepancies noticed are included:

- Different interpretation of the terminology used such as 'Invasive' (in Greece all species were listed as invasive-not true) or 'alien' species (some countries such as Spain) have included species extending their biogeographic range due to climate change;
- Number of species cited in the report and listed in table 8a differ (e.g. in Cyprus only 1 species in Table 8avs.126 species stated in the main report);
- Nomenclature used was different not only among countries but among different MSFD areas in the same country
- Lack of coherence between inventories in country databases, review papers and reporting in IA for MSFD.e.g.. UK: 90 species were reported in British waters (Minchin et al., 2013)vs.105 listed in UK IA; Croatia**:** 61 species in Pećarević et al.(2013)vs.18 species reported in IA

With regards to pathways, in agreement with previous EEA and JRC findings (Katsanevakis et al., 2013), shipping is the most important pathway of introduction at Pan-European level especially near large ports. Aquaculture has been highlighted as the main activity for introduction of NIS in France and Italy. Among other activities, corridors, appears to be a key pathway for Cyprus and Greece only (dispersal of NIS introduced via the Suez Canal). Tourism/Recreation ranks second in Lithuania and Croatia, whereas Renewable Energy was considered a significant factor for NIS introductions in Belgium next to shipping.

Assessment of GES was feasible only by countries with advanced knowledge, that have developed relevant indicators such as the Baltic countries by employing the biopollution index (Olenin et al., 2007). For all other countries the trend in introduction is used as a proxy to the trends in GES.

Conclusively, assessment of descriptor D2, is mostly unknown due to the lack of data in the vast majority of MS. Moreover, reporting was inconsistent between Member States and is not comprehensive.

**Discussion:**

The vague wording of in MSFD GES decision was probably the reason why Member States reportign was relatively inconsistent and not comprehensive. The avenue for WGITMO input could be to develop and test concrete indicator(s) (e.g. arrival of new NIS to MC by distinct vectors/patways). It was stressed that the suggested indicator(s) should be tied to 'level of certainty' and inevitably linked to management. Next year, after WGITMO members have submitted data for 2014 to AquaNIS database (deadline 30 November) and all new entries validated, Lithuania will make an overview on new alien species invasions (by patways) and range expanding invasions in the ICES area, subjected to discussions at WGITMO 2015 meeting.

## 4.4 Term of Reference d)

*Continue identification and evaluation of climate change impacts on the establishment and spread of non-indigenous species. Produce draft manuscript on temperature effects on non-*

*indigenous species and develop further research agenda. This activity will mostly be carried out intersessionally and take several years (ToR lead Jim Carlton).*

### Global Warming and the Introduction and Impact of Non-Indigenous Marine Species: A Review of Observations and Predictions, and a Research Agenda (Presentation by Jim Carlton)

That the world's shallow coastal waters are warming has been long recognized and is a phenomenon we now know to be due to human-induced changes in the Earth's atmosphere. A rapidly growing literature (we provide a number of examples in the References) focuses on how climate change, particularly increased temperatures, will alter bioinvasions in marine environments. We address the role of coastal warming on the introduction and impact of non-indigenous marine species through three approaches: (1) potential changes in geographic sources of new invasions; (2) how specific stages in the invasion sequence may be influenced by warming waters, and thus how invasion timing may be altered, and (3) how changes in the abundance and diversity of both native species and already-established invaders, in response to warming temperatures, may, in turn, alter the success of future new invasions.

Although we focus on increasing temperatures as one axis of global climate change (GCC), many other phenomena are in play. For example, not all regions are experiencing the same direction and consistency of increased warming. In some areas increased coastal upwelling (due to warmer adjacent land temperatures) has led to cold or even colder water temperatures. In the Northeastern Pacific Ocean, cold-phase Pacific Decadal Oscillations may oppose the short term longer global trends and cause the reversal of expanding distributions of certain species of warmer-water affiliations. Other aspects of GCC include changes in *acidification*, *salinity ultraviolet radiation exposure*, *sea level rise*, and *storm frequencies.* Each of these may critically impact the ability of species to colonize and thrive in new regions, in part by interacting with altered temperature regimes, increasing the challenges of making accurate predictions. Temperature, however, is one of the most prominent processes regulating the global distribution of marine species, and thus provides a useful and compelling gateway by which to examine what we may expect relative to the transportation and future invasions of non-native species due to GCC.

The following three specific issues are being considered:

i ) ***Potential changes in geographic sources of new invasions***: To be expected are novel invasions from overseas due to ameliorating and milder temperatures at, for example, higher latitudes (including potentially shorter and warmer winters). Species that may have been arriving for centuries – attached, for example, to the hulls of ships – may now find conditions amenable for colonization. That is, the same global conveyor belts that have been transporting the same species for centuries may now result in the invasion of those species that were previously excluded by temperatures too cold for reproduction if not survival itself. We are compiling data on examples of recent invasions that likely correlate strongly with this model, while addressing alternative hypotheses as well.

ii ) ***How specific stages in the invasion sequence may be influenced by warming waters, and thus how invasion timing may be altered:*** All invasions pass through a series of emigration and immigration stages that have been described as the invasion sequence or invasion process (Blackburn et al., 2011). Hellmann et al. (2008) and Walther et al. (2009) examine how climate change would alter the outcome of specific stages of this sequence. We are examining how temperature change will alter the probability of invasions, focused on high latitude cold and warm temperate climates, as in, for example, the Western and Eastern shores of the North Atlantic Ocean. For example, temperature changes will alter the diversity and abundance of the species pool in ports and harbours; in turn, these changes may alter the probability of species engaging with an outbound vector, such as hull fouling or ballast water. Survival across oceans during transit, on many routes, may similarly be altered by changing ocean temperatures. Milder and/or water regimes in recipient ports may, in turn, increase the likelihood of survival and reproduction of newly arriving species. We are compiling data on examples of invasions that may link with these predictions, while addressing alternative hypotheses as well.

iii ) ***How changes in the abundance and diversity of both native species and already-established invaders, in response to warming temperatures, may theoretically lead to both increased and decreased future invasions***: We are examining complex conceptual models relative to how native species and established invasions may respond in terms of changes in (a) population size (abundance and density) and (b) local distribution, to increased temperatures. In turn, we are asking how such changes could then cascade, through altered competitive and predator networks, to potentially lead to both *decreases* and *increases* in future new invasions and in already established invasions. For example, an *increase* in warm water-affinity native species abundance could lead to increased competitive or predator pressure on established invasions, which could then *decrease*. Similarly, as warm-water non-native species *increase*, this could lead to similar pressures on native species, which could, in turn, *decrease*. Decreases in cold-affinity species could have the reverse effect, leading to *increases* in warm-affinity native and introduced species, as well as *increases* in new invaders. We are compiling data on examples of recent invasions that may correlate strongly with these models, while addressing alternative hypotheses as well.

Finally, we are outlining a detailed research agenda focused on robust empirical, quantitative and experimental approaches to address many of these hypotheses.

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Discussion: the presentation raised several discussion points, by including:

- Human-induced introductions vs. range expansions (both natives and non-natives) as a result of human-changed environmental conditions;
- Native pests vs. non-native species;
- Linking climate-change driven NIS invasions/secondary spread to vectors/pathways;
- Relation between NIS invasions and ecosystem resilience and marine regime shifts;

- Importance of species adaptation potential, species traits and genetics in the context of climate impacts on NIS;
- Importance of other climate-change factrs than temperature. Salinity and ocean acidification were mentioned as potentially the most important single factors, but also their synergistic effects.

## 4.5 Term of Reference e)

*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 Andrea Sneekes).*

### Rapid assessment of marinas for regional assessment of NIS (Presentation by Dan Minchin)

It is not always convenient to sample in port regions for non-indigenous species and there are restrictions on entering the water to obtain samples in most ports. Marinas occur in many port regions as do floating pontoons that service port operations. These pontoons are easily accessed at all tidal states and the biota associated with pontoons can easily be sampled. A method used to sample from marinas involves the use of the abundance and distribution range of the biopollution method of Olenin et al. (2007) for a targeted set of species. The sampling team need to be familiar with the target species set and be able to recognize these on site using field characteristics. A study in Northern Ireland revealed from 12 marinas and nine pontoons, examined over a ten day period, two species of concern found for the first time *Didemnum vexillum* and *Undaria pinnatifida*, four other species new to Ireland and over fifty range extensions. Levels of abundance and distribution were calculated for the prominent species that could be easily identified in the field.

### The fouling community on a Belgian research vessel reveals its whereabouts and forms a source of potential new introductions into the North Sea (Presentation by Francis Kerckhof)

The fouling on the Belgian research vessel Belgica is regularly sampled when dry-docking. The Belgica usual operates in the North Sea but every year also for several weeks in more southern waters such as the Bay of Biscay and Ireland. Last year was of particular interest because in June 2013 the Belgica operated in Iberian waters and off the coast of northern Morocco (northwest Africa) for only 3.5 weeks and this was clearly visible in the fouling. The preliminary results showed that the fouling community contained more species than ever and that several species of southern origin non-indigenous to the North Sea where present in the fouling. And importantly, most of the biota were still alive, despite the water in the port of Zeebrügge being not really clear and despite the North Sea conditions. The fouling community contained, apart from indigenous biota, known introduced species to Europe and spreading species (indigenous elsewhere in Europe – Atlantic ocean). This was, for example, especially apparent in the barnacle fauna (Cirripedia Balanomorpha) of which 11 species were identified, where in the previous 2 sampling occasions (2011 and 2012) only 5 species were present. The barnacle fauna included besides species indigenous to the North Sea such as Balanus crenatus and Semibalanus balanoides also the established introduced Elminius modestus, several spreading southern species such as Solidobalanus fallax and Balanus perforatus, the latter already present in the North Sea but until now not found in the fouling of the Belgica. The barnacle fauna contained further such species as Balanus trigonus and Balanus eburneus – both introduced species to Europe that have established populations in southern Europe but that could be candidates for entering and spreading into the North Sea. Also in other groups such as Algae, tunicates and bryozoans, a similar tendency could be observed. In conclusion, the preliminary results show that part of the biota present in the fouling on the Belgica originated from the Southern North Sea, notably Zeebrügge the home port of the vessel and another fraction could be attributed to a remote origin notably the Iberian Peninsula where the vessel had sojourned.

### Experiments of fouling communities on renewable energy constructions in the Gulf of Riga and Finland (Presentation by Liis Rostin)

Environmental concerns related to development of renewable energy projects is a hot topic all over the world. Recent development plans on the establishment of offshore wind parks in the northern Baltic Sea have raised the seires of questions on legal and environmental topics. As this kind of experience is currently lacking (there is no major offshore wind parks currently in operation in the northern part of the Baltic Sea) we have started several investigations to clarify all possible environmental riskis of establishment of offshore wind parks in the Baltic Sea area.

To study impact of establishment of wind farms in Estonian coastal sea in conditions of hard substrata series of benthic disturbance experiments were carried out at proposed wind farm project site in the SW part of Gulf of Finland, Neugrund Bank. Experiment was set up April 2008 and ended October 2008. We simulated the mechanical disturbance caused by building of the gravitational foundations for wind turbines and followed the recovery of the benthic communities during one vegetation period in three depth intervals. We used nondestructive sampling – species coverage estimations from underwater photography. The main results of these experiments showed that total recovery occurred only in the shallowest sites while in other depth intervals the difference between the control (undisturbed community) and disturbed one even encreased during the vegetation period. Repeating the experimental sites after four years showed that at larger depth difference between undisturbed sites could be observed even after several vegetation seasons. This means that this type of activities can significantly affect benthic communities on hard substrata.

Experiment of effect of eutrophication and other environmantal factors on colonization pattern of new hard substrata was set up in May and June 2012 and ended in spring 2013. Sampling is completed, but data analysis are not done at the moment. The aim of experiment is to assess the effect of eutrophication and other environmantal factors on the colonization pattern of new substrata and structure of pioneer community.

New substrata colonization experiments utilizing basement of wind measurement construction was set up July 2013 on the location near the Kihnu Island. In August 2010, wind measurement construction was installed in the Gulf of Riga by Eesti Energia. Wind measurements were carried out in the area proposed for development of offshore windpark. Part of the construction, which was above the water, was removed in the end of the same year. Foundation was left behind. Due to the knowledge of exact timing of the installation of the construction it is a good oportunity to evaluate colonization process and utilize this knowldge for future EEA of proposed windfarm. The aim of the experiment is to evaluate the impact of installation of new hard substrata in soft bottom habitat. Our main hypothesis is that newly introduced hard substrata will increase habitat diversity and will add to the species diversity and overall biomass. What is unknown is how the depth and other environmantal variables will affect this process.

### Discussion:

The Group had specific questions related to details of each of the projects described under ToR d). A discussion occurred surrounding harbour surveillance and the ability, or inability, to determine if new species records represent non-native occurrences or occurrences of rare native species. The usage of the term 'cryptogenic' in the scientific literature was reviewed. Further, there was discussion about freshwater run-off as a potential mitigation approach for non-native biofouling taxa in marine harbours; however, the issue could not be fully considered in the short time of the meeting.

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 antifouling systems and different designs for niche areas to minimize biofouling);

.2 in-water cleaning that ensures effective management of the antifouling 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.

Finally, the Group noted that the WGBOSV/WGITMO proposal for a theme session at the ICES Annual Science Conference surrounding "the increasing importance of biofouling for marine invasions" was accepted; the Group agreed to submit a general overview presentation for the theme session with Andrea Sneekes as the lead author.

## 4.6 Term of Reference f)

*Investigate and report on new developments in non-native species issues into and through the Arctic region (joint Term of Reference with WGBOSV) (ToR lead Anders Jelmert).*

### What does it take to become an invader in the Arctic? (Presentation by Anders Jelmert)

This is a short review based on accounts of NIS and benthic macrofauna along the Norwegian coast. (Distribution change betwwen 1997 and 2010). It does not look at e.g. bacteria and fish. Some of the aspects of Artic climate (temperature and salinity) along the Siberian coast (from the Barents- to the East Siberian Sea is discussed. The current numbers of known NIS in the Barents Sea is discussed in relation to range expansion patterns. The results from monitoring efforts for new species arrival at the "Melkøya " LNG facility ( approx 70°N) and one recent inventory in Narvik (Approx. 68°N.

The "True Arctic" is more species-rich than pervious thought (Has been dependent of effort). There is a decline in species from the Barents Sea via the Kara sea, the Laptev sea and the East Siberian Seas (first approx 2000 species, the last some 800 species). All these seas are "shelf seas" with substantial (but variable) influence of freshwater from the large Russian rivers. Stratification facilitates early ice-formation, and the species along these seas must be euryhaline, tolerate low temperatures (both in winter extremes and summer on-growth period.

Species will likely continue to migrate (and being transported) into the Barents Sea, which is the sea most influenced by influx of warming Atlantic water. But on a short time perspective (5-25 years) it seems unlikely that Atlantic water to great extent will move past Novaja Semlja and into the Kara Sea. Currently, Temperature mismatch with donor ecosystems seems to override effects ofporpagule pressure. This may change on a longer scale (2050-2100).

### Canadian activities in the Arctic (Presentation by Sarah Bailey)

Most aquatic invasive species (AIS) introductions have occurred in temperate latitudes where shipping activity is greatest; however, as few systematic surveys have been conducted in the Canadian Arctic historically, we have little knowledge of the presence or impact of AIS in this region. Global climate change and increased resource exploitation are expected to increase shipping activities in the Canadian Arctic, resulting in higher risk of AIS introductions in the near future.

A number of research and monitoring initiatives have recently been conducted to examine the current and future risk of ship-mediated AIS in the Canadian Arctic, including a risk assessment to identify high-risk recipient ports, and high-risk shipping pathways, based on level and type of shipping activity, environmental similarity between source and destination ports, and the number of high-impact AIS in source ports for ships entering Arctic waters. In addition, biological sampling of ballast water and hulls of ships arriving to major Arctic ports was conducted to determine identity of, and probability of arrival for, potential AIS. In many cases, collected specimens were juvenile forms and it was not possible to confidently identify individuals to the species level. Molecular tools are now being utilized in an attempt to better identify collected specimens. This project is in the final stages, with results expected before the end of 2014.

### The cold route (Presentation by Dan Minchin)

Non-indigenous species (NIS) have been spread between northern oceans arising from stocking and aquaculture activities. These will have been distributed mainly by aircraft. As a result some NW Pacific species, and their associates, successfully colonized North Atlantic waters. Very few NIS are known to have spread between these oceans with shipping that will have endured transit through tropical seas. This situation is likely to change to enable ship transport during summer periods and with this is the potential risk of spread of NIS via the cold water route. However, shipping is not the only possible pathway to result in a spread of NIS through, and to, Arctic seas as aquaculture and ranching activities, incremental spread from fishing activities, exploitation of mineral resources are likely to feature in NIS spread. In addition natural spread by warm currents and by rafting is likely to enable the extension to the range of many species in both the North Atlantic and North Pacific oceans.

### Dutch activities in the Arctic (Presentation by Andrea Sneekes)

For multiple decades there is an interest of the Netherlands for the polar regions. Several research projects are being undertaken by the Dutch, specifically by the University of Groningen (RUG) and Wageningen University and Research groups (WUR). The Netherlands Polar Programme (NPP) funds scientific research into and in the polar regions. This programme wants to contribute to solutions for fundamental scientific and socio-political issues. In 2013, NPP granted twelve proposals within a policy call, of which WUR is involved in four proposals with research topics on seabirds, biodiversity under the sea ice, climate change and a simulation model. Additionally to the granted projects, WUR is active researching the challenges in sustainable Arctic Development using the triple P methodology where smart use of the marine ecosystem services provide for sustainable Profit of the Planet for People (TripleP@Sea programme, http://www.wageningenur.nl/en/About-Wageningen-UR/Strategic-plan/TriplePSea-Coastal-and-Marine-resources.htm). Impacts of new activities in the Arctic are assessed using a generic framework that deals with cumulative effects. Part of the framework is an environmental impact assessment (EIA) that deals with pressures of one or more activities on ecosystems components (figure 1).

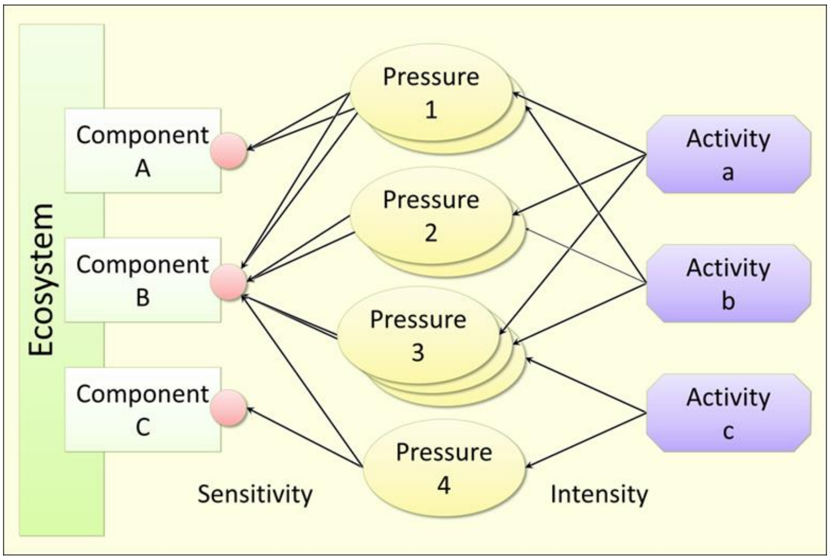


**Figure 1 schematic view of an environmental impact assessment that deals with cumulative effects (source: IMARES Wageningen UR).**

This generic framework is used in the development of the Arctic Handbook for the industry. The Arctic Handbook aims at contributing to internationally accepted standards and guidelines for Arctic operations (https://www.wageningenur.nl/en/show/The-Arctic-Handbook.htm). Some example cases that feed information to an EIA have been presented.

The first case related to ecosystems presented was ARCIND – development of Arctic biological INDicators for the impact assessment of (new) human activities (http://www.wageningenur.nl/en/show/ARCIND-Development-of-ARCtic-biological-INDicators-for-the-impact-assessment-of-new-human-activities.htm). This PhD project (2013-2017) looks at developing tools to determine pressures on the ecosystem, specifically indicator tools. Indicators are simple measures that determine the state of the environment and can be used as diagnostic tool through detecting trends, to be applied in monitoring or to assess results of mitigation measures.

The second example case showed the importance of understanding the activity shipping related to differences in effectiveness of ballast water treatment techniques in the Arctic region. A literature study performed for DFO Canada listed the potential risks of ballast water treatment in the Arctic which can be summarized as the risk of reduced efficacy of treatment systems and increased potential environmental threat of treatment systems using biocides (http://edepot.wur.nl/278821).

The increased potential environmental threat of ballast water treatment using biocides in the Arctic region was given as example case on pressure. During summer and winter in the Netherlands ecotoxicity testing using natural local communities were performed and then during an expedition in summer 2013 to the Arctic (Dutch research station at Svalbard) this type of testing was done using local Arctic species that could be collected locally.

### Red king crab and snow crab (Presentation by Anders Jelmert)

The King crab in the Barents sea had a maximum population size in 2008 (> 5 *10^6 ind) . From 2008, a decline in the population has been observed until 2012. The numbers of catchable males (CL> 130 mm) have increased from 0.8*10^6 in 2012 to 0.95*10^6 in 2013. The proportion of large specimen has however declined. Little spread further into the SW. While strong conclusions are premature, the low expansion/spread coincides with the free fishery W of 26° E. In Norway EEZ, the catch quotas E of 26° E have been set to1000 tons for males, 50 tons for females, and an allowance for 1% bycatch in other fisheries.

The biogeographic origin of the snow crab in the Barens Sea remains unresolved, but it has been verified a siginificant genetic distance to the Greenland/Canada stock. The accurate pathway an eventual vector (it may have migrated by itself) has not been clarified. The snow crab has had a tremendous growth in the Barents Sae, (especially in the Russian sector). Only a few specimen has been caught close to the Norwegian coast and near Svalbard (Spitsbergen). The highest density is found W of Novaja Semlja, on the Central Bank and the Goose Bank. Population densities between 1000 and 2800 ind/nm trawled have been encountered. It has been calculated that the SSB of the snow crab now is more than 10 times (!) the king crab. The Russians are planning a fishery on the snow crab in 2014, and bilateral negotiations of eventual Norwegian fishery will be negotiated.

### Discussion:

Arctic research was identified recently as one of the high-priority research areas for ICES. The group had specific questions related to details of each of the projects described under ToR e). 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. Research on non-native species issues in the Arctic has begun only recently, and the Group agreed to keep the ToR at least for another year to further look into the issue. Finally, the Groups noted that the WGBOSV/WGITMO proposal for a theme session at the ICES Annual Science Conference surrounding "Arctic biodiversity under climate change and other stressors" was accepted; the Group agreed to submit a general overview presentation for the theme session with Sarah Bailey as lead author.

## 4.7 Term of Reference g)

*Collaborate with ICES Study Group on Integrated Morphological and Molecular Taxonomy (SGIMT) regarding identification, early detection and monitoring of non-native species, as appropriate (joint Term of Reference with WGBOSV) (ToR lead Maiju Lehtiniemi).*

Molecular methods are helpful in many aspects concerning non-native species. Thus the cooperation with WGIMT will be started during 2014. Based on e-mail discussions with the chairs of these 3 working groups themes for collaboration were presented. The themes were 1) including molecular data to non-indigenous species database; AquaNIS. This should be dobe by including so called deep links to GenBank via accession codes of species in the AquaNIS database. 2) Molecular identification of tricky specimens via cooperation could be cautiously planned taking into account the limited resources of participating laboratories. 3) Probable need for certain species/taxa to be collected for DNA 'libraries' where BOSV/ITMO people could help in collecting the speciemens for molecular analyses. The goal of the cooperation would be peer-reviewed paper(s) probably covering a particular region of interest or an important problematic species. The discussion and planning the cooperation will continue 28 March 2014 in WGIMT meeting in Reykjavik, Icleand.

**Discussion:**

The Group discussed possible projects which could be of mutual interest for the three ICES working groups (WGBOSV, WGITMO and WGIMT), including linking the AquaNIS database to the GenBank database, enhancing DNA reference libraries to facilitate future molecular identification of non-native species, and examination of geographic invasion routes using molecular tools. WGBOSV and WGITMO suggested that a joint meeting of all three Groups in the future could be beneficial, if it could be logistically arranged. It was finally decided that Maiju Lehtiniemi will continue to act as a contact point between the Groups and will compile a list of potential collaborative projects, which will be presented for WGIMT for further discussion.

## 4.8 Term of Reference h)

*Finalize the draft alien species alert report on Ensis directus (ToR lead Stephan Gollasch).*

A few still outstanding issues concerning the alien species alert report entitled 'Current Status of Invasions by the Marine Bivalve *Ensis directus*' (authored by Stephan Gollasch, Francis Kerckhof, Johan Craeymeersch, Philippe Goulletquer, Kathe Jensen, Anders Jelmert and Dan Minchin) were discussed and agreed upon during the meeting. These mostly concerned content, format and layout of Figures 2, 3 and 5 (see Annex 5). Both the timeline as well as procedure were agreed on how to finalize these figures.

## 4.9 Other discussion items and any other business

There were several discussion items and/or presentations which did not directly qualify to under any of the Terms of References. These are briefly summarized below:

### 4.9.1 WGITMO 40th meeting anniversary

WGITMO was established in 1969 and celebrated this year its 40th meeting anniversary. Between 1970 and 1980 the WG was called the "Working Group on the Introduction of Non-Indigenous Marine Organisms". No meetings were held in 1974-1978, and in 2005, the meeting was held in correspondence (Annex 6).

### 4.9.2 ICES–CIESM joint *Mnemiopsis leidyi* workshop

ICES and CIESM have agreed to jointly organize an ICES–CIESM workshop on *latest advances regarding the ecology and impact of Mnemiopsis leidyi', including* its associated alien predatory ctenophore *Beroe* spp. and economic aspects (see Annex 7). The workshop, envisaged for 2014, would be attended by around 20 specialists jointly selected by ICES and CIESM from a variety of marine science disciplines (incl. hydrology, molecular biology, ecology, and marine economics).

WGITMO was asked to draft terms of reference for the workshop and suggest co-chair on behalf of ICES. The meeting agreed:

1 ) To nominate Sophie Pitois (Cefas, UK) on behalf of ICES to co-chair the workshop).
2 ) To propose the following draft Terms of Reference for the workshop:
    a) Compile existing knowledge of spatio-temporal occurrence in areas where *M. leidyi* is already established across the ICES-CIESM sea basins. By identifying and geolocating the likely vectors of introduction, establish which the areas most at risk are and where it is likely to be established next.
    b) Compare environment-specific parameters used for modelling potential habitat and population dynamics of *M. leidyi* across different sea basins. Discuss the potential sea-basin specific physiological adaptations.
    c) Review the molecular genetic techniques that have or could be used to study this species. Discuss sampling techniques used and the need for a standard protocol.
    d) Review the environmental and socio-economic consequences of *M. leidyi* in areas that have already been affected.
    e) Outline future research needs/next steps and identify management measures.

One of the possible venues where this workshop could be held is at Cefas in Lowestoft, United Kingdom.

### 4.9.3 Amending the national report format

The national report format was discussed. It was agreed that the section on intentional introductions needs further elaboration as to which information to provide. Cynthia McKenzie agreed to work on this intersessionally and distribute the amended reporting format for comments by summer. It was also agreed, that the new amended format should be used for reporting in 2015.

### 4.9.4 Theme sessions at ICES ASC 2014

Two Theme session proposals submitted on behalf of WGITMO/WGBOSV were accepted for ASC 2014:

- Arctic biodiversity under climate change and other stressors (co-conveners Sarah Bailey (Canada), Phillipe Archambault (Canada), and Andrea Sneekes (the Netherlands))
- The increasing importance of biofouling for marine invasions: an ecosystem altering mechanizm (co-conveners Andrea Sneekes, (the Netherlands), Francis Kerckhof (Belgium), and Thomas Therriault (PICES, Canada)).

It was discussed and agreed to i) invite all expert group members to actively contribute to these theme sessions and ii) to submit contribution on behalf of WGITMO/WGBOSV to both theme sessions.

#### 4.9.5 Over one decade of invasion: the non-indigenous cladoceran *Evadne anonyx* G.O. Sars, 1897 in a low - salinity environment (Presentation by Marilyn Kalaus)

Invasive species are often in focus in the non-indigenous species (NIS) research. Rare and low-abundant NIS may remain unnoticed for a long time, however, they may become invasive if environmental conditions change and become appropriate. Therefore, in addition to the currently invasive species, rare NIS also deserve attention. Among others, it might provide valuable information on patterns of bioinvasion histories, facilitate better understanding on population dynamics of NIS, and help to define ecosystem baselines and management targets. In the current paper, we have investigated the invasion history and population dynamics of the small-sized cladoceran *Evadne anonyx* in the Gulf of Riga (Baltic Sea) almost since its first detection in 2000. It appears the species was widespread across the whole open part of the Gulf of Riga already in 2001 and was not found only in a very few samples taken in summer since then. However, the abundance of the species remained relatively low and only rarely exceeded the level of 100 ind $m^{-3}$. Both, sea surface salinity (SSS) and temperature (SST) appeared as significant factors affecting the spatial distribution and population abundance of *E. anonyx* whereas the species was found to occur only sporadically at salinities below ca. 6 PSU. It is also suggested here that the whole sample need to be analysed to obtain reliable estimates on the low-abundant small-sized alien mesozooplankters.

#### 4.9.6 Varia

Henn Ojaveer briefly introduced the ICES new Strategic Plan for 2014-2018 and in more detail, the ICES Science Plan. Bearing in mind the primarily science-orientation activities of WGITMO, it was discussed and agreed that it would be beneficial if WGITMO started reporting to SCICOM from 2015.

# 5 Closing of the meeting

The meeting was closed at 17:00 on March 21th, 2014. The chair thanked the group for all their input and participation during the meeting and intersessionally. The chair also thanked Sergej Olenin for hosting the meeting

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## Annex 2. Meeting agenda

**ICES Working Group on Intorductions and Transfers of Marine Organisms**

**19-21th March, 2014**

**Hotel Alka**

**S. Daukanto str. 21**

**Palanga 00135, Lithuania**

**AGENDA**

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**WEDNESDAY 19TH MARCH**

**JOINT MEETING WITH WGBOSV**

**09.00 Opening of the joint meeting**

- Welcoming remarks from **Sarah Bailey** and **Henn Ojaveer** (Co-Chairs) and **Sergej Olenin** (Meeting Host)

- Introduction of participants

- Review of Terms of Reference and Agenda

**09.20 ICES update:** ICES Strategic Plan 2014-2018, WGITMO advice 2013, cooperation with CIESM and PICES. **Henn Ojaveer**

**09.40 ToR d)** Investigate and report on new developments in non-native species issues ass

ciated with biofouling (e.g. artificial structures in the marine environment and recreational

boating) (joint Term of Reference with WGBOSV) ***ToR lead: Andrea Sneekes***

- Presentation: Rapid assessment of marinas for regional assessment of NIS. **Dan Minchin**

- Presentation: The fouling community on a Belgian research vessel reveals its whereabouts and forms a source of potential new introductions into the North Sea. **Francis Kerckhof**
- Presentation: Experiments of fouling communities on renewable energy constructions in the Gulf of Riga and Finland. **Liis Rostin**

**10.30-11.00 Coffee break**

- **ToR d)** continued

- **ToR e)** Investigate and report on new developments in non-native species issues into and through the Arctic region (joint Term of Reference with WGBOSV). ***ToR lead: Anders Jelmert***

- Presentation: What does it take to become an invader in the Arctic? **Anders Jelmert**

- Presentation: Canadian activities in the Arctic. **Sarah Bailey**

- Presentation: Arctic pathways. **Dan Minchin**

- Presentation: Dutch activities in the Arctic. **Andrea Sneekes**

- Presentation: Red King Crab and the Snow Crab. **Anders Jelmert**

**12.30-13.30 Lunch break**

- **ToR e)** continued

- **ToR f)** Collaborate with ICES Study Group on Integrated Morphological and Molecular Taxonomy (SGIMT) regarding identification, early detection and monitoring of non-native species, as appropriate (jointly with WGBOSV). ***ToR lead: Maiju Lehtiniemi***

**15.00-15.30 Coffee break**

- General discussion under ToR f)

- Return to any issues needing more discussion

**16.00** Any other business

- Location of next meeting and joint 2015 ToR's
- Any Other Business
- Wrapping up

**17.00 End of joint meeting and close of the day**

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**THURSDAY 20TH MARCH**

**09.00 Review of Terms of Reference and Agenda**

**ToR a)** Synthesize and evaluate national reports using the adopted format for reporting and contributions to the database that includes species, locations (latitude and longitude), status of invasions as appropriate, region of origin, status of eradication efforts, and habitat, and develop an annual summary table of new occurrences/introductions of aquatic non-indigenous species. *ToR lead : Henn Ojaveer*

**Highlights from national reports**

- Belgium Francis Kerckhof
- Canada Cynthia McKenzie
- Denmark Kathe Rose Jensen
- Finland Maiju Lehtiniemi, Lauri Urho
- France Daniel Masson
- Germany Stephan Gollasch
- Greece Argyro Zenetos

**10.30-11.00 Coffee break**

Highlights from national reports continued

- Ireland Dan Minchin
- Italy Anna Occhipinti-Ambrogi
- Lithuania Sergej Olenin
- Netherlands Andrea Sneekes
- Norway Anders Jelmert
- Portugal Paula Chainho
- Russia Elena Ezhova

- Sweden Malin Werner
- United Kingdom Lyndsay Brown
- Estonia Henn Ojaveer

**12.30-13.30 Lunch break**

**ToR b)** Continue verifying selected datasets of the newly developing database on marine and other aquatic organisms in European waters by making other components of the database available online, in addition to the Baltic Sea which is already available. This activity will mostly be carried out intersessionally and take several years. *ToR lead: Sergej Olenin*

- Presentation: AquaNIS database. **Sergej Olenin**
- Presentation: European Alien Species Information Network (EASIN). **Stelios Katsanevakis**

**15.00 – 15.30 Coffee break**

- Presentation: Non-indigenous species of the Black Sea and the Sea of Azov. **Borys Alexandrov**
- Presentation: Non-native species invasions in southern seas of Eurasia: pathways, vectors and risk assessment. **Tamara Shiganova**
- Presentation: NIS monitoring program in the Madeira archipelago and invasions in offshore islands**. João Canning Clode**

**ToR b)** continued

**ToR h)** Finalize the draft alien species alert report on *Ensis directus*. *ToR lead: Stephan Gollasch*

**18.00 Close of the day**

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**FRIDAY 21th MARCH**

09. 00 **ToR h)** continued

09.30 **ToR c)** Continue addressing EU MSFD D2 on further developing alien species indicators, incl. evaluating of ecological impacts caused by alien species. *ToR leads: Sergej Olenin and Henn Ojaveer*

- Presentation: EU MSFD D2: What we knowvs.what is reported on MS IAs for the MSFD. **Argyro Zenetos**

**10.30 - 11.00 Coffee break**

**ToR d)** Continue identification and evaluation of climate change impacts on the establishment and spread of non-indigenous species. Produce draft manuscript on temperature effects on non-indigenous species and develop further research agenda. This activity will mostly be carried out intersessionally and take several years. *ToR lead: Jim Carlton*

12.30-13.30 Lunch

- Presentation the cladoceran *Evadne anonyx*. **Marilyn Kalaus**

Finalizing **ToR's b-d)**

**15.00 – 15.30 Coffee break**

**15.30-17.00 AOB**

- ToR's for 2015 meeting
- National and Data reporting format
- ICES-CIESM *Mnemiopsis leidyi* workshop
- Theme sessions at ICES ASC 2014

17.00 Close of the meeting

# Annex 3. National reports

## 3.1 Belgium

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

### Highlights

During 2013 the introduced sea spider *Ammothea hilgendorfi* has been found in the Hinder Banks area some 30 km offshore.

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 legislation to report.

### 2. Intentional introductions

There is no information available on intentional introductions if any.

### 3. Unintentional introductions:

During 2013 the introduced sea spider *Ammothea hilgendorfi* has been found at a site in the Hinder Bank area some 30 km offshore. Two specimens where present in a sample taken by a Hamon grab at a depth of about 31 m in a gravelly area west of the Oosthinder Sand Bank.

*Ammothea hilgendorfi* is originally recorded from the Mid- and North Pacific Ocean. In the years 1979–1981, it was found in the Lagoon of Venice in the Mediterranean Sea, probably introduced via intercontinental shipping. In 1978 two immature specimens of *A. hilgendorfi* were found near Southampton in south England. The first record from the North Sea dates from 2010, in the Blackwater Estuary, Essex and very recently, in August 2013 *A. hilgendorfi* has been found in Zierikzee, the Netherlands (Faasse, 2013). Most of the introduced findings where done in coastal environments including marinas. Our finding is remarkable because the specimens were living offshore.

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

#### CONFERENCE

On 20-22 November 2013 a conference on Non-indigenous species in the Northeast Atlantic was organized in Oostende. The conference is Open for scientists, policymakers/advisors, academics and stakeholders and will deal with various aspects related to introduced species

website: www.ilvo.vlaanderen.be/NISconference2013

e-mail address: NIS@ilvo.vlaanderen.be

On 12 March 2014 a symposium *Aliens on the horizon* organized by Belgian Biodiversity Platform took place at the Belgian Science Policy Office (BELSPO) in Brussels. During this symposium, a closer look will be taken at measures of prioritization, prevention, early detection & rapid response in Belgium. This work is performed as part of the Alien Alert project, in which eight Belgian scientific institutes cooperate. Coordination is provided by the Belgian Biodiversity Platform; funding is provided by the Belgian Science Policy Office.

http://ias.biodiversity.be/symposium

On 2 April 2014 a Benelux Conference on invasive species *Science for the new regulation* will be organized at the University of Ghent.

http://ias.biodiversity.be/regulation

## 6. Research projects:

The research project 'MEMO: *Mnemiopsis* Ecology and Modelling: Observation of an invasive comb jelly in the North Sea' started that started in January 2011 has come to an end. The MEMO project, framed in Interreg IV A '2 Seas', is a cross-border cooperation between ILVO (Institute for agricultural and fisheries research, Belgium), IFREMER (Institut français de recherche pour l'exploitation de la mer, France), ULCO-LOG (Université du Littoral Côte d'Opale-Laboratoire d'Océanologie et de Géosciences, France), Cefas (Centre for Environment, Fisheries and Aquaculture Science, Great-Britain) and Deltares (the Netherlands). The project consisted of three main activities. The first activity will monitor the spatial and temporal distribution of *Mnemiopsis leidyi* in the 2 seas region. A habitat model based on biological and environmental parameters will be made. The second activity focuses on the biology, physiology and feeding behaviour of *Mnemiopsis leidyi*. Using prey-predator interactions, a life cycle model will be constructed. The third activity will develop an applied integrated plankton ecosystem model to predict ecological and socio-economic impacts. Now several publications related to this project are in preparation.

New project: 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.

## 7. References and bibliography

Boets, P.; Lock, K.; Goethals, P.L.M. (2013). Assessment of biopollution in Belgian coastal harbours, in: Robbens, J. et al. (Ed.) (2013). Non-indigenous species in the Northeast Atlantic. Ostend, 20-22 November 2013: Book of abstracts. VLIZ Special Publication, 66: pp. 16

De Blauwe, H., Kind, B., Kuhlenkamp R., Cuperus J., van der Weide B. & F. Kerckhof. 2014. Recent observations of the introduced Fenestrulina delicia Winston, Hayward & Craig, 2000 (Bryozoa) in Western Europe. In: Rosso A., Wyse Jackson P.N. & Porter J. (eds) Bryozoan Studies 2013. Studi Trentini di Scienze Naturali, 47: xxx-xxx, in press.

Faasse, M.A. 2013. Further dispersal of the sea-spider Ammothea hilgendorfi (Böhm, 1879) in the North Sea to The Netherlands. - BioInvasions Records 2(4): 287–289

Hostens, K.; Courtens, W.; Craeymeersch, J.; Goudswaard, P.C.; Houziaux, J.-S.; Merckx, B.; Van Hoey, G.; Kerckhof, F.; Perdon, K.J.; Stienen, E.W.M.; Van Lancker, V.; Vigin, L.; Vincx, M.; Degraer, S. (2013). Invasive American razor clam Ensis directus in Belgian waters: a true opportunity for shell-fisheries?, in: Robbens, J. et al. (Ed.) (2013). Non-indigenous species in the Northeast Atlantic. Ostend, 20-22 November 2013: Book of abstracts. VLIZ Special Publication, 66: pp. 43,

Kerckhof, F.; De Mesel, I.; Rumes, B.; Degraer, S. (2013). The ongoing hardening of the coasts, an ecosystem altering mechanizm favouring non-indigenous species. The example of the Southern North Sea, in: Robbens, J. et al. (Ed.) (2013). Non-indigenous species in the Northeast Atlantic. Ostend, 20-22 November 2013: Book of abstracts. VLIZ Special Publication, 66: pp. 5-6

# 3.2 Canada

Prepared by Cynthia McKenzie, Ph.D. DFO NL Region

## Overview:

Fisheries and Oceans Canada is currently developing regulations that would help address Aquatic Invasive Species and is also revising the National Code on Introductions and Transfers of Aquatic Organisms. In 2013 a new species was discovered in Canada, *Didemnum vexillum*, Minas Basin, Bay of Fundy, Nova Scotia. Other species that have already invaded Canadian waters continue to spread, including European Green Crab, Vase Tunicate, *Codium fragile*, (oyster thief), Golden Star Tunicate, *Styela clava* (clubbed tunicate), *Diplosoma listerianum* and *Botrylloides violaceus*.

## 1. Regulations:

Fisheries and Oceans Canada is developing a regulatory proposal to manage and control Aquatic Invasive Species (AIS) in Canada.

Consultations are currently ongoing with the Provinces and other stakeholders, 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:

Appendix 1 details the intentional introductions by province for 2013.

## 3. Unintentional Introductions:

### New Sightings

In 2013 *Didemnum vexillum*, carpet tunicate, was discovered for the first time in Atlantic Canada in Minas Basin, Bay of Fundy, Nova Scotia. It was first reported by a scuba diver and identification confirmed using DNA analysis. Several rapid assessment surveys have taken place near the US border. The detection in Nova Scotia is beyond the rapid assessment areas and current rapid response surveys are attempting to delineate the *D. vexillum* invaded area.

### Previous Sightings

*The national data excel spreadsheet (separate document) provides as information on new detections and expansion of previously detected aquatic invasive species of interest to Canada and does not represent all data points collected during the 2013 sampling season. Canada has a database that is updated on an ongoing basis, based on regional staff capacity.*

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 European Green Crab, Vase Tunicate, *Codium fragile*, (oyster thief), Golden Star Tunicate, *Styela clava* (clubbed tunicate), *Diplosoma listerianum* and *Botrylloides violaceus*.

Some specific examples include;

European Green Crab continues to spread into northeastern New Brunswick, Prince Edward Island and Nova Scotia. Green crab continue to spread in Newfoundland in Placentia Bay and along the west coast of the province and was found in Fortune Bay on the south coast for the first time. It has also extended its range north to Port Saunders on the northern peninsula.

Vase Tunicate, *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 Pennisula in Placentia Bay. In 2013 mitigation measures were taken in collaboration with the Province of Newfoundland to reduce the population and prevent the spread outside the current location. Vase tunicate (L'ascidie jaune) has been observed in Cap-aux-Meules in limited numbers since 2006. In 2013, the infestation grew, in order to prevent further spread mitigation measures were taken in collaboration with the province of Quebec.

Oyster thief seaweed, *Codium fragile*, was found for the first time in Newfoundland attached to the substrata at one location outside Placentia Bay, in Pelley's Tickle, Notre Dame Bay. This is a concern as it is near several mussel grow out sites and mussel seed sites.

Golden Star Tunicate, is now present in most Bays and harbours along the south, and southwest coast of mainland Nova Scotia, as well as in coastal Cape Breton and the Bras D'Or lakes. 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 addition it was observed for the first time at an aquaculture site on the Magdalen Islands, having previously only been observed at marinas and docks.

*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. In the last two years the species has increased in abundance at the Havre-Aubert marina and now outnumbers Golden Star Tunicate that was present there first.

## 4. Pathogens

None reported.

## 5. Meetings

### Past year

18th International Conference on Aquatic Invasive Species. Niagara Falls, Ontario, Canada, April 21-25, 2013.

Canadian Aquatic Invasive Species Network Annual General Meeting. Banff, Alberta, Canada. May 2013

Eighth International Conference on Marine Bioinvasions. Vancouver, British Columbia, Canada. August 20-22, 2013

**Canadian Science Advisory Sector Meetings**

National Risk Assessment for Ballast Water Introduction of Aquatic Non-indigenous Species to Canada, Burlington, ON, June 19-21, 2013

Arctic Ballast exchange Winnipeg Nov 2013

### Future meetings

Canadian Aquatic Invasive Species Network II Annual General Meeting. Gatineau, QB, April 2014

## 7. References and bibliography

Deibel, D., McKenzie, C.H., Rise, M.L., Thompson, R.J., Lowen, J.B., Ma, C.K.C., Applin, G., O'Donnell, R., Wells, T., Hall, J.R., Sargent, P., and Pilgrim, B.B. 2014. Recommendations for eradication and control of non-indigenous, colonial ascidian tunicates in Newfoundland harbours. Can. Manuscr. Rep. Fish. Aquat. Sci. xiii + 76 p.

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2013/064

Sargent, P.S, Wells, T., Matheson, K., McKenzie, C.H., and Deibel, D. 2013. First record of vase tunicate, Ciona intestinalis (Linnaeus, 1767) in coastal Newfoundland waters BioInvasions Records (2013) Volume 2, Issue 2: 89-98.

Savoie, A. M. and Saunders, G. W., 2013. First record of the invasive red alga Heterosiphonia japonica (Ceramiales, Rhodophyta) in Canada. BioInvasions Records (2013) Volume 2, Issue 1: 27–32

Simard, Nathalie, Pereira Selma, Estrada Rafael and Nadeau Madeleine (2013 In revision). Situation state of marine invasive species in Quebec. Can. Manuscr. Rep. Fish. Aquat. Sci. xxxx : viii + 61p.

## Appendix 1

**Total number/weight of organisms approved by Introductions & Transfers Committees across Canada:**

| Species | | Aquaculture1 | Enhancement/Stocking | Research | Other (Specify) |
|---|---|---|---|---|---|
| British Columbia | Burbot (Lota lota) (Adult) | | | 30 | |
| | Burbot (L. lota) (Juvenile) | | 580,000 | | |
| | Carp – Koi (Cyprinus carpio) | | | | 5 (Educational) |
| | (Adults & Juveniles) | | | | & 70,665 (Ornamental) |
| | Catfish - Brown Bullhead | | | | 1 |
| | (Ameiurus nebulosus) | | | | (Educational) |
| | Char – Arctic (Salvelins alpinus) (Eggs) | 70,000 | | | |
| | Clam - Geoduck | 1,100 | | | |
| | (Panopea generosa) (Adult) | | | | |
| | Clam – Geoduck (Panopea generosa) (Juvenile) | 4,110,000 | | | |
| | Clam – Fat Horse (Tresus capax) (Adult) | | | 10 | |
| | Clam – Pacific Horse (Tresus nuttali) (Adult) | | | 10 | |
| | Clam - Manila (Venerupis philippinarum) (Juvenile) | 3,000,000 | | | |
| | Crab - European Green | | | 800 | |
| | (Carcinus maenas) (Adult) | | | | |
| | Crayfish - Signal | | | | 2 (Educational) |
| | (Pacifastacus leniusculus) (Adult) | | | | |
| | Dace – Nooksack (Rhinichthys sp.) | | | 142 | |
| | Dogfish - Pacific (Squalus suckleyi) (Adult) | | | 60 | |

| Species | | Aquaculture1 | Enhancement/Stocking | Research | Other (Specify) |
|---|---|---|---|---|---|
| | Dogfish - Spiny (Squalus acanthias) (Adult) | | | 150 | |
| | Goldfish – (Carassius auratus auratus) (Adult) | | | 100 | |
| | Grayling – Arctic | | | 16 | |
| | (Thymallus arcticus) (Adult) | | | | |
| | Greenling – Kelp | | | | 10 (Display) |
| | (Hexagrammos decagrammus) | | | | |
| | Hagfish - Pacific | | | 220 | |
| | (Eptatretus stoutii) (Adult) | | | | |
| | Halibut – Pacific | | | | 1 (Display) |
| | (Hippoglossus stenolepis) | | | | |
| | Herring – Pacific (Clupea pallasii) (Adult) | | | | 500 (Display) |
| | Lamprey - Pacific | | | 500 | |
| | (Lampetra tridentate) (Juvenile) | | | | |
| | Lamprey – Western Brook | | | | 1 (Educational) |
| | (Lampetra richardsoni) | | | | |
| | Lancelet - Florida | | | 500 | |
| | (Branchiostoma floridae) (Adult) | | | | |
| | Mussel – Bay (M. trossulus) (Adult) | | | 400 | |
| | Mussel - California | | | | 200 (Monitoring) |
| | (Mytilus californianus) (Adult) | | | | |
| | Mussel – Gallo | 5,000,000 | | | |
| | (M. galloprovincialis) (Juvenile) | | | | |
| | Mussel – Various spp. | 3,000,000 | | 2,190 | 4,000 (Monitoring) |
| | Oyster - Pacific | ######## | | 30,000 | |

| Species | | Aquaculture1 | Enhancement/Stocking | Research | Other (Specify) |
|---|---|---|---|---|---|
| | (Crassostrea gigas) (Juvenile) | | | | |
| | Oyster - Pacific (C. gigas) (Adult) | | | 1,000 | |
| | Midshipman – Plainfin | | | 15 | |
| | (Porichthys notatus) | | | | |
| | Piddock (Pentiella spp.) (Adult) | | | 20 | |
| | Piddock – Turner's | | | 10 | |
| | (Pentiella tumerae.) (Adult) | | | | |
| | Pupfish (Cyprinodon variegatus) (Adult) | | | 2,000 | |
| | Ratfish – Spotted (Hydolagus colliei) Eggs/Milt | | | | 20 (Display) |
| | Rockfish – Black (Sebastes melanops) | | | | 20 (Display) |
| | Rockfish – Blue (Sebastes mystinus) | | | | 10 (Display) |
| | Rockfish – China (Sebastes nebulosus) | | | | 10 (Display) |
| | Rockfish – Copper (Sebastes caurinus) | | | | 10 (Display) |
| | Rockfish – Quillback | | | | 10 (Display) |
| | (Sebastes maliger) (Adult) | | | | |
| | Rockfish – Tiger | | | | 3 (Display) |
| | (Sebastes negrocinctus) | | | | |
| | Rockfish – Vermillion | | | | 5 (Display) |
| | (Sebastes miniatus) | | | | |
| | Rockfish – Yellowtail | 20 | | | |
| | (Seabastes flavidus) | | | | |
| | Sablefish (Anoplopoma fimbria) (Adult) | 1,866 | | | |
| | Sablefish (A. fimbria) (Juvenile) | 27,850 | | | |
| | Sablefish (A. fimbria) (Eggs/Milt) | 300,000 | | | |

| Species | | Aquaculture1 | Enhancement/Stocking | Research | Other (Specify) |
|---|---|---|---|---|---|
| | Salmon - Atlantic3 (S. salar) (Juvenile) | | | 500 | |
| | Salmon - Chinook3 | | | 700 | |
| | (Oncorhynchus tshawytscha) (Adult) | | | | |
| | Salmon - Chinook3 | | 65,000 | 1,150 | 25 (Display) |
| | (O. tshawytscha) (Juvenile) | | | | |
| | Salmon - Chinook3 | 100,000 | 56,000 | 24 | |
| | (O. tshawytscha) (Eggs/Milt) | | | | |
| | Salmon - Chum3 | | | | 30 (Display) |
| | (Oncorhynchus keta) (Juvenile) | | | | |
| | Salmon - coho3 | | | 24,046 | |
| | (Oncorhynchus kisutch) (Adult) | | | | |
| | Salmon - coho3 | | 80,000 | 10,800 | 500 |
| | (O.kisutch ) (Juvenile) | | | | (Porpoise food) |
| | | | | | & 30 (Display) |
| | Salmon – Kokanee | | 76,600 | 3,000 | |
| | (Oncorhynchus nerka) (Juvenile) | | | | |
| | Salmon – Kokanee | | 50,000 | | 100 |
| | (O. nerka) (Eggs/Milt) | | | | (Educational) |
| | Salmon - Pink3 (Oncorhynchus gorbuscha) (Juvenile) | | | | 40 |
| | | | | | (Display) |
| | Salmon - Pink3 (Oncorhynchus gorbuscha) (Adult) | | | 400 | |
| | Salmon - Pink3 | | | 6,000 | |
| | (O. gorbuscha) (Eggs/Milt) | | | | |
| | Salmon – Sockeye | | | 500 | |

| Species | | Aquaculture1 | Enhancement/Stocking | Research | Other (Specify) |
|---|---|---|---|---|---|
| | (Oncorhynchus nerka) (Adult) | | | | |
| | Salmon – Sockeye (O. nerka) (Juvenile) | | 910,000 | 5,515 | |
| | Sanddab – Pacific | | | | 10 |
| | (Citharichthys sordidus) | | | | (Display) |
| | Scallop - Giant Rock | 100 | | | |
| | (Crassadoma gigantean) | | | | |
| | Scallop – Pacific (Pactinopectin caurinus x yessoensis) | 500,000 | | | |
| | Scallop - Weathervane | 200 | | | |
| | (Pactinopectin caurinus) (Adult) | | | | |
| | Sculpin – Buffalo (Enophrys bison) | | | | 10 (Display) |
| | Sculpin - Prickly (Cottus asper) (Adult) | | | | 2 (Educational) |
| | Sculpin - Red Irish Lord | | | | 10 |
| | (Hemilepidotus hemilepidotus) | | | | (Display) |
| | Sculpin – Staghorn | | | | 12 |
| | (Leptocottus armatus) | | | | (Display) |
| | Sea Cucumber - Giant Red (Parastichopus californicus) (Adult) | | | 500 | |
| | Sea Cucumber - Giant Red (P. californicus) (Juvenile) | 500,000 | | | |
| | Sole – CO (Pleuronichthys coenosus) | | | | 10 (Display) |
| | Sponge – Glass (Aphrocallistes vastus) | | | 20 | |
| | Sponge – Scarlet (Acarnus erithacus) | | | | 10 (Display) |
| | Stickleback – Threespine | | | 4,738 | 20 |
| | (Gasterosteus aculeatus) (Adult) | | | | (Educational) |
| | Stickleback – Threespine | | | 16,090 | |
| | (G. aculeatus (Eggs) | | | | |

| Species | | Aquaculture1 | Enhancement/Stocking | Research | Other (Specify) |
|---|---|---|---|---|---|
| | Sturgeon - White | | 20 | 15 | |
| | (Acipenser transmontanus) (Adult) | | | | |
| | Sturgeon - White | | 522,000 | 1,000 | |
| | (A. transmontanus) (Juvenile) | | | | |
| | Sturgeon - White | | 100,000 | 1,000 | |
| | (A. transmontanus) (Eggs/Milt) | | | | |
| | Tilapia (Oreochromis niloticus) (Adult)5 | 2,343,559 | | | |
| | Tilapia | 25,100 | | 75 | |
| | (O. niloticus) (Juvenile) | | | | |
| | Trout - Cutthroat3 | | 240 | | |
| | (Oncorhynchus clarkii) (Adult) | | | | |
| | Trout - Cutthroat3 | | 2,700 | | |
| | (O. clarkia) (Juvenile) | | | | |
| | Trout - Cutthroat3 | | | 7,000 | |
| | (O. clarkii) (Eggs) | | | | |
| | Trout - Rainbow3 | | 350 | 390 | |
| | (Oncorhynchus mykiss) (Adult) | | | | |
| | Trout - Rainbow3 | 2,200 | 353,900 | 23,416 | |
| | (O. mykiss) (Juvenile) | | | | |
| | Trout - Rainbow3 (O. mykiss) (Eggs) | 2,570,000 | 2,388,500 | 1,400 | |
| | Trout - Steelhead3 (O. mykiss) (Adult) | | 190 | | |
| | Trout - Steelhead3 | | 45,589 | | |
| | (O. mykiss) (Juvenile) | | | | |
| | Whitefish – Mountain (Prosopium williamsoni) (Eggs/milt) | | | 30 | 2 (Display) |

| Species | | Aquaculture1 | Enhancement/Stocking | Research | Other (Specify) |
|---|---|---|---|---|---|
| | Wolf Eel (Anarrhichthys ocellatus) (Adult) | | | 17 | |
| | Wolf Eel (A. ocellatus) (Juvenile) | | | | 25 (Display) |
| | 1 Total does not include routine movements covered in aquaculture conditions of licence. | | | | |
| | 2 Totals are estimates only. Amounts indicated are based solely on information provided in applications, as blanket licenses for import of shellfish for aquaculture do not specify amount permitted. | | | | |
| | 3 Numbers indicated for these species do not include transfers to labs for research purposes covered under blanket licenses, as numbers are not specified in those cases. | | | | |
| | 4 Numbers do not include species released from seasonal aquariums. | | | | |
| | 5 Estimated maximum value of Tilapia that could be moved. | | | | |

## 3.3 Croatia

Prepared by Marijana Pećarević and Josip Mikuš, University of Dubrovnik, Dubrovnik

### 1. Regulations:

IPA CBC Adriatic project Ballast Water Management System for Adriatic Sea protection (BALMAS) which includes partner from all countries on Adriatic Sea will prepare a common Ballast Water Management (BWM) Plan for the Adriatic Sea area, and implement the BALMAS BWM decision support system (DSS) including compliance control and enforcement (CME), compliant with the International Convention for the Control and Management of Ship´s Ballast Water and Sediments (BWM Convention) considering local specifics.

### 2. Intentional:

Synthesis of introductions – No data available.

### 3. Unintentional:

**New Sightings**

Invertebrates

Spongia

*Paraleucilla magna*

Cnidaria

*Oculina patagonica*

Vertebrates

Pisces

*Lagocephalus sceleratus*

Previous Sightings - No data available.

Not Seen Species Yet - No data available.

### 4. Pathogens

Sightings/records – No data available.

General information - No data available.

### 5. Meetings

No new data

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# 3.4 Denmark

Prepared by Kathe R. Jensen, Zoological Museum (with contributions from Ole Tendal, Hans Ulrik Riisgård and Per Dolmer)

## Highlights:

The occurrence of *Beroe ovata* in Danish waters has been confirmed by molecular methods.

The largest oyster (*Crassostrea gigas*) in the world (35.5cm long) found in Danish Wadden Sea

The round goby, *Neogobius melanostomus*, is now a nuisance species in waters around the islands of Lolland and Falster (Baltic Sea coast).

## Regulations:

Work towards implementation of the Ballast Water Convention is continuing by the Danish Nature Agency.

## Intentional introductions:

None reported

## Import and export of live marine species:

Fisheries statistics for 2012 (the most recent available) can be downloaded from: http://webfd.fd.dk/info/sjle3/fsa_bog2012/Fiskeristatistik.pdf

There are no official statistics on import and export of live fish or other organisms for aquariums etc..

## Unintentional introductions:

### Invertebrates

*Beroe ovata*

The ctenophore *Beroe ovata* has now been confirmed by molecular analysis from the Great Belt near Kerteminde (Shiganova *et al.*, 2014). The specimens were collected between December 2011 and January 2012, and were reported in the National Report for 2012 with unconfirmed identity. At the same time also *B. gracilis*, which is considered native but rare, was identified.

*Mnemiopsis leidyi*

Population dynamics of *Mnemiopsis leidyi* and *Mertensia ovum* (the latter not yet recorded from Danish waters) have been studied in the Baltic Sea and Kattegat in relation to salinity (Jaspers *et al.*, 2013) and other environmental factors (Haraldsson *et al.*, 2013). Also, a large cooperative study on population genetics of *M. leidyi* throughout European waters revealed that populations in the North Sea and Western Baltic Sea do not mix, but form genetically stable populations, but that the population in the Central Baltic Sea is unstable and genetically less diverse (Bolte *et al.*, 2013). Finally, predation impact on zooplankton has been compared for *M. leidyi* and the native scyphozoan *Aurelia aurita* in the Limfjord (Riisgård *et al.*, 2012). It is assumed that populations of *M. leidyi* die out in cold winters in the Limfjord and need to be replenished from the North Sea every year.

An appeal to the public from the Natural History Museum of Denmark resulted in the reporting of *Mnemiopsis leidyi* from the west coast of Jutland (North Sea) on 30 March, 2013 (http://snm.ku.dk/SNMnyheder/alle_nyheder/2013/2013.4/saa-er-draebergoplen-her-igen/)

*Crassostrea gigas*

A Pacific oyster (*Crassostrea gigas*) collected in the Danish Wadden Sea on 17 December 2013 was entered in Guinness Book of Records as the largest ever recorded (length 35.5cm, width 10.7cm) (http://www.guinnessworldrecords.com/world-records/1/largest-oyster). It is estimated to be between 15 and 20 years old (which incidentally coincides with the first report of the species from Danish waters from 1996).

A Scandinavian project (SNOK) has carried out a risk assessment of Pacific oyster, *Crassostrea gigas*, in Scandinavian waters (Dolmer *et al.*, 2014). Extension of distribution range depends strongly on winter temperatures, small and young populations often becoming extinct after a severe winter. Impacts include habitat modification (reef formation), interactions with native as well as other alien species, and nutrient enrichment. They concluded that there is high invasion risk of *C. gigas* at two habitat types, littoral biogenic reefs and sublittoral sediments. For other habitats the invasion risk is low or medium.

Population genetic studies of European populations of *Crassostrea gigas* have shown that northern populations (German Wadden Sea, Danish, and Swedish localities) have lower genetic diversity than southern populations (France and Netherlands), and that the latter are indistinguishable from Japanese population, the assumed source of introduction (Rohfritsch *et al.*, 2013).

*Potmopyrgus antipodarum*

The New Zealand mudsnail, *Potamopyrgus antipodarum*, from Roskilde Fjord continues to be used in laboratory tests of toxicology of heavy metals, this year copper (Pang *et al.*, 2013).

*Marenzelleria viridis*

Experimental studies on impacts of *Marenzelleria viridis* have continued. One study examined influence of bioturbation on solute fluxes ($CO_2$, $O_2$, $SO_4^{2-}$, $H_2S$, $NH_4^+$ and DOC) (Quintana *et al.*, 2013). Another study describe the distribution in the sediment of *M. viridis* and associated invertebrates in Odense Fjord and Roskilde Fjord and the correlation with behavior (Kristensen *et al.*, 2013). A Bachelor thesis from Roskilde University also examined nutrient concentrations in sediment and porewater in laboratory experiments with *M. viridis* and *Nereis diversicolor* (Calderon *et al.*, 2013).

**Macroalgae:**

*Gracilaria vermiculophylla*

A study on impacts of *G. vermiculophylla* has shown that it negatively affects biomass of *Zostera marina*, but has positive effect on species richness and density of most mobile macro-invertebrates (Thomsen *et al.*, 2013). Another study showed that *G. vermiculophylla* collected from non-native areas (the latter including 4 localities in Danish waters – see Data report) was less palatable to grazing *Littorina* snails than specimens from native localities (Hammann *et al.*, 2013).

*Sargassum muticum*

A student report has examined feeding preference of the sea urchin *Psammechinus miliaris* for 3 native algal species and *S. muticum*. In almost all combinations *S. muticum* was less preferred, or there was no significant preference in some multiple-choice experiments (Johnsen *et al.*, 2013).

**Fish:**

*Neogobius melanostomus*

The round goby, *Neogobius melanostomus*, is now so abundant around the islands of Lolland and Falster that local fishers consider it a nuisance species. It is estimated that this species comprise most of the fish biomass in Guldborgsund, the narrow sound separating Lolland and Falster (Henriksen, 2013). Two measures are suggested for regulating the population: One is to target a fishery of the species, and the second is to stop fishing the large predatory fish as pike and hope that they will feed on the invasive gobies.

Not established:

*Acipenser gueldenstaedtii*

A sturgeon (diamantstør) was caught in Sejerøbugten (just north of entrance to Great Belt) in late November. The Fish Atlas project has no idea how it got there. It is for sale as garden pond fish and is found in some "put-and-take" facilities (see https://www.facebook.com/Fiskeatlas).

Meetings:

Danish Society of Marine Biology (Dsfmb), 10 September 2013: 3 presentations on introduced species and management (http://www.dsfmb.dk/User_files/5fa66f2291033b92a0cf4d7be66e0e75.pdf -in Danish)

1 ) DNA and environmental DNA (eDNA) in monitoring of marine and invasive species (J. Kielgast)
2 ) Risk assessments of aquatic invasive species (K.R. Jensen)
3 ) Jellyfish and combjellies in Danish waters (O.S. Tendal)

**Student theses/ reports:**

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Danish with English abstract], Roskilde University, 25pp. Available at: http://rudar.ruc.dk/handle/1800/11838 (accessed 28 March 2014).

### Acknowledgements:

I would like to thank my colleagues Ole Tendal, Hans Ulrik Riisgård and Per Dolmer for their contributions to this report.

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## 3.5 Estonia

Compiled by Henn Ojaveer (with contributions from Jonne Kotta, Kristjan Herkül and Arno Põllumäe), Estonian Marine Institute, University of Tartu

### Overview

National alien species monitoring was continued in the scope and aims as in previous years. One of the aims is to monitor alien species in the high-risk areas of new invasions. Base on surveys in vicinity of the largest port in the country – Muuga harbour – no new alien species were identified in 2013. The new polychate species found in Pärnu Bay in 2012, belonging to the genus *Laonome*. The species was recently described as *Laonome armata* sp. nov. (Sabellida, Sabellidae) and by now has established a permanent population. The bloody-red shrimp *Hemimysis anomala* and the round goby *Neogobius melanostomus* expanded their distribution areas while the abundance of Chinese mitten crab *Eriocheir sinensis* continued to be low. The grass prawn *Palaemon elegans* was found across the whole Estonian coastal sea in 2013.

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

The IMO BWMC is still not yet ratified because the socio-economic analysis performed does not provide full-scale overview on the implications related to joining the Convention. Currently, the still missing information is being collected.

### 3. Unintentional introductions

A new polychaete species was found at very high densities in the eastern part of the Baltic Sea in Estonia in 2012. The species represented the sabellid genus *Laonome* Malmgren, 1866, but it could not be assigned to any of its previously described species. The species survived a very cold winter and by now has established a permanent population. The alien polychaete was described by examining living specimens and with scanning electron and light microscopic methods. Morphological analyses were supplemented by molecular characters from sequences of the mitochondrial COI and 16S rRNA and the nuclear 18S rRNA and 28S rRNA genes. *Laonome armata* Bick and Kotta sp. nov. is characterized by the presence of acicular spines on first thorax chaetigers, dorsal pinnular and ventral radiolar appendages. Sequences of each of the four gene fragments also serve as unique taxonomic barcodes. The abundance of *L. armata* sp. nov. exhibited a strong seasonal variation, peaking between July and November. Besides seasonality, the quantity of decomposed microalgae in the sediment and exposure to waves contributed most to explaining the abundance variation in the niche model. *Laonome armata* sp. nov. now reaches high densities locally at low salinity area of the Baltic Sea. The species may potentially modify sediment morphology and chemistry, disrupt natural infaunal communities by establishing new ecological relationships, displacing or completely disassembling native communities but likely also facilitating some native species through the provision of alternative substrata and/or food to them.

In 2013, alien species monitoring was continued in the scope and aims as in previous years. One of the aims is to monitor alien species in the high-risk areas of new invasions. Base on surveys in vicinity of the largest port in the country – Muuga harbour – no new alien species were identified in 2013. The samples taken both from the harbour area as well as adjacent localities confirm that *M. neglecta* was the most frequently found alien species in these areas (with co-domination in a few localities), with the other zoobenthic alien/cryptogenic species being *Potamopyrgus antipodarum*, *Amphibalanus improvisus* and *Mya arenaria* (Anon. 2013). The another major aim of the alien species monitoring program is to track the long-term performance of the already existing alien species in Estonian coastal sea. The following sections provide short summary on findings (please also see figures 1-6 at the end of the report).

Time-series are available for *Cercopagis pengoi*, *Evadne anonyx*, *Amphibalanus improvisus* larvae and *Marenzelleria neglecta* larvae. In 2013, the abundance of *M. neglecta* larvae was consistently high both in the Gulf of Finland and the Gulf of Riga, while *A. improvisus* larvae and *C. pengoi* were either low or at about at the level of the long-term mean (Figuers 1and 2).

The alien cladoceran *Evadne anonyx* is present across the whole Estonian coastal sea. (present in 44% of samples in 2013). In general, the species occurs late summer and early autumn (but can be present in zooplankton community in May and June) with relatively low densities – a few hundred individuals per $m^2$.

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.

The bloody-red shrimp *Hemimysis anomala* has been increasingly found in the Estonian coastal sea. Although its densities are very low, new a number of new localities (i.e. Pärnu Bay, the Gulf of Riga) in 2009, 2012 and 2013; Muuga Bay (Gulf of Finland) in 2012) suggest an expansion of the dispersion area of *H. anomala*. In 2013, the species was also found in Tallinn Bay (Gulf of Finland; for details, please see Estonian data report).

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 (for details, please see Estonian data report).

The Harris mud crab *Rhithropanopeus harrisii* was first found in Estonian waters in 2011. Further investigations in 2012 corroborated that the species has colonized whole Pärnu Bay and already occurring outside the area in the NE Gulf of Riga (Kotta and Ojaveer 2012). There is no evidence on the further expansion of the distribution area of the species in 2013.

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 two years (Figure 5; Anon 2014).

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 2013, the fish constituted nearly 94% in terms of biomass in experimental catches with gillnets of mesh size of 36-44mm (Figure 5, Anon 2014). In addition, the species is also spreading spatially and have colonized several localities around the Estonian coast. The fish has colonized and is common in two islands in the central/northern Gulf of Riga (Ruhnu island, first found in 2010; Kihnu island, first found in 2012).

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 alien fish is most abundant at the south coast of Saaremaa (Kõiguste) in the northern Gulf of Riga with relatively stable values during the several past years (Figure 6). 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. Pathogens

Nothing to report.

## 5. Meetings

Several EU FP7 VECTORS project meetings were attended to further develop the information system of the Aquatic Non-Indigenous Species in Europe (AquaNIS). Attendance of ICES-CIESM alien species cooperation meeting.

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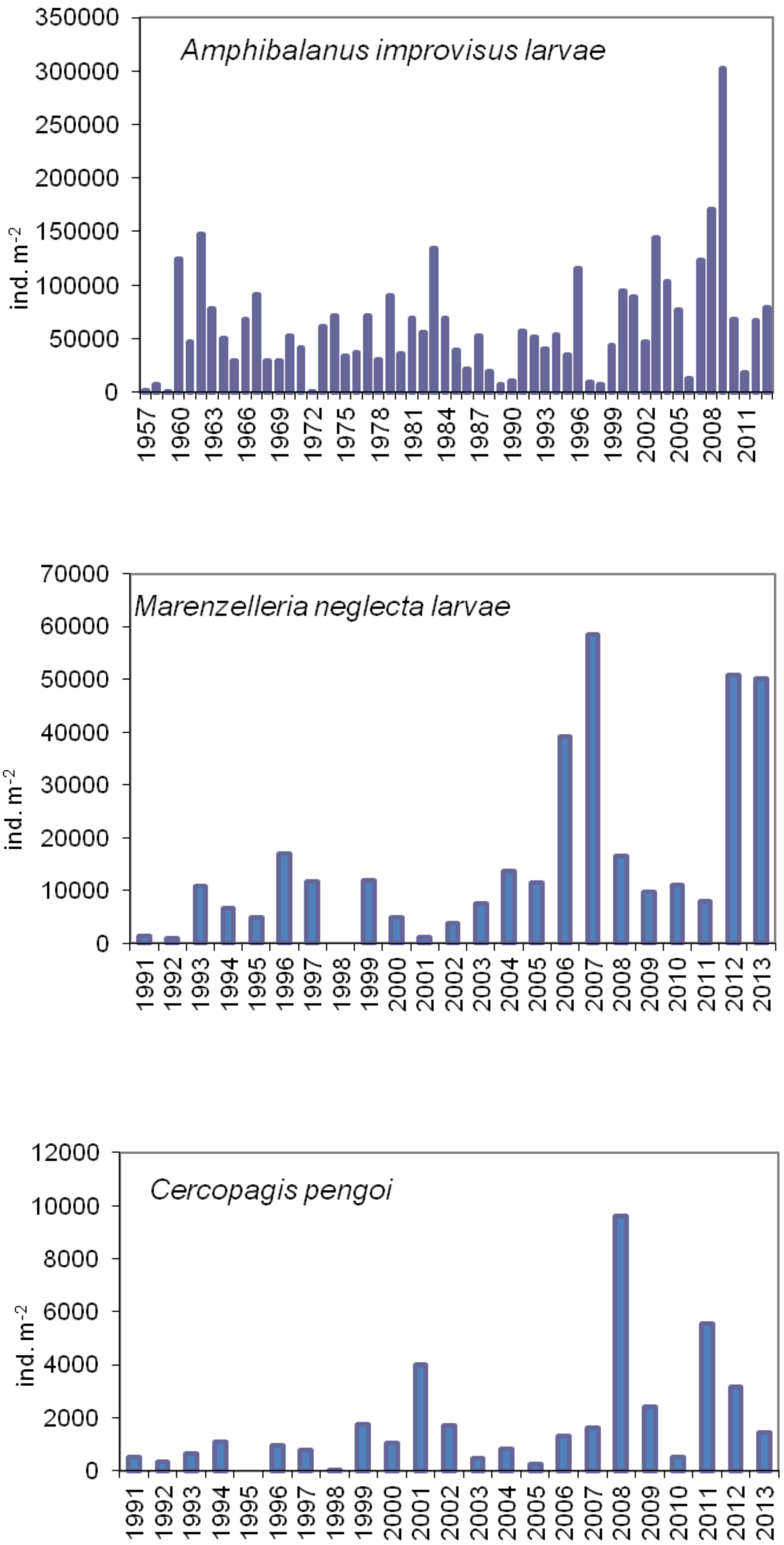



**Figure 1. Long-term abundance dynamics of *Amphibalanus improvisus* larvae, *Marenzelleria neglecta* larvae and *Cercopagis pengoi* in the NE Gulf of Riga (Baltic Sea). Anon 2014.**

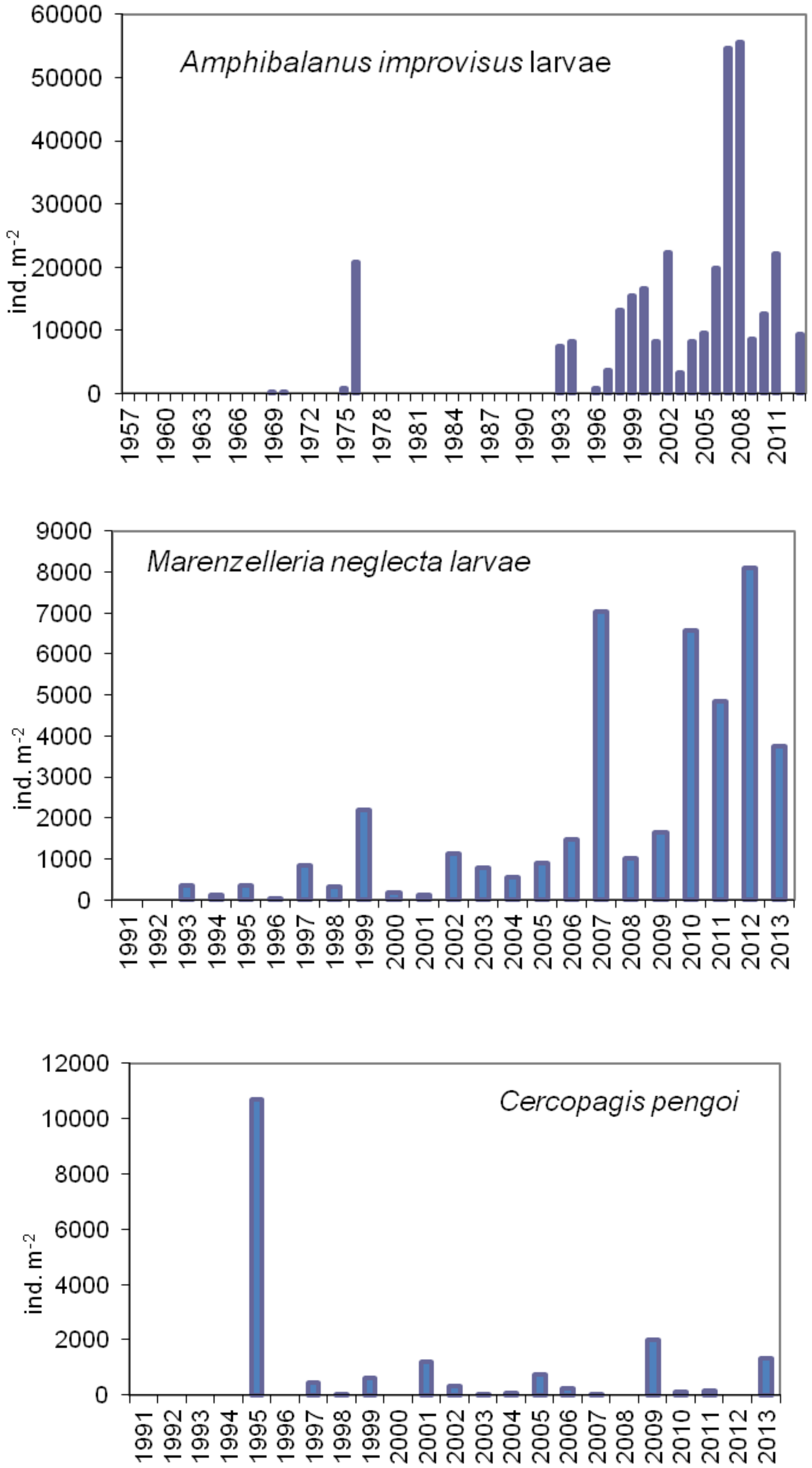



**Figure 2. Long-term abundance dynamics of *Amphibalanus improvisus* larvae, *Marenzelleria neglecta* larvae and *Cercopagis pengoi* in Tallinn and Muuga Bays (Gulf of Finland, Baltic Sea). Anon 2014.**

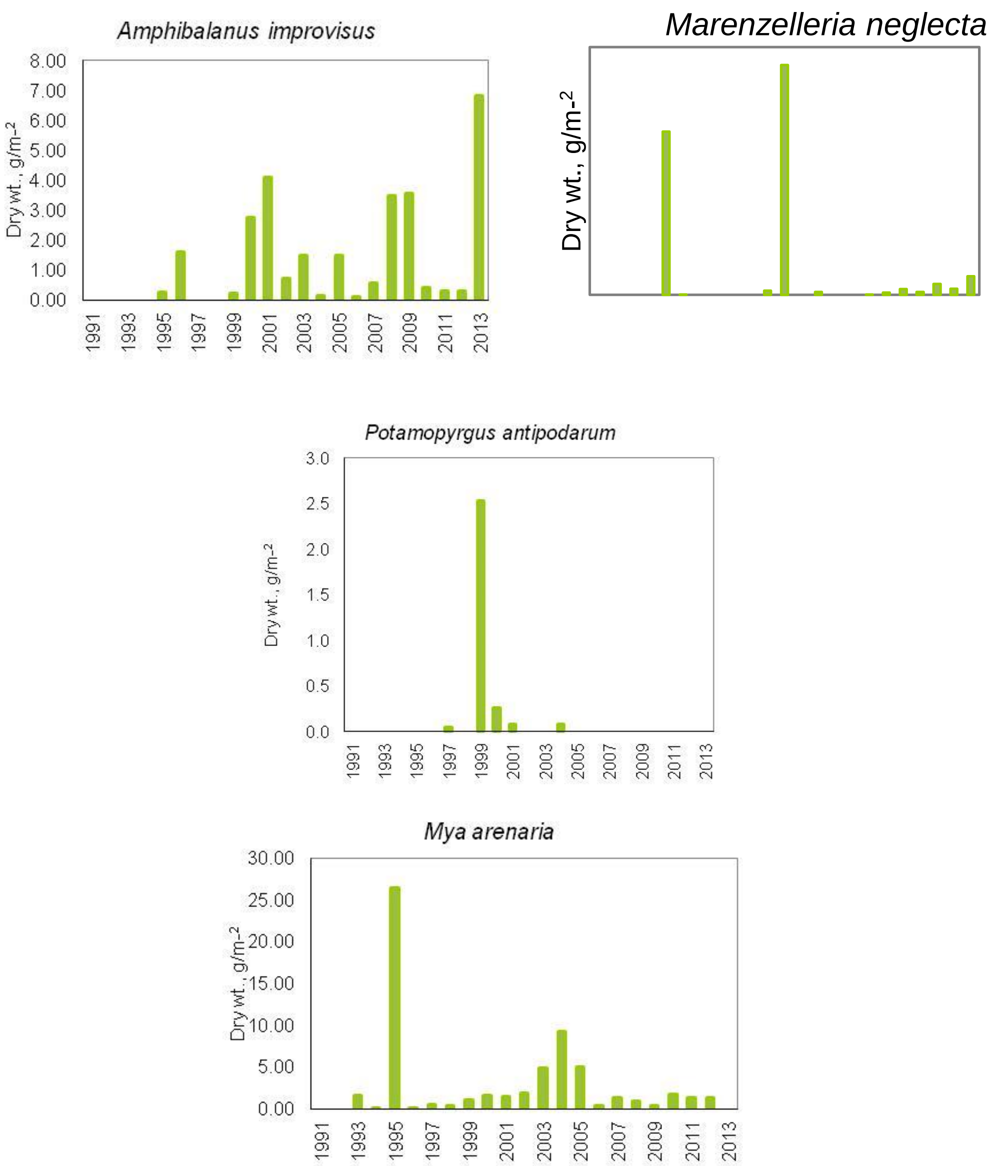



**Figure 3. Long-term biomass dynamics of selected benthic alien species in Tallinn and Muuga Bays (Gulf of Finland, Baltic Sea). Anon 2014.**

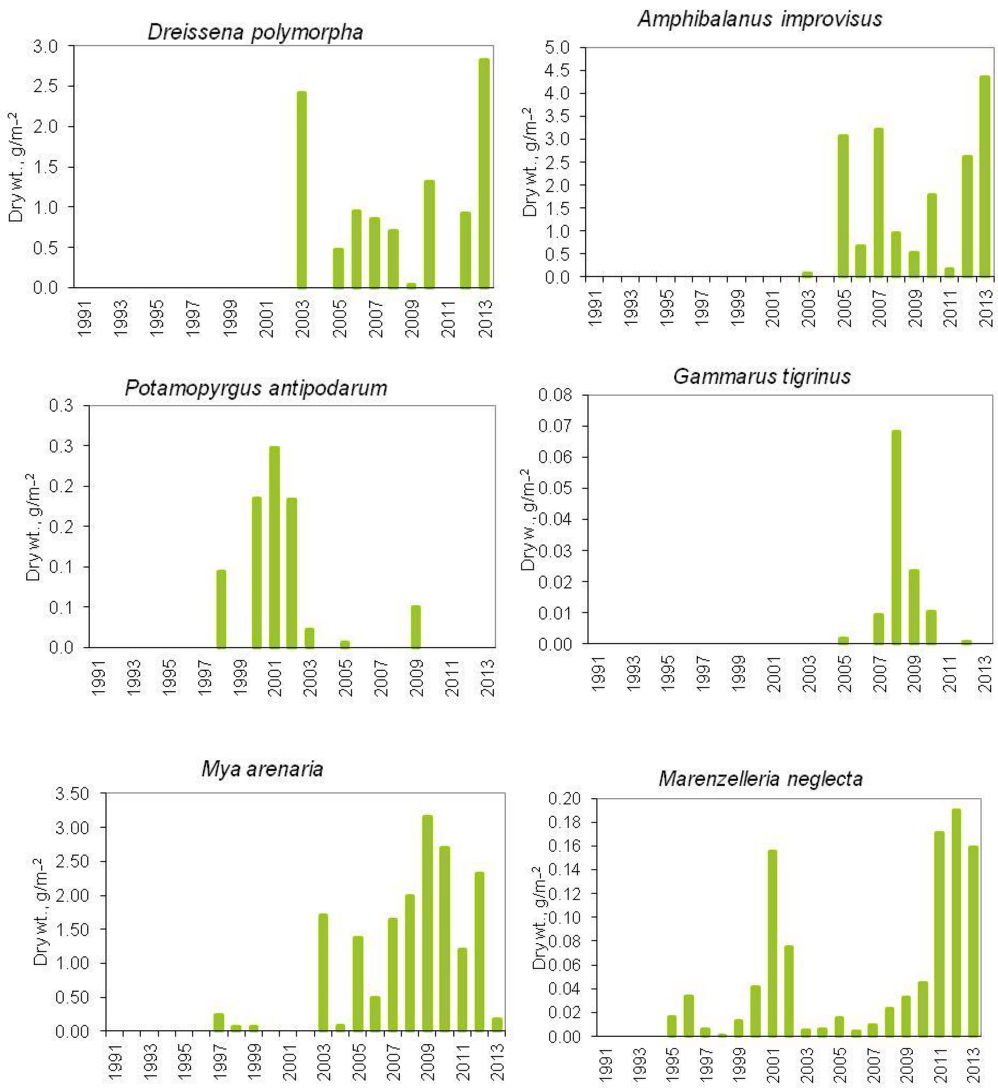



**Figure 4. Long-term biomass dynamics of the selected benthic alien species in the Gulf of Riga (Baltic Sea). Anon 2014.**

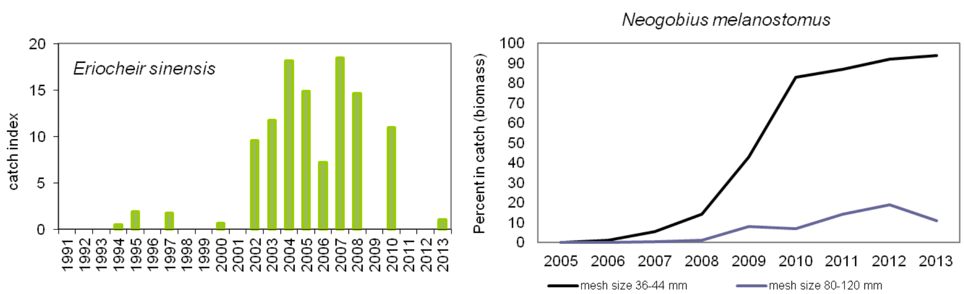
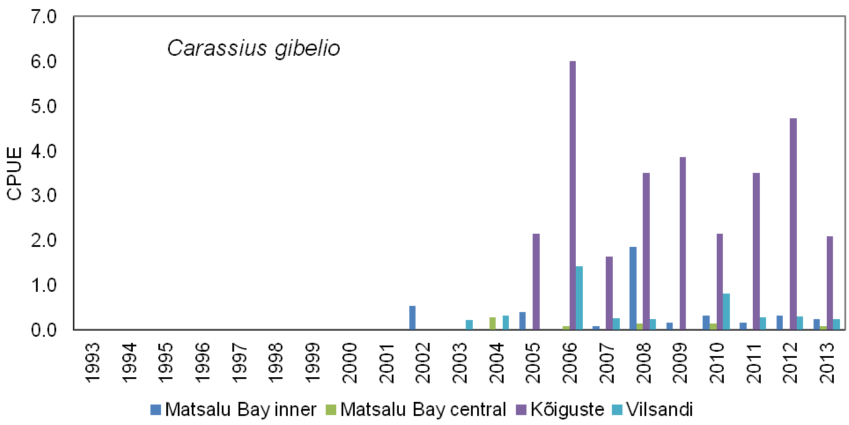



**Figure 5. Catch index of the Chinese mitten crab *Eriocheir sinensis* (left panel) and percent contribution of the round goby *Neogobius melanostomus* (right panel) in experimental gillnet catches in Muuga Bay (Gulf of Finland, Baltic Sea) (Anon 2014).**



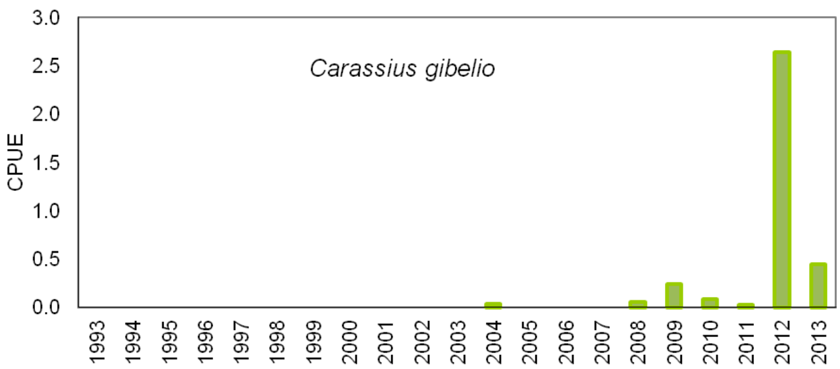




**Figure 6. Catch per unit of effort (cpue) of gibel carp *Carassius gibelio* in various locations in Estonian coatsal sea: Matsalu Bay (West-Estonian Archipelago Sea), Kõiguste (south coast of Saaremaa in the Gulf of Riga), Vilsandi (west coast of Saaremaa Island) and Käsmu (south coast of the middle Gulf of Finland). Anon 2014.**

## 3.6 Finland

Compiled by Maiju Lehtiniem, Finnish Environment Institute and Lauri Urho, Finnish Game and Fisheries Research Institute

### Overview:

One new alien species was found in Finnish waters in 2014. It is at present an unknown gastropod species. The identification is underway with molecular analysis. The round goby, *Neogobius melanostomus*, is increasing in abundant and in the number of ports occupied. The mud crab *Rhithropanopeus harrisii* was found to still increase in abundance in the Archipelago Sea. Port monitoring was conducted according to HELCOM protocol in 3 Finnish ports in spring and late summer 2013. Finnish board on invasive species issues was set up and started its work in September 2013. The ratification of the IMO's BWM Convention by Finland was delayed and will take place during 2014.

## 1. Regulations:

The National Strategy on Invasive Species (coordinated by the Ministry of Agriculture and Forestry) was accepted by the parliament in 2012. The strategy listed all harmful and potentially harmful alien species in Finland (and species that could come to Finland) as well as suggested the most important management options and authorities responsible for the management. To better implement the Strategy a Board on invasive species issues was set up and started its work in September 2013. In addition a group dealing with NIS monitoring issues was set up and will work in contact with the Board.

Finland 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) during 2014.

Sampling protocol for port monitoring was developed under HELCOM ALIENS 2 and 3 to prepare and create unified approaches for the exemption-procedures of BWMC in the Baltic Sea when the Convention enters into force. The sampling protocol was tested in three Finnish ports (Kotka/Hamina, Kilpilahti and Kokkola ports) during spring and summer 2013.

A scheme (parameters, stations/areas, frequency, methods) for alien species monitoring for Finnish waters was developed during 2013 in order to fulfill the requirements of the MSFD descriptor 2. This national monitoring program takes also into account the developed port monitoring program, which serves in addition to the BWMC also MSFD.

## 2. Intentional:

Deliberate releases into the Baltic Sea were (including rivers draining into the Baltic) for fisheries and fish stock enhancement purposes in 2013 as follows (some values are underestimates):

0.1 million newly hatched and 1.7 million older salmon (*Salmo salar*), and

1.0 million newly hatched and 1.2 million older sea trout (*Salmo trutta* m. *trutta*),

something around 30 million newly hatched and 28.5 million older whitefish (*Coregonus lavaretus*).

Salmonids, mostly Rainbow trout (*Oncorhynchus mykiss*) were imported from Denmark and USA for cultivation. Eel were imported from England via Sweden and sturgeons (Acipenseridae, *e.g. A.baerii*) from Spain and Estonia (TRACES).

## 3. Unintentional:

One new alien species was found in Finnish waters in 2013, a gastropod species in the Gulf of Finland, northern Baltic Sea. Several specimens were found in benthos samples from the shallow littoral. The identification of the species is underway in several laboratories with molecular methods.

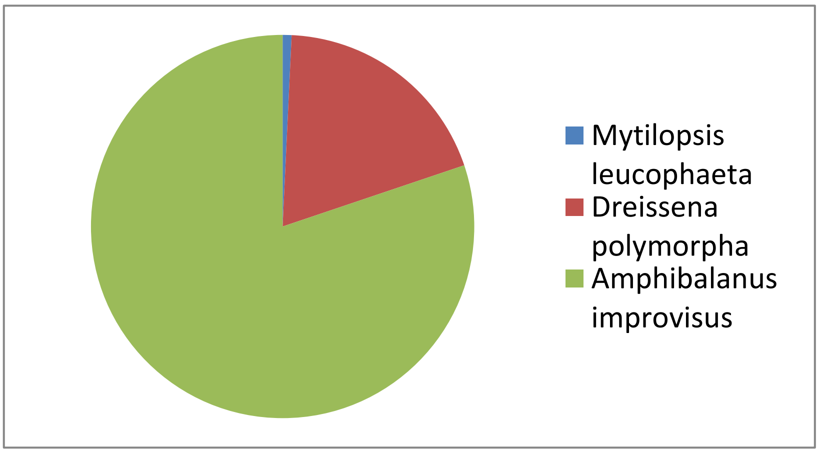
In addition there were changes in species abundance and distribution in established alien species.

Kotka/Hamina and Kilpilahti ports were revealed to host several alien species, which were found in samplings done following the developed port sampling protocol. The observed alien species in the ports were:

| Ports in the Gulf of Finland | Ports in the Gulf of Bothnia |
|---|---|
| Acartia tonsa | Amphibalanus improvisus |
| Amphibalanus improvisus | Cordylophora caspia |
| Cercopagis pengoi | Evadne anonyx |
| Cordylophora caspia | Gammarus tigrinus |
| Dreissena polymorpha | Marenzelleria neglecta |
| Evadne anonyx | |
| Gammarus tigrinus | |
| Marenzelleria spp. | |
| Potamopyrgus antipodarum | |
| Mytilopsis leucophaeata | |
| Neogobius melanostomus | |
| Prorocentrum minimum | |

**Invertebrates:**

The mussels *Mytilopsis leucophaeata* and *Dreissena polymorpha* were observed to be abundant on several sampling stations in the eastern Gulf of Finland (Figure 1). Although barnacle (*Amphibalanus improvisus*) is the dominant (80%) sessile organism on hard bottoms *D. polymorpha* has increased in abundance and is reproducing efficiently. It is at present the dominating mussel species in the area. There are no native hard bottom-living mussels there.




Proportions of sessile invertebrates in the samples of Eastern Gulf of Finland during 2011-2013.

The crustacean, mud crab *Rhithropanopeus harrisii* has continued to increase in abundance as well as in distribution in the Archipelago Sea. Fishers often report of fish that have stomachs full of mud crabs. This was especially common during winter 2013 when fishers reported of fish full of mud crabs caught by ice fishing.

**Fish:**

Twenty biggest ports were tested for the occurrence of round goby, *Neogobius melanostomus* with a set of seven Gee-traps and three trapnets. The round goby was found in five of the ports, all of which were already known to be occupied with it during the previous years. However, the round goby was found for the first time in four ports when angling or seining was used. In Helsinki area, where the round goby was first found in 2009, the distribution area has expanded on average 1 km per year.

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 has been recorded for the first time in the Estonian coastal sea in Narva Bay, eastern Gulf of Finland, in 2006 and thereafter. *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 2013 for NIS.

## 5. Meetings

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

Meetings with HELCOM ALIENS3-project concerning port monitoring.

Benthic Ecology Meeting. 20.- 23.3.2013 in Savannah, GA: Puntila, R., Vilizzi, L., Lehtiniemi, M. and Copp, G. H. 2013: First Application of FISK, the Freshwater Fish Invasiveness Screening Kit, in Northern Europe: Example of Southern Finland. Poster.

European Vertebrate Pest Management Conference - EVPMC9. Turku Finland 22.-27.9.2013.: Puntila, R., Vilizzi, L., Lehtiniemi, M. and Copp, G. H. 2013: First Application of FISK, the Freshwater Fish Invasiveness Screening Kit, in Northern Europe: Example of Southern Finland. Oral Presentation.

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Jonne Kotta, Merli Pärnoja, Tarja Katajisto, Maiju Lehtiniemi, Stanislaw A. Malavin, Greta Reisalu and Vadim E. Panov: Is a rapid expansion of the invasive amphipod Gammarus tigrinus Sexton, 1939 associated with its niche selection: a case study in the Gulf of Finland, the Baltic Sea Aquatic Invasions 8 (3): 319-332

## 3.7 France

Compiled by Amelia Curd (Ifremer) with contributions from Guy Bachelet (CNRS – University of Bordeaux 1), Jean-Claude Dauvin (CNRS – University of Caen), Sandrine Derrien-Courtel (MNHN – Concarneau), Patrice Francour (University of Nice Sophia Antipolis), Laurent Guerin (MNHN – Dinard), Frédérique Viard (CNRS – Station Biologique de Roscoff), Antoine Carlier, Herlé Goraguer, Philippe Goulletquer & Laurence Miossec (Ifremer).

### Overview:

This year was the discovery of the European green crab *Carcinus maenas* in the French overseas territory of St Pierre et Miquelon. In mainland France, several species identified in previous reports are showing range expansions, including the algae *Heterosiphonia japonica* and *Undaria pinnatifida,* the amphipod *Grandidierella japonica* and the crab *Hemigrapsus sanguineus*. Several molecular barcoding research projects studying non-native species are ongoing. Finally, it is worth noting that a tentative commercial exploitation of the slipper limpet *Crepidula fornicata* is underway in the vicinity of the Mont St Michel bay.

### 1. Regulations:

The international convention for the control and management of ships' ballast water and sediments (BWM Convention), which needs to be ratified by 30 states before entering into force, has now been ratified by 38 states. However these 38 states represent only 30.38% of the registered world merchant's shipping tonnage, when 35% is required by the BWM Convention. Once the threshold of 35% world merchant's shipping tonnage has been reached, the BWM Convention will enter into force within 12 months. The French Ministry of Environment has therefore organized several meetings in order to examine exemption requests, and is in the process of forming a technical working group in order to analyse the invasive species risk linked to these exemption requests. The aim of this working group is to define a process or set of criteria through which the petitioners can carry out a risk analysis. Work should begin this month (March 2014) – more detail can be found in the WGBOSV French national report. The regional seas conventions of HELCOM and OSPAR are in the process of publishing joint guidelines for the contracting parties on the granting of exemptions under the BWM Convention.

One of the key requirements of the Marine Strategy Framework Directive (MSFD) is the establishment and implementation of a coordinated monitoring program for ongoing assessment and regular monitoring of targets, in order to measure progress towards achieving Good Environmental Status. This strand of work is to be implemented by July 2014. With respect to high-level descriptor 2 "Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems." Three broad surveillance programs are in the process of being defined at a national level concerning the following topics:

- main vectors and pathways (ballast water and sediment, bio-fouling and live import and export) with the aim of making maximum use of existing data sources;

- *in-situ* monitoring in areas considered most vulnerable and at risk

- characterization of the state and impact of invasive non-indigenous species.

Development of these surveillance programs will be ongoing during 2014; work is carried out at the level of each MSFD marine subregion. These monitoring programs are national draft recommendations, which still need to be detailed and coordinated across the marine subregions, before being reported to the EC. It is anticipated than the first subprogram (main vectors & pathways) will be implemented in two phases; the first phase will focus on research and knowledge acquisition, and will only become operational during a second phase. Links with the MSFD program of measures are strong and are currently being studied. Optimization with other monitoring programs (e.g. biodiversity) is also still under consideration.

## 2. Intentional:

### 2.1 Invertebrates

*Mollusca*

French customs import and export statistics for the Pacific oyster *Crassostrea gigas* and can be found for 2012 on the FranceAgriMer website (http://www.franceagrimer.fr/content/download/27524/242632/file/BIL-MER-commerce_extérieur-A13.pdf). In 2012, 7000 tons of Pacific oyster were exported from France, mainly to other Member states (with Italy importing 3121 tons) and to the Asian market. Information on the imports of non-native species of live crustaceans and bivalve molluscs other than oysters are available in this report, although the nomenclature used by customs is too imprecise to isolate individual species.

A paper by Copp et al. (in press) describes the European Non-native Species in Aquaculture Risk Assessment Scheme (ENSARS), which was developed for carrying out assessments under Council Regulation (CR) No 708/2007 of the European Commission (EC) on 11 June 2007 concerning the Use of Alien and Locally-Absent Species in Aquaculture (EC-ASR). The ENSARS 'Organism' module was used to assess species listed in Annex IV of the EC-ASR, which includes two marine species; the Pacific oyster *Crassostrea gigas* and the Manila clam *Ruditapes philippinarum.*

A study by Brenner et al. (2014) describes the impacts of transfer activities of cultured bivalve shellfish along the European Atlantic coast. The paper identifies hitchhiker species, fouling organisms or infectious agents, which can be translocated with a target species. Further, the study highlights the need for thorough, standard risk reduction measures designed to minimize the impact on ecosystems worldwide.

### 2.2 Algae

A new population of *Undaria pinnatifida* was recorded in 2013 in a wild site near the Cap Frehel (Brittany). This adds to the record database for the presence of *U. pinnatifida* in Brittany, which is maintained by the Station Biologique of Roscoff (contact. F. Viard/L. Leveque).

## 3. Unintentional:

### 3.1 New Sightings

*Tunicata*

*Current status of Ciona intestinalis type A in Brittany*: 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 thesis work (Sarah Bouchemousse supervised by F. Viard) started in 2012 to study the hybridization processes between the two *Ciona* species that are interfertile in the laboratory. This thesis work includes biannual surveys. In 2013, two surveys were carried out to replicate the records made in 2012 in Brittany. Results show that *Ciona* type A is less dominant over type B than in 2012. Molecular studies showed that only a few number of adult specimens show traces of hybridization with type B, suggesting that efficient barriers to hybridization are acting in the wild.

*Crustacea*

The European green crab, *Carcinus maenas*, was detected for the first time in the French overseas territory of Saint-Pierre & Miquelon (Sellier *et al*. 2014). A monitoring program was initiated during the summer of 2013, with Fukui cages deployed. Details of the ongoing dedicated AIS monitoring programs in Saint-Pierre & Miquelon can be found in Sellier *et al.* (2014), and were presented at the AIS Monitoring Atlantic Zone meeting in Mont-Joli (Quebec, Canada) in February 2014. Genetic analysis of the green crab, but also of the ascidians *Ciona intestinalis, Didemnum vexillum*, the algae *Codium fragile* and the bryozoan *Caprella mutica* are currently underway in order to pin down the origin of these introduced species.

Two non-indigenous peracarid crustaceans were recently recorded in Arcachon Bay, SW France. The isopod *Paranthura japonica* has been found on several occasions since 2007, in a variety of intertidal and shallow habitats, often associated with engineer species (oyster reefs, mussel and slipper limpet beds, *Zostera marina* meadows), and in low abundance. Native to the Sea of Japan, outside its native area this species was only known to occur along the Pacific coast of North America (Lavesque *et al*. 2013). The second species is the amphipod *Grandidierella japonica*, collected in relatively large numbers in August 2012 and October 2013, mainly in the intertidal habitats of Arcachon Bay. Also native to the NW Pacific, *G. japonica* was previously known in Europe from the British Isles and the bay of Marennes-Oléron (Lavesque *et al*. 2014). For both species, an accidental introduction with oyster transfers is hypothesized as the most likely vector of introduction.

*Algae*

A paper by Jongma et al. (2013) identified, via morphological and molecular studies, a slender *Caulerpa* strain now taxonomically recognized as *Caulerpa taxifolia* var. *distichophylla.* Western and eastern Mediterranean populations of *Caulerpa taxifolia* var. *distichophylla* are probably the result of introduction events from southwestern Australia. Due to its genetic proximity, interbreeding with other *C. taxifolia* strains might be expected to occur.

## 3.2 Previous Sightings

*Mollusca*

Introduction history, acclimation and adaptation in *Crepidula fornicata*: A genome-scan study, carried out as part of the ANR project HiFlo (http://lienss.univ-larochelle.fr/HI-FLO) and published by Riquet et al. (2013), showed the large genome-wide polymorphism of introduced populations of *C. fornicata,* a likely origin of European populations from two sources in the USA and no evidence of selection on standing genetic variation following the introduction of the slipper limpet from the USA to Europe. This latter result suggests that the invasiveness of the slipper limper may also rely on acclimation processes. In this context, it is worth noting the PhD work of Fanny Noisette (defended in 2013, supervision S. Martin/D. Davoult) who showed that adults of *Crepidula fornicata* present slight sensitivity to elevated pCO2. In their early-stages, the encapsulation of *C. fornicata* embryos did not protect them against the deleterious effects of predicted pCO2 increase but *C. fornicata* larvae seemed less affected than other mollusc species.

Bivalve Larvae – molecular barcoding: The early stages of most bentho-pelagic species are overlooked in monitoring and surveys of non-native species because they are often difficult to identify, as exemplified in bivalves. As part of the Marinexus project (http://www.marinexus.org/), molecular barcoding approaches were carried out to analyse the diversity of the bivalve larval pool in the bay of Morlaix used as a pilot site (resp. T. Comtet). Over a 9-month monitoring period (2012), 48 different potential species of bivalves were identified and surprisingly, *Venerupis philippinarum*, an introduced species, represented more than 10% of the bivalve larvae analysed.

It is worth noting that the agribusiness group Britexa has launched a SME named “Slipper Limpet Processing” based in Cancale, northern Brittany, a company whose aim is to process and preserve for human consumption up to 20 tons of *C. fornicata* per day. The company currently handles 10 tons of shells per day and targets the catering sector, with exports towards the UK, Germany and Spain, as well as the Asian market.

*Crustacea*

A study of the demographic development and geographical distribution of *Hemigrapsus sanguineus* was carried out during 2011-2012 and published in Gothland *et al.* (2013). Although first observed in France in 1999, no study of the spread of *H. sanguineus* was initiated until 2008. During the 2012 survey ovigerous females were reported, when none were reported in spring 2008, indicating that *H.sanguineus* is ‘naturalised’ along the French coast. Increasing densities and abundances were recorded between 2008 and 2011; however in 2012 populations were subsequently halved. The implementation of pluri-annual surveys seems of prime importance to correctly evaluate population dynamics of alien species (Gothland *et al.*, 2013).

*Algae*

An article assessing the current distribution and abundance of the Siphoned Japan Weed *Heterosiphonia japonica* along the Brittany coastline was published in 2013 (Derrien-Courtel & Le Gal 2013). This article underlines a significant range expansion since this red seaweed was first reported in 1984.

### 3.3 Not Seen Species Yet

***General Information***

Marinexus project (http://www.marinexus.org; leader, M. Cock, Station Biologique de Roscoff): this Interreg IV A project launched at the beginning of January 2010 and built-up on a network of marine specialists from Plymouth (UK, lead) and Roscoff (France) will be ending in June 2014 (See 2012 report for a brief presentation). Aquatic invasions are addressed in a dedicated Work package (co-supervised by J. Bishop, MBA-UK and F. Viard, Roscoff-France). In the course of the programme, new introduced species or clades were recorded as well as new locations for previously reported NIS ( e.g. see § *Undaria pinnitifida*), effects of environmental changes on emblematic invaders were investigated (e.g. see § *Crepidula fornicata)* and the importance of ballast tank and hull of a ferry in transporting native and non-native species was documented.

The ANR project HySea (ANR-12-BSV7-0011; resp. F. Viard) started in November 2012 is targeted the genomic processes involved in hybridization between related species that came into secondary contacts, including 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 *Crassostrea angulata*, in Europe.

The IUCN Centre for Mediterranean Cooperation has published a strategic and practical guide for monitoring marine invasive species addressed to marine protected area managers (Otero *et al*., 2013). To support this monitoring, a "Mediterranean Black List for Mediterranean MPAs" was developed with the assistance of Mediterranean taxonomic and IAS experts. This list is dynamic and will need to be reviewed every 2-3 years with the assistance of the Advisory Group and other expert groups from the Mediterranean region (IUCN Invasive Species Specialist Group and CIESM exotic-species experts, among others) in the light of new information on risk assessments and environmental impacts.

EDF-EN (Electricité de France - Energies Nouvelles) has installed an "OpenHydro" hydrokinetic turbine prototype on the north coast of Brittany (Paimpol-Bréhat site). The power cable was immersed during the summer of 2012. Ifremer (resp. A. Carlier) has been tasked with monitoring the biocolonization of the 13km-long unburied cable casing, through dive video-surveys and videos, before and after the turbine is put into service.
Preliminary results showed that at least two introduced species (the ascidian *Styela clava* and the gastropod *Crepidula fornicata*) occur on the cable protection structures with significant abundances. Results have not yet been published.

## 4. Pathogens

Prado-Alvarez *et al*. (2013) published a paper on the molecular basis that governs the interactions between *Bonamia ostreae* (an intracellular parasite of *Ostrea edulis* haemocytes) and its host *Ostrea edulis*.

## 5. Meetings

***Past year (2013)***

OSPAR Convention Meeting of the Intersessional Correspondence Group on the Co-ordination of Biodiversity Assessment and Monitoring (ICG-COBAM) (Gothenburg, Sweden, 11-12 September, 2013)

MG4U Workshop on the Potential of Genomics for Marine Monitoring and Biodiversity Mapping (Dublin, Ireland, 28 June 2013) http://www.mg4u.eu/images/mg4u/News/mg4u%20_dublin_workshop_report_v2.pdf

Non-indigenous species in the Northeast Atlantic (Ostend, Belgium, 20-22 November 2013) http://www.ilvo.vlaanderen.be/NISconference2013

***Meetings in 2014***

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

OSPAR Convention Meeting of the Intersessional Correspondence Group on the Coordination of Biodiversity Assessment and Monitoring (ICG-COBAM) (Brussels, Belgium, 25-27 March, 2014)

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## 3.8 Germany

Prepared by S. Gollasch, GoConsult, Germany; and S. Kacan, Federal Maritime and Hydrographic Agency, Germany.

### Overview:

No new findings were reported since last year's meeting. 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. The impact of *Gracilaria vermiculophylla* on Fucus was studied in the Kiel Fjord and it was concluded that Gracilaria is able to influence *Fucus* in the Baltic Sea through direct competition for resources and by exposing it to higher grazer pressure (Hammann et al 2013). Floating *Sargassum muticum* are found since 1981/1982 and the first attached algae were found in 2011. Attached *S. muticum* seem to spread along the Lower Saxony coast (Island of Juist) (Markert & Wehrmann 2013). A species not yet known from Germany is *Didemnum vexillum*, but it is found in other European countries. 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)

No new German legislation was developed or implemented.

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 ends in earl y2014, but no report is yet available. For more information contact:

duerselen@aquaecology.de

Another pilot study runs 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:

Mario.von.Weber@lung.mv-regierung.de

### Zoological gardens and aquaria

Although dominated by terrestrial species the following instruments address accidental escapes from zoological gardens and aquaria and provide information on containment and proper infrastructure to avoid unintentional releases from such facilities.

- The EUROPEAN CODE OF CONDUCT ON ZOOLOGICAL GARDENS AND AQUARIA AND INVASIVE ALIEN SPECIES. Code, rationale and supporting information, FINAL VERSION of October 2012 refers to escapees from such facilities as possible species introduction vector. It is stated that zoological gardens and aquaria are recognized as a potential pathway of invasions in Europe.

- The Council Directive 1999/22/EC of 29 March 1999 (EC Zoo Directive) relates to the keeping of wild animals in zoos and states that Member States shall take measures to ensure all zoos implement the following conservation measures: "preventing the escape of animals in order to avoid possible ecological threats to indigenous species and preventing intrusion of outside pests and vermin" and "keeping of up-to-date records of the zoo's collection appropriate to the species recorded."
- European Code of Conduct for Botanic Gardens on Invasive Alien Species. Council of Europe.

### New Guidelines for reintroductions

IUCN/SSC (2013). Guidelines for Reintroductions and Other Conservation Translocations.

## 2. Intentional:

No major changes since last year's National Report. The species which were reported 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:

### New Sightings

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

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 impact of *Gracilaria vermiculophylla* on Fucus was studied in the Kiel Fjord and it was concluded that *Gracilaria* is able to influence *Fucus* in the Baltic Sea through direct competition for resources and by exposing it to higher grazer pressure (Hammann et al 2013).

Floating *Sargassum muticum* are found since 1981/1982 and the first attached algae were found in 2011. Attached *S. muticum* seem to spread along the Lowerr Saxony coast (Island of Juist) (Markert & Wehrmann 2013).

*Procambarus fallax*, a freshwater crayfish, was found in ponds from where a mass invasion was reported in Saxony-Anhalt. These ponds are strongly influenced by leaching of salts from the sediment and the salinity may reach >5 psu. However, no citations about the salinity tolerance of this species were found. This fact and the P. fallax ability of parthogenesis indicate the importance of this species as potential threat!

#### Not Seen Species Yet

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.

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## 3.9 Greece

Prepared by: Argyro Zenetos and Kostas Tsiamis, Hellenic Centre for Marine Research

### Overview

In 2013 six marine alien species were reported for the first time from the Greek Seas. These include the polychaet *Dipolydora blakei* from the Ionian and Aegean Sea, the shrimps *Meliceros hathor* and *Farfantepenaeus aztecus* from south and north Aegean Sea respectively, the decapod crab *Xanthias lamarcki* from the Rhodes area (south Aegean); the barnacle *Megabalanus coccopoma* from Saronikos Gulf, and the hydrozoan *Sertularia marginata* from the Aegean Sea.

In addition, 40 alien species have expanded their distribution in Greek waters, some of them exhibiting invasive behaviour (*Callinectes sapidus, Lagocephalus sceleratus*).

## Unintentional: Introductions

### New alien species for Greek waters

***Dipolydora blakei*** (Maciolek, 1984)

The spionid polychaete *Dipolydora blakei* was identified from benthic samples collected in the Aegean Sea off Chalkis and the Ionian Sea off Kalamitsi, both on the coast of Greece. In the Ionian Sea, adults of *D. blakei* were found off the Kalamitsi coast, inhabiting silty tubes in clusters of empty calcareous serpulid tubes on a sandy seabed with shell debris, at a depth of 63 m. In total, 313 specimens were found in two Ponar grab samples, each with a sampling surface area of 0.045 $m^2$. In the Aegean Sea, the only individual of *D. blakei* was found off the Chalkis coast, on a muddy sand seabed with fragments of a stony coral *Cladocora caespitosa* (Linnaeus, 1767) (Radashevsky & Simboura, 2013). This is the first report of the species from the Mediterranean Sea and European waters and the second record (after one from Brazil) outside its type locality in deep water off New England, Northwest Atlantic Ocean.

***Farfantepenaeus aztecus*** (Ives, 1891)

The northern brown shrimp, *Farfantepenaeus aztecus* (Ives, 1891) is very abundant in the Western Atlantic coast and prefers shallow waters. Its presence in the Mediterranean basin has been reported in South Turkey (Gökoğlu & Ovzarol, 2013), in the Montenegrin waters (Marković *et al*., 2014). In 2013 it was recorded for the first time in Papapouli lagoon (North Aegean Sea). The capture of subadult and adult individuals indicates the establishment of a vivid population in the Eastern Mediterranean Basin (Nikolopoulou *et al*., 2013).

***Megabalanus coccopoma*** (Darwin, 1854)

One empty specimen was present in an aggregation of barnacles scraped from the hull of a frigate in Saronikos Gulf. This species is also a common member of the fouling community of ship hulls (Kerckhof & Cattrijsse, 2001). This is the first record in Greek waters but also from the Mediterranean where the species is presumably unrecorded due to its similarity with *Megabalanus tintinnabulum* (Polychronidis *et al*., in Siokou et al., 2013).

***Meliceros hathor*** (Burkenroad, 1959)

*Melicertus hathor* lives in shallow marine and estuarine waters (down to 40 meters) on sandy-mud bottoms. The species was first found in the coasts of Israel (Eastern Mediterranean) in 1997 and after that in South Turkey. Three individuals (two males and one female) were caught from a sandy bottom of 10–20 cm by a brail net from the Agios Savvas area, Kastellorizo island, SW Aegean Sea in August 2012. This is the first record for *M. hathor* from the Greek Aegean Sea (Kapiris & Dogrammatzi, in Siokou *et al*., 2013)

***Sertularia marginata*** (Kirchenpauer, 1864)

This species is a circumtropical and subtropical hydroid species that has an uncertain type locality. S*ertularia marginata* has been detected in estuaries and anthropogenic habitats in the Alboran Sea (Western Mediterranean) and along the Atlantic coast of the Strait of Gibraltar. It was collected in 1990 in Paros Island but reported in 2013 by González-Duarte *et al*. (2013). Due to its limited dispersion capacity and the history of its records, the observations provided by González-Duarte *et al*. (2013) support the hypothesis of an introduction and spread by anthropogenic vectors.

***Xanthias lamarcki*** (H. Milne Edwards, 1834)

A single specimen of *Xanthias lamarckii* was collected in March 2013 from the shallow waters of Chtenia, a rocky islet near Rhodes Island, southeastern Aegean Sea. The occurrence of this Indo-West Pacific species is reported for the first time in Mediterranean waters. The vector of introduction of *X. lamarckii* is unknown so far, waiting for future information on establishment and spread of the species in its new environment.

## Previous Sightings

## Range expansions

### Establishment success

*Alepes djebada* from questionable to established: Kriti, Golani *et al*., 2013.

*Callinectes sapidus*: established in the Ionian Sea: Karachle in Bilecenoglu *et al*., 2013.

| SPECIES NAME | COLLECTION DATE | LOCATION | SOURCE |
|---|---|---|---|
| *Alepes djedaba* | 09/10/2013 | port of Heraklion | Golani et al., 2013 |
| *Amphistegina lobifera* | 01/07/2012 | Alykanas bay, Zakinthos isl. | Triantaphyllou & Dimiza in Siokou et al., 2013 |
| *Aplysia dactylomela* | 30/07/2012 | Elafonisos, Lakonia | Pirkenseer, 2013 |
| *Aplysia dactylomela* | 18/08/2012 | Kriti isl, Saronikos | Zenetos et al., 2013 |
| *Asparagopsis taxiformis* | Jun-08 | Andros, Chora Androu | Tsiamis et al., 2013 |
| *Atherinomorus forskalii* | 22/08/2012 | Kapsali, Kythira isl. | Zenetos et al., 2013 |
| *Balanus trigonus* | 40,422 | Salamina , Skaramangas | Polychronides et al in Siokou et al., 2013 |
| *Brachidontes pharaonis* | 40,928 | Kriti isl, Saronikos | Zenetos et al., 2013 |
| *Callinectes sapidus* | 10/07/2012 | Peristera isl, Chalkidiki | Zenetos et al., 2013 |
| *Callinectes sapidus* | 41,548 | Corfu isl., Antinioti Lagoon | Karachle, 2013 in Bilecenoglu et al., 2013 |
| *Callionymus filamentosus* | 25/08/2012 | Kythira isl- Kapsali | Zenetos et al., 2013 |
| *Cassiopea andromeda* | 11/08/2012 | Paralia Monastiri, Poros isl. | Zenetos et al., 2013 |
| *Caulerpa racemosa var. cylindracea* | 41,456 | Kriti isl.- Gramvousa | Katsanevakis in Bilecenoglu et al., 2013 |
| *Caulerpa racemosa var. cylindracea* | 10/09/2012 | Skyros isl | Zenetos et al., 2013 |
| *Caulerpa racemosa var. cylindracea* | Jun-08 | Andros, Korthi | Tsiamis et al., 2013 |

| | | | |
|---|---|---|---|
| *Caulerpa racemosa var. cylindracea* | Mar-13 | Argostoli, Kephallonia | Panayotidis & Tsiamis, 2013 |
| *Caulerpa racemosa var. cylindracea* | Mar-13 | Paxoi | Panayotidis & Tsiamis, 2013 |
| *Caulerpa racemosa var. cylindracea* | May-13 | Korithos, Korinthiakos Gulf | Panayotidis & Tsiamis, 2013 |
| *Caulerpa racemosa var. cylindracea* | May-13 | Kyllini, Peloponnisos | Panayotidis & Tsiamis, 2013 |
| *Caulerpa racemosa var. cylindracea* | May-13 | Gytheio, Lakonikos | Panayotidis & Tsiamis, 2013 |
| *Caulerpa racemosa var. cylindracea* | Jun-13 | Glyfa, Evoia straights | Panayotidis & Tsiamis, 2013 |
| *Caulerpa racemosa var. cylindracea* | Jun-13 | Mathraki, Othonoi | Panayotidis & Tsiamis, 2013 |
| *Caulerpa racemosa var. cylindracea* | Jun-13 | Agios Ioannis, Maliakos Gulf | Panayotidis & Tsiamis, 2013 |
| *Centropages furcatus* | | NE Aegean | Siokou et al., 2013 MMS |
| *Chama asperella* | 01/09/2010 | Skaramangas, Saronikos Gulf | Polychronides et al in Siokou et al., 2013 |
| *Chama pacifica* | 2011 | Fokia Bay (Karpathos Island) | Crocetta & Russo, 2013 |
| *Codium fragile* | Jun-08 | Andros, Chora Androu | Tsiamis et al., 2013 |
| *Colpomenia peregrina* | Jun-08 | Andros, Chora Androu | Tsiamis et al., 2013 |
| *Conomurex persicus* | 01/07/2013 | Kriti isl.- Lazareta, Stavroa | Katsanevakis in Bilecenoglu et al., 2013 |
| *Cucurbitula cymbium* | 01/09/2010 | Skaramangas, Saronikos Gulf | Siokou et al., 2013 MMS |
| *Cylichnina girardi* | 15/05/2012 | Anavyssos, Saronikos | Zenetos et al., 2013 |
| *Dendostrea frons* | 08/06/2012 | Agia Marina, Saronikos | Zenetos et al., 2013 |
| *Fistularia commersonii* | 10/10/2011 | Gialova, Pylos/ Palaiochora, Chania | Zenetos et al., 2013 |
| *Fulvia fragis* | Dec. 2010 | Palioura, Thermaikos | Manousis et al., 2013 |
| *Ganonema farinosum* | 01/07/2013 | Kriti isl.: Iligas Lazareta, Marathi, Souda | Katsanevakis in Bilecenoglu et al., 2013 |
| *Halophila stipulacea* | 10/09/2012 | Skyros isl. - Kalamitsa | Zenetos et al., 2013 |
| *Halophila stipulacea* | Mar-13 | Paxoi | Gerakaris & Tsiamis, 2013 |
| *Lagocephalus sceleratus* | 08/08/2012 | many places | Zenetos et al., 2013 |
| *Lophocladia lallemandii* | 10/08/2010 | Lentas, S. Heraklion | Zenetos et al., 2013 |
| *Megabalanus tintinnabulum* | 40,422 | Salamina Naval Base, Skaramangas | Polychronides et al in Siokou et al., 2013 |
| *Melibe viridis* | 23/10/2012 | Kastelli, Chania | Zenetos et al., 2013 |
| *Percnon gibbesi* | 40,391 | Epidauros, Agia Roumeli, Chania, Kythira isl., Palaiochora, Gialova | Zenetos et al., 2013 |

| | | | |
|---|---|---|---|
| *Percnon gibbesi* | July-August 2012 | Elafonissos, Lakonia | Pirkenseer, 2013 |
| *Pinctada imbricata radiata* | 20/11/2012 | Kriti isl: Elounda, Lasithi, Andros isl | Zenetos et al., 2013 |
| *Pinctada imbricata radiata* | 01/07/2013 | Kriti isl.- Achlia, Stavros | Katsanevakis in Bilecenoglu et al., 2013 |
| *Polydora cornuta* | 9.2.2012 | Saronikos Gulf | Radashevsky & Selifonova, 2013 |
| *Pteragogus pelycus* | Aug-10 | Epidauros, Argolikos | Zenetos et al., 2013 |
| *Sargocenton rubrum* | 12/11/2012 | Kitries, Mesiniakos | Zenetos et al., 2013 |
| *Septifer cumingii* | 12/06/2010 | Lagonisi, Saronikos | Zenetos et al., 2013 |
| *Siganus luridus* | 03/08/2012 | Poros isl. , Kythira, Skyros isl, Andros isl., Donousa isl., Kriti isl | Zenetos et al., 2013 |
| *Siganus luridus* | 01/07/2013 | Kriti isl. | Katsanevakis in Bilecenoglu et al., 2013 |
| *Siganus rivulatus* | 10/08/2010 | Kriti isl - Palaiochora | Zenetos et al., 2013 |
| *Siganus rivulatus* | 01/07/2013 | Kriti isl. | Katsanevakis in Bilecenoglu et al., 2013 |
| *Smaragdia souverbiana* | 01/11/2012 | Kalamaki, Korithiakos | Zenetos et al., 2013 |
| *Sphyraena chrysotaenia/pinguis* | 01/07/2013 | Kriti isl. | Katsanevakis in Bilecenoglu et al., 2013 |
| *Stypopodium schimperi* | Jun-08 | Andros, Korthi | Tsiamis et al., 2013 |
| *Stypopodium schimperi* | 21/06/2012 | Donousa isl. - Kedros | Zenetos et al., 2013 |

### Invasive in the Ionian

***Callinectes sapidus* Rathbun, 1896**

The species is well established and commercially exploited in the Aegean Sea. Following sparse records in the Ionian in 2011-12, an established population was detected in a lagoon at N Corfu isl. (Karachle in Bilecenoglu *et al.*, 2013). According to local fishers that exploit the lagoon, the presence of the species dates back to the late 2000's, whereas its exploitation has a history of only a couple of years. The fisheries production of the species is rather low (approximately 5-7 kg per day). This production is being distributed to the local market, since the species has also "invaded" the local cuisine and is being used in the preparation of traditional fish-dishes (e.g. bourdeto, pastitsada).

***Lagocephalus sceleratus* (Gmelin, 1788)**

The species is invasive in the Aegean sea reaching as north as Thermaikos Gulf. Following a 2009 record in the SW Peloponnesos (ELNAIS), the 2012-13 records (Zenetos *et al.*, 2013) indicate that the species is established and has an invasive behavior in the Greek Ionian Sea.

Sightings/records

General information

(Add links and references)

## 5. Meetings

7th to 9th October 2013: "**Mediterranean marine biodiversity in view of climate change and the invasion of alien species**" Held in the premises of "Thalassocosmos", Heraklion, Crete, Greece. The conference was organized by the Institute of Marine Biology, Biotechnology and Aquaculture (IMBBC) of the Hellenic Centre for Marine Research (HCMR) in the context of the EU (FP7-REGPOT-2010-1) project "Supporting Research Potential for Marine Biodiversity and Genomics in the Eastern Mediterranean" (MARBIGEN, http://www.marbigen.org/).

### Future meetings

COST1209 training school: to be held in Rhodes 9-11 April 2014. Organized by HCMR.

COST1209 WG meeting on pathways: Rhodes 8-11 April 2014.

### Association with EASIN

In November 2012, the Ellenic Network on Aquatic Invasive Species (ELNAIS), joined EASIN. Overall, the tools provided by EASIN can greatly aid scientists and policy-makers in obtaining high quality information on marine alien species in Greece, Maps can be produced by EASIN to show differences in patterns of distribution in Greece for the most abundant Phyla of marine alien species - Mollusca, Arthropoda, Chordata and Annelida. Katsanevakis *et al*., (2013) showed that the two main pathways of introduction of marine alien species (Lessepsian migration and Shipping) are related to different patterns of species spatial distribution in Greece.

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## 3.10 Ireland

Compiled by Dan Minchin, Marine Organism Investigations and Francis O'Beirn, Marine Institute

### Overview:

Ireland will have had a joint co-operative programme with Northern Ireland dealing with non-indigenous species 'invasive species Ireland'. The contracts for this joint work have terminated and much of the continued biodiversity is undertaken now by the biodiversity centre (http://www.biodiversityireland.ie/) part of this cross border cooperation will have involved a marina and shore survey of the north coast of Ireland and in Carlingford Lough (http://www.doeni.gov.uk/niea/marina_report_final.pdf). This last study has revealed two NIS not previously known in Ireland, *Undaria pinnatifida* and *Perophora japonica* and four further species to this part of the island of Ireland. The bryozoan *Bugula fulva*, was new to the Republic of Ireland and *Bugula neritina*, *Watersipora subtorquata* and the carpet tunicate *Didemnum vexillum* to Northern Ireland. There were thirty-five new range extensions since a survey in 2006.

Within transitional and inland water the expansion of the Asian clam *Corbicula fluminea* is of some concern with high densities, locally forming ~19,000 m2 (J Caffrey,pers. comm.) occurring in one estuarine region. This species is now known from five localities . No further records of the Chinese mitten crab *Eriocheir sinensis* have been reported.

### Regulations:

Comments relating to fifteen separate points (Appendix 1) were provided to the state agencies and to the World Conservation Union Proposal following the distribution of the Regulation of the European Parliament and of the Council on the prevention and management of the introduction and spread of invasive alien species Brussels 9.9.2013 COM(2013) 620 final 2013/0307 (COD) {SWD(2013) 321 final} {SWD(2013) 322 final} {SWD(2013) 323 final} English version.

## Unintentional:

### Algae:

The sporophytes of the brown alga *Undaria pinnatifida* were found attached to a marina in Belfast Lough in 2012. In the following year there were many small plants. The red alga *Gracilaria vermiculophylla* continues to spread with large accumulations on one shore. *Heterosiphonia japonica* seasonally forms extensive local cover on the lower shore in Strangford Lough.

### Invertebrates:

The Asian clam *Corbicula fluminea* has now been rcorded from five separate sites in Ireland. In one river estuary densities of up to 19000/m2 have been recorded, elsewhere densities of 3000/m2 are known. The native mysid *Mysis salemaai* was found to migrate inshore to shallows in winter and was found together with the bloody-red shrimp *Hemimysis anomala* and there are concerns that the invasive shrimp may have an impact on native mysid populations.

The amphipod *Chelcorophium curvispinum* is now abundant in the lower Shannon and may be transported on the hulls of leisure craft and C*rangonyx pseudogracilis* is abundant on Irelands largest river, the Shannon and *Gammarus tigrinus* is common in Shannon lakes. Native amphipods are less often found.

*Bugula neritina* and *Watersipora subtorquata* were new to Northern Ireland. *Bugula fulva* was new to the Republic of Ireland. New localities were found for the tunicates *Styela clava, Corella eumyota*, *Botrylloides violaceus* and several new records were obtained for cryptogens: *Bugula simplex, B. fulva* (bryozoans); *Monocorophium acherusicum*, *M. insidiosum* and *M. sextonae* (amphipods) and *Cordylophora caspia* (hydroid). There were thirty five new locality records since 2006. Notable has been the range expansion of the southern hemisphere *C. eumyota* to five further marinas since the last study.

### Vertebrates:

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## Appendix 1

Comments on the Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the prevention and management of the introduction and spread of invasive alien species Brussels

9.9.2013 COM(2013) 620 final 2013/0307 (COD)

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[by Dan Minchin and Sergej Olenin]

2013-09-29

| | |
|---|---|
| Page 7, para. 1 | The number of alien species indicated in the document is based on findings of the EU FP6 project DAISIE with data up to 2008. In fact, this number is greater now in the end of 2013. For example in the marine environment alone nearly 40 new aliens to Europe have been recorded in the up-to-date information system AquaNIS developed in the framework of the FP7 project VECTORS (www.corpi.ku.lt/databases/aquanis ). |
| Page 8, para. 4 | Suggest: delete unnecessary phrase '…as far as possible…' because 'as appropriate' covers the situation. |
| Page 9, para 10 | The list of 'such invasive alien species' (IAS) should be based on scientifically sound risk assessment procedures according to their potential to spread and have adverse impact. It should not be a permanent list, as species may be added or removed according the best information available. For example, the species can be removed on the basis of successful management or/and as a result of changing environmental conditions which reduce their adverse impacts. Also the potential invaders to Europe should be considered. This list should be regularly updated.<br><br>The risk assessment procedure should be used to define which MS are unlikely to be affected, and such MS should not be required to take actions. For example, the impacting Mediterranean thermophilic IAS are unlikely to be of the consequence in Subarctic areas of EU.<br><br>The list should not be based on a quota (e.g. 3%), it should based on scientific screening. |
| Page 9, para 11 | See comment to Page 9, para 10 |
| Page 10, para 13 | Species should not be mentioned in the document but rather should be indicated in the Annex |
| Page 10, | We agree with this point but it should be brought forward before |

| | |
|---|---|
| para 14 | paragraph 10 (page 9). |
| Page 11, para 20 | The International Council for the Exploration of the Sea Code of Practice on the introductions and transfers of marine organisms (Copenhagen, 2005) should be included. |
| Page 12, para 21 | The definition of 'targeted and general surveys' should be either included in tot the Article 3. 'Definitions' or explained in Article 12 'Surveillance system'. |
| Page 14, para 32 | This paragraph is difficult to understand. Does this mean that those cultivating (or ranching) will be required to cease trading with selected aquaculture products? |
| Page 16, para 10 | It should make clear what a pathway and vector is, because there is often confusion of these terms:<br>A pathway is the route an alien species takes to enter or spread through a non-native ecosystem (e.g. vessels). Each pathway may have a number of vectors.<br>A vector is a transfer mechanizm and is the physical means by which species are transported from one geographic region to another. More than one vector within a pathway may be involved in a transfer of species. |
| Page 16, para 2(a) | Within EU there are different biogeographical regions, both terrestrial and marine. Therefore a species which is native in one bioregion may be alien to another should it be introduced there. For example the Ponto-Caspian aquatic fauna (native to MS Bulgaria or Romania) are of consequence to other European bioregions. The management decision should be based on bioregions rather than on the territory of the entire EU. |
| Page 17, para 2(a) | The list should not be based on any predefined number of IAS. See comment to Page 9, para 10. |
| Page 28, Article 20 | The information support is crucial to implementation of the "Regulation…" and therefore the requirements for the information system should be more explicitly indicated in this Article. |
| Pages 32-33 | Duration and estimated financial impact is disproportionally small in relation to the annual IAS costs in EU. Attendance to meeting of MS representatives will not solve the problem. Sufficient financial support should be foreseen for development and maintenance of the scientifically sound information system, from which risk assessments of target IAS can be derived. |
| Page 34 Footnote 25 | A centralized EU-wide information system should contain the legally binding list of target IAS. The information to produce and regularly update such a list should be drawn down from specialized databases which cover specific environments and/or taxonomic groups. Such databases are more able to explicitly record appearances of new alien |

species, their impacts, pathways of introduction, environmental tolerance limits, etc. Such databases should be harmonized and linked to the central EU information system.

## 3.10 Israel

By Bella S. Galil, National Institute of Oceanography, Haifa

### Highlights

Eleven marine alien species were newly reported from the 180 kms long Mediterranean coast of Israel. These include 4 molluscs: *Elysia grandifolia*, *Pseudorhaphitoma iodolabiata*, *Monotygma watsoni*, *Cylichna villersii*; 4 decapod crustaceans: *Lucifer hanseni*, *Matuta victor*, *Saron marmoratus*, *Actaea savignii*; 3 fish: *Vanderhorstia mertensi*, *Gymnothorax reticularis*, *Parupeneus forsskali*. Eight of the species are new records for the Mediterranean Sea, undelining the need for closely monitoring the southeast Levantine Sea for incoming thermophilic Erythraean aliens. The population of *Cheilodipterus novemstriatus*, first recorded in 2010, is undergoing rapid expansion.

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

-

### 2. Intentional introductions

No intentional introductions were reported in Israeli coastal waters in recent years.

### 3. Unintentional introductions

New Sightings

#### Mollusca

The alien sacoglossan opisthobranch ***Elysia grandifolia*** Kelaart, 1858**,** first recorded in the Levantine basin, eastern Mediterranean Sea, in 2001, has established a flourishing population along the Mediterranean coast of Israel. In August 2012 large numbers were observed on bryopsidacean-covered rocky outcrops off the central Mediterranean coast of Israel, 32.414526N, 34.8687E. Pairs of specimens and clusters of several individuals with extended penes may be copulatory aggregations. The records from Israel, Lebanon and Turkey confirm that a self-sustaining population of *E. grandifolia* exists in the Levantine Basin of the Mediterranean Sea (Pasternak & Galil, 2012).

A live juvenile specimen of the mangeliid gastropod ***Pseudorhaphitoma iodolabiata*** (Hornung and Mermod, 1928) was noted off the Mediterranean coast of Israel on

April 25, 2010, outside the port of Haifa, 32°51′09″N, 35°01′23″E, at depth of 20.5 m. The genus is known from the tropical and subtropical Indo west Pacific, and has not been hitherto represented in the Mediterranean Sea. The species was described by Hornung and Mermod (1928) from Massaua in the southern Red Sea. The occurrence of this Red Sea endemic raises the number of alien mollusc species recorded off the Israeli coast to 137 (Bogi & Galil, 2012).

Several specimens of ***Monotygma watsoni*** (Hornung & Mermod, 1927), a minute parasitic pyramidellid gastropod is newly were recorded in the Mediterranean Sea from specimens collected in 2011 and 2012 off Haifa and palmahim (Israel). The species matches the

three syntypes of *Ceratia watsoni* collected in the southern Red Sea. It is the fourteenth Erythraean alien pyramidellid species recorded in the Levantine Basin. The large populations of a great number of Erythraean aliens in the Levantine Basin may serve as reservoir hosts for pyramidellids, many of which seem to be parasitic generalizts, and may be introduced to native Mediterranean hosts (Bogi & Galil, 2013a).

***Cylichna villersii*** (Audouin, 1826), a minute 'bubble snail' was newly recorded in the Mediterranean Sea from specimens recently collected along the Israeli coastline (Ashdod, Sorek, Hadera, Haifa Bay). The earliest specimens of *C. villersii* collected in the Mediterranean date back to 1999. These were initially mistaken for juvenile *C. cylindracea*. Recent benthic samples from Soreq have a much increased number of specimens, from 1-4 per 0.11 $m^2$ in October 2008, to as many as 37 per 0.11 $m^2$ four years later. The type specimens have been collected in Suez (Pallary, 1926), and subsequently in the Great Bitter Lake, Suez Canal (Hoenselaar & Dekker, 1998). It is the eighth Erythraean alien cephalaspideid species recorded in the Levantine Basin. The recent collection of many living specimens in several continuously sampled locations attests to the speed of its establishment in the SE Levant (Bogi & Galil, 2013b).

### Crustacea

Specimens of **Lucifer hanseni** Nobili, 1905 were obtained along the Mediterranean coast of Israel (off Herzlia, Ashdod, Maagan Michael) between 2008-2011. A single specimen collected in 1924 from Port Said harbour, Egypt, was hitherto the only record of the species in the Mediterranean Sea. The number of specimens in the recent records, as well as the presence of mature males and females does indicate that the species is now likely established in the southeastern Mediterranean. As one of the locations where the species was recently collected had been sampled by the same means, biannually, for the past 22 years, it is likely that the sudden appearance of the species results from a recent invasion through the Suez Canal (De Grave et al 2012).

Specimens of ***Matuta victor*** (Fabricius, 1781) were collected in Haifa Bay, Israel in fall 2012 and in 2013. Moon crabs are carnivorous and facultative scavengers, their diet composed primarily of crustaceans and molluscs, with smaller individuals feeding on smaller, softer-shelled species, whereas large size classes prey on shelled sessile or slow-moving species such as anomurans, bivalves and gastropods (Perez and Bellwood 1988). As a predator of slow-moving benthic invertebrates, *M. victor* may influence the abundance and distribution of its prey items were it to achieve numerical abundance in Levantine sandy shores (Galil & Mendelson, 2012).

***Saron marmoratus*** (Olivier, 1811), a colourful Indo-Pacific 'marble shrimp', is newly recorded in the Mediterranean Sea from specimens photographed off Nahariya, Israel, 33°02.032'N 35°04.261'E, 20 July 2013 (Rothman et al 2013). The species is widely distributed in the Indo-Pacific, from the Red Sea and eastern Africa to Australia, French Polynesia and Hawaii. In its native habitat the species is one of the most common forms of the indowest-pacific coral reefs, found on coarse coral rubble or under rocks. A territorial predator, nocturnal in its habits, it shelters in crevices during the day and forages for prey at night. "Marble shrimps" are hardy and attractive crustaceans, popular among aquarists for their ornamental coloration. However, given the species' presence in the Red Sea, the Gulf of Suez, and the length of its zoeal stage, it is suggested that it entered the Mediterranean through the Suez Canal, as have nearly four-fifths of the alien crustaceans in the Mediterranean Sea (Galil, 2011).

***Actaea savignii*** (H. Milne Edwards, 1834) was recently collected off Israel and Turkey. A single adult specimen was collected in Haifa Bay, Israel, 32°49'55.20"N 34°58'1.20"E, in 2010, and two specimens were captured off Mersin, Turkey, 36°11'36.80"N 33°45'55.37"E, in 2011. Repeatedly reported from the Suez Canal since 1924, the species has not been previously recorded in the Mediterranean. Considering the findings at well removed localities of the small and cryptic species, it is likely the species has already been established along the entire Levantine coast (Karhan et al 2013).

### Fish

The Indo-Pacific gobiid fish ***Vanderhorstia mertensi*** Klausewitz, 1974, was found in Haifa Bay, Israel, 032854.632N 035801.034E, depth 30 m, on 18 November 2012. The species was previously reported from the Mediterranean coast of Turkey. Like its cogeners, *V. mertensi* is an obligate symbiot with alpheid shrimps, sharing a burrow maintained by the shrimp and guarded by the fish. Its presence verifies the status of *V. mertensi* as an Erythraean alien. The rare specimen may suggest that the Israeli gobiid population is small as its habitat lies in heavily disturbed bottom-trawled grounds (Goren et al 2013).

A single specimen of ***Gymnothorax reticularis*** Bloch, 1795 was captured by a commercial bottom-trawl vessel off off Rosh Hanikra, Israel, 33°02' N, 35°04' E, 60 m, in January 2013 (Stern & Goren 2013). Comparison with the single Red Sea record indicate that the newly reported specimen most likely originated in the Red Sea and entered the Mediterranean via the Suez Canal. This is the first report of an Indo-Pacific moray eel in the Mediterranean Sea.

The Red Sea goatfish, ***Parupeneus forsskali*** (Fourmanoir & Gueze, 1976) was collected for the first time off the Mediterranean coast of Israel. This finding, in addition to another specimen reported recently from Lebanon and numerous observations by underwater divers, strongly suggests that this species has established a population in the eastern Mediterranean (Sonin et al 2013).http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=8998963 - aff3#aff3

## Previous sightings

### Fish

In June 2010, two specimens of the cardinal fish ***Cheilodipterus novemstriatus*** (Rüppell, 1838) was collected by divers at shipwreck off Tel Aviv, 32°05'24"N, 34°45'32"E, at a depth of 30 m (Goren et al 2010). The species is known from the Red Sea, Gulf of Oman, and Persian Gulf. It is the fifth Erythraean alien apogonid fish recorded off the Israeli coastline. In October 2012, a school numbering hundreds of adult specimens was photographed off Rosh HaNikra, 34°04.144N; 35°05.561E (Rothman et al 2012). Recently, Bariche and Azzurro (2012) reported the species north of Beirut, Lebanon. These findings confirm the presence of an established population of the species along the Levantine coast of the Mediterranean Sea.

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## 3.12 Italy[1]

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### Overview:

Three new species of algae and three invertebrates have been recorded in Italian marine waters. Information on already established alien species, including macroalgae, invertebrate and fish NIS is given.

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

The Institute for Environmental Protection and Research (ISPRA), appointed by the Italian Ministry of the Environment, is coordinating the activities within the Marine Strategy Framework Directive (MSFD) of the European Union. Italy complied with the art 8,9, and 10 of the MSFD and is now planning the monitoring activities (art. 12) in other to fill the information gaps identified in the Initial Assessment and to make good environmental status (GES) and Target Indicators operative within 2018. The initial assessment, the determination of GES and environmental targets for the Descriptor 2 (Non-indigenous species) were carried out by ISPRA with the collaboration of several Italian research Institutes.

### 2. Intentional introduction

No new intentional introductions have been reported.

[1] **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 2013.

# 3. Unintentional introduction

## New Sightings

### Algae & higher plants

*Grateloupia minima*, a red alga, was found in the Mar Piccolo di Taranto in March 2010 (Cecere et al., 2011). It was found in 2008 in the Thau Lagoon (France). The species is widely distributed in the

Northeast Atlantic Ocean from Portugal to southern England and its presence in two Mediterranean lagoons where shellfish trade is very active, clearly indicates aquaculture as the most likely vector of introduction. aquaculture. The green alga *Uronema marinum* was recorded in the lagoon of Venice, the lagoons and ponds of the Po Delta and in the brackish water basin called Pialassa della Baiona in Emilia-Romagna. *U. marinum* was identified for the first time in the summer of 2012, although it has been present since at least 2008. This species, originally described in South Australia and Western Australia and probably imported with the Manila clam *Tapes philippinarum,* is prevalently associated with the thalli of other introduced species, *Agardhiella subulata* and *Gracilaria vermiculophylla*, which also have a Pacific origin and have recently colonized the same lagoon areas (Sfriso et al., 2014).

The red alga *Grateloupia yinggehaiensis* was collected in May 2008 in the central part of the lagoon of Venice near the Fusina thermoelectric power plant where water temperature is 3-4°C higher than in all the other lagoon areas. However, it was identified only in 2012 by molecular analyses (Wolf et al., 2013). This species is native of the tropical area of the Province of Hainan (China) and was probably imported with the Manila clam *Tapes philippinarum*. In 2008, scattered thalli of *G. yinggehaiensis* colonized the borders of the tidal lands close to Malamocco -Marghera Canals. In 2013large populations were present all around the area directly influenced by the power plant.

### Invertebrates

A new Scyphozoan, *Pelagia benovici* sp. nov., has been described in the Mediterranean Sea (North Adriatic) based on morphological and molecular (COI and 28S) analyses of specimens from several localities in the Gulf of Venice. The species appeared in mid-September 2013 with a large outbreak, and persisted for several months. Given the numerous marine biological stations in the Adriatic Sea, the long history of investigations on gelatinous zooplankton in the area, and the increasing attention on jellyfish blooms in recent years, it is highly unlikely that *P. benovici* remained unnoticed until 2013. Most probably, *P. benovici* was transported as viable jellyfish in the ballast waters of ships coming from the native area of this species, where it remains still undetected.

Another Scyphozoan medusa, *Cassiopea andromeda,* has been recorded in 2013 in the Gulf of Palermo - Sicily (Gravili pers. comm.) This is the second record of the species in the Central Mediterranean , after the finding in 2009 in Malta (Schembri et al., 2010).

The anthurid isopod *Paranthura japonica,* new to the Mediterranean Sea has been observed in samples from three localities along the Italian coast: the Lagoon of Venice (North Adriatic Sea), La Spezia (Ligurian Sea) and Olbia (Sardinia, Tyrrhenian Sea) (Marchini et al., 2014). The authors suggest that the presence of this Pacific isopod in several regions of coastal Europe might be due to aquaculture-mediated introduction events that occurred during the last decades of the 1900s. Since then, established populations of *P. japonica*, probably confused with other anthurid species, remained unnoticed for a long time.

### Previous Sightings

#### Algae & higher plants

A slender form of *Caulerpa,* morphologically different from *C.taxifolia,* has been identified as an Australian endemic green alga, *Caulerpa distichophylla,* along the coasts of Sicily. However,

genetic data do not provide undisputed evidence that the species are distinct. Jongma et al. (2012) therefore propose a new combination *Caulerpa taxifolia* var. *disticophylla.* Field observations and sampling were performed in February 2008 by scuba diving at a depth of 3 m in Punta Braccetto (Ragusa province), located just west of the southern tip of Sicily (36°48′ N, 14°27′ E). The strain introduced in Sicily is identical with the "*C. taxifolia* " reported by Cevik et al. (2007) from the Gulf of Iskenderun (Turkey), and both populations are probably the result of introduction events from southwestern Australia.

The growth and autoecology of two alien invasive species, *Sargassum muticum* and *Undaria pinnatifida* spreading in the Venice Lagoon, were studied monthly over one year, in two sites at different depths (Sfriso et al., 2013). *U. pinnatifida* prefers eutrophic areas and is not present along the sea coastline. Its total standing crop does not exceed 0.2 ktonnes fwt for all the Venice Lagoon. Conversely, *S. muticum* colonizes areas with a lower eutrophication level, such as the lagoon inlets, reaching a total lagoon standing crop of 4–6 ktonnes fwt.

Three alien macrophytes, *Ascophyllum nodosum*, *Colpomenia peregrina* and *Polysiphonia morrowii*, have been reported for the first time from the Mar Piccolo of Taranto (Ionian Sea). Two other species, *Agardhiella subulata* and *Codium fragile* subsp. *fragile* that had not been, or had only sporadically been detected in the basin since their first record in 1987 and 2002, respectively, were also recorded. In the Mar Piccolo, an enclosed coastal inlet near the port of Taranto, a close link is apparent between the establishment of alien species and the regular import of shellfish for direct sale (Petrocelli et al., 2013). *Agardhiella subulata* was also found at Capo Peloro (Sicily) (Manghisi et al., 2010).

The seagrass *Halophila stipulacea* underwent a progressive decline since 2007 when recorded at Palinuro (Tyrrhenian coast near Salerno) until a complete disappearance in 2011. The decline coincided with the construction of the artificial rocky reef, which has probably reduced water circulation (Gambi and Barbieri, 2013).

#### Invertebrates

The Hydrozoan *Clytia hummelincki* is well established along the coast of Apulia (south Adriatic) since 2008: in 2013, permanent populations were found in two localities of the Salento Peninsula: Torre Lapillo e Santa Caterina (Martell-Hernandez et al., 2013).

The tropical calcareous sponge *Paraleucilla magna,* previously found only in Southern Italy, was recorded in the Ligurian Sea at Portofino Promontory, Paraggi, Pontetto (Eastern Liguria) and Arenzano, Varazze (Western Liguria) and Lago di Faro (Sicily, Messina) (Bertolino et al., 2013). Its introduction in the Ligurian locations is likely to be attributed to the transfer of mussel stocks from farming facilities located in Taranto (Apulia).

The first observations on the reproductive biology of the polychaete *Branchiomma bairdi* in the Mediterranean Sea are provided by Arias et al. (2013) as well as additional Mediterranean records of the species, which can help us to understand its introduction and spread. Re-examination of the specimens from Miseno harbour (Tyrrhenian Sea, Italy) revealed the presence of *B. bairdi* in the central-Mediterranean since September 2004. Its expansion to several Mediterranean localities (new localities documented are: the Maltese Islands, Miseno, Ischia and Brindisi), is largely a consequence of this species' capability of colonizing extremely different habitats and substrata, the occurrence of sexual and asexual reproductive strategies, and the combination of both. Furthermore, *B. bairdi* appears to be particularly abundant in confined and degraded areas. Finally, the Authors suggest that the pathway of introduction in the Mediterranean, previously hypothesized as the Suez Canal, is most likely to be via the Strait of Gibraltar.

The amphipod *Caprella scaura* was recorded in three Tyrrhenian lagoons along the coasts of Sardinia (Santa Gilla) and Latium (Fogliano and Caprolace). It was very abundant only in Sardinia in October 2010 (Cabiddu et al., 2013). Other locations where *C. scaura* has been found are: Livorno, Civitavecchia and Palermo, all of which are in the Tyrrhenian Sea (Ros et al., 2014). The life-history traits of *C. scaura* were investigated in the Mar Piccolo basin (southern Italy, Ionian Sea), over a one-year period (Prato et al., 2013).

A survey was carried out seasonally over a yearly cycle using crab traps, in the two coastal lakes in Apulia, Aquatina (Adriatic Sea) and Torre Colimena (Ionian Sea), giving rise to a quantitative analysis of spatial-temporal variations in abundance and other biological characteristics (body size, sex ratio, fecundity) of *Callinectes sapidus* (Mancinelli et al., 2013).

A study by Lodola et al. (2013) provided information on the distribution and abundance of the invasive pearl oyster *Pinctada imbricata radiata* in the Sicilian Channel (Marine protected area of Linosa Island).

The invasive mussel *Brachidontes pharaonis*, which has been shown to be capable of outcompeting native organisms for space and resources along Sicilian shores, was used as a model species for a bioenergetics study by Sarà et al (2013a). Specimens used in the laboratory experiments were collected from the Ettore Pond of Stagnone di Marsala (Trapani, Western Sicily; 37° 52′ N,12°28′ E), where a very abundant population is established. The Authors performed a validation exercise that compared life-history traits as obtained by Dynamic Energy Budget (DEB), model - implemented with parameters obtained using classical laboratory methods - with the actual set of species traits obtained in the field. Correspondence between the two approaches was very high with respect to estimating both size and fitness. The results demonstrate a good agreement between field data and model output for the effect of temperature and food density on age–size curve, maximum body size and total gamete production per lifespan. The DEB approach was subsequently adopted (Sarà et al., 2013b) for an assessment of how the physical environment affects the potential distribution of *B. pharaonis.* The examination of 26 sites throughout the central Mediterranean Sea, in intertidal and subtidal situations, combined with models of larval dispersal enabled the Authors to provide estimates of the likelihood that this invasive species will become established.

The finding of *Haminoea japonica* from Sabaudia Lake (a brackish pond of Latium) enlarges the distribution of this species, which has completely replaced populations of other native *Haminoea* species (Crocetta et al., 2013).

### Fish

No information

### Species not yet seen

The alien Erythraean jellyfish *Rhopilema nomadica* was first recorded in Tunisian waters (Gulf of Gabes) in 2008. Subsequently it was sighted in the Bizerte Channel and Gulf of Tunis where it has been regularly observed since 2010 during the summer and autumn months (Dali Yahia et al., 2013).

An established population of the polychaetous annelid *Perinereis linea* was reported for the first

time outside its native distribution range (NW Pacific), in the Mar Menor lagoon (Spain) via the importation of live fishing-bait (Arias, 2013).

A single adult female specimen of the Northern brown shrimp, *Farfantepenaeus aztecus*, a species native to the western Atlantic coasts, was caught in Boka Kotorska Bay (southern Adriatic Sea) in September 2013. This is the first record of this alien species in the Adriatic Sea (Marković et al., 2014).

The solitary ascidian *Herdmania momus*, an Indo-Pacific species that has been introduced into the Mediterranean Sea via the Suez Canal over the last century, has so far been restricted to the Levantine region. It has been recorded in the Maltese Islands in June 2013 (Evans et al., 2013).

### Natural range expanding species

In this section we list a few species that have been recorded in Italy, but are not included in the Italian list of NIS, since they probably enter the Mediterranean Sea through the Gibraltar Strait, without direct human intervention. The large size species, belonging to the fish, cephalopod mollusc and decapod crustacean fauna, are sometimes called vagrant species.

The quotation of Meloni et al. (2012) concerning the diamondback squid (*Thysanoteuthis rhombus*) included in the last report is incorrect, since the species must be considered native to the Mediterranean.

Two specimens of the Azorean rockling *Gaidropsarus granti* (Regan 1903) were caught in the period August 1989–January 1990, on a seamount located about 29 nautical miles south of Genoa, Ligurian Sea. The records remained unpublished because of errors in the literature concerning the two Macaronesian species *Gaidropsarus granti* and *Gaidropsarus guttatus*. On the basis of the analysis of the few records of this deep-water benthic species, it is not possible to resolve if : i) Mediterranean specimens are not native or ii) if Mediterranean specimens are part of the Mediterranean fauna but have been concealed till now by their remote habitat (Relini-Orsi e Relini, 2013).

An additional record of the scorpion fish *Pontinus kuhlii* has been reported from Maltese waters (Castriota and Deidun , 2014) . It is a widely distributed eastern Atlantic fish, occurring in the Lusitanian and Mauretanian regions. In the Mediterranean Sea, after the first finding off Sicily at the end of 1800, it was recorded in the 20$^{th}$ century twice in Spain and more recently (2005) in Sardinia.

## 4. Pathogens

No new information

## 5. Meetings and research projects

The National Interuniversity Consortium For Marine Sciences, known with the acronym of CoNISMa, is performing a project financed by ISPRA (Italian Agency for the protection and the Research on the Environment). Several experts and data providers are gathering and organizing the existing knowledge and data on NIS abundance and impacts. Up to now, a proposal for environmental targets and the development of an Early Warning System in the area at high risk of introduction of NIS (ports, aquaculture sites, etc) have been released. The proposal for indicators for GES evaluation, taking into account both the presence (abundance and distribution) of NIS and their impacts, including ad hoc monitoring activities to be continued until 2018, is being prepared.

A discussion on the occurrence of non indigenous species of Hydrozoans can be found in the paper by Gravili et al. (2013). The state of knowledge of the alien marine Mollusca in Italy has been reviewed and updated by Crocetta et al (2013).

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## 3.13 Lithuania

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### Highlights

No new intentional NIS introductions recorded in 2013. One new NIS species recorded, most probably spreading from the neighboring Kaliningrad area. Monitoring of marine NIS is included into a proposal for the renewed National Monitoring Program for the Marine Strategy Framework Directive.

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

No new national regulations concerning introductions to marine environment since 2010.

Lithuania completed initial assessment for D2 non-indigenous species for the Marine Strategy Framework Directive, based on all D2 indicators proposed by EC regulation on criteria and methodological standards on good environmental status of marine waters (2010/477/EU): accumulative number of NIS, ratio between NIS and native species and Biopollution index.

### 2. Intentional introductions

*Acipenser ruhenus*

An advisory council on Invasive species control under the Environmental Protection Agency has approved the proposal to reintroduce the sterlet sturgeon *Acipenser ruhenus* L. to Nemunas river (upstream of Kaunas Hydropower Station). The proposal comes from Belorussian authorities (Protocol 2014). Earlier there were attempts to introduce this species to Nemunas, from where has spread to the Curonian Lagoon, however population did not established (Virbickas, 2000).

## 3. Unintentional introductions

*Rangia cuneata* – found in the Lithuanian coastal zone

The estuarine clam *R. cuneata* was first found in the Lithuanian coastal waters at the depth of 13-14 m: one specimen at station 7 (near Nida, E 20,9550, N 55,3116) and another one at station 6 (near Juodkrantė, E 21,07833, N 55,5583) (Solovjeva 2014). In this area near bottom salinity is rather stable (ca. 7‰) and mean temperature ranges from 1,8°C in winter to 18,8°C in summer. Earlier the species was recorded in 2010 in the Russian part of the Vistula Lagoon (Rudinskaya and Gusev, 2012) and later in the open part of the sea (Gusev, pers. comm.).

*Neogobius melanostomus*

The round goby *Neogobius melanostomus* is still spreading further from the Klaipeda port area, both inside the Curonian Lagoon and northward along the mainland coast. A comprehensive study addresses the role of this species in the trophic network of the Curonian Lagoon (Rakauskas et al. 2013). The species is being used commercially, price at the local fish market (Klaipeda) is about 1 – 1,5 EUR / kilo.

## 5. Meetings and projects

### Meetings

IV International Symposium ALIEN SPECIES IN HOLARCTIC. 2013.09.23-27. Borok, Russia.

- Anastasija Zaiko et al. Aquatic invasive species and biotic indices: a fake evidence of water quality improvement?
- Aleksas Narščius et al. The information system on aquatic non-indigenous species (AquaNIS).
- Sergej Olenin et al. Biogeographical regions defined by aquatic non- indigenous species assemblages and pathways of introduction.
- Dan Minchin et al. The cold route: alien biota spread to and via Arctic seas

Baltic Sea Science Congress New Horizons for Baltic Sea Science 26-30 August, 2013 Klaipėda, Lithuania

- S. Olenin & A. Narščius. Biogeography of Baltic Neobiota at Pan-European and regional scales
- G. Narvilas and R. Jankauskienė. Role of the round goby (*Neogobius melanostomus*) in the diet of piscivorous fish
- E. Šidagytė, K. Arbačiauskas, J. Lesutienė and Z. R. Gasiunaitė. Relating species richness of peracarida, ecosystem productivity and trophic niche of Ponto-Caspian mysid and amphipod in native and invaded areas.

Workshop on Needs for further research to support improved and more efficient monitoring programmes under MSFD. 2013.05.12-13. DG RTD, Brussels, Belgium

- S. Olenin. MSFD D2. Non-indigenous species.

Workshop on Identification of research needs with regard to the pressures and their impacts on marine ecosystems under MSFD. STAGES project. 2013.09.4-5. Rome, Italy.

- S. Olenin. MSFD D2. Non-indigenous species.

**Projects:**

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

The project addresses a complex array of vectors effecting marine life, biodiversity, sectorial interests, and uses of regional seas. The Lithuanian team (KUCORPI) is developing AquaNIS, an information system on aquatic non-indigenous species of Europe and neighboring areas.

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

The project aims at improving understanding of human activities impacts (cumulative, synergistic, antagonistic) and variations due to climate change on marine biodiversity, using long-term series (pelagic and benthic). A major aim is to test the indicators proposed by the EC, and develop new ones for assessment at species, habitats and ecosystems level, for the status classification of marine waters, integrating the indicators into a unified assessment of the biodiversity and the cost-effective implementation of the indicators (i.e. by defining monitoring and assessment strategies). 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 mechanizms by synthesis of new methods (2012 -2014). Dr. R. Paškauskas <ricardas.paskauskas@botanika.lt>
- DREISENA - The role of invasive zebra mussel on functioning of aquatic ecosystems and water quality (2012 -2014). Prof. A. Razinkovas-Baziukas <art@corpi.ku.lt>

## 6. References and bibliography

### Cited literature

Protocol 2014. Invazinių rūšių kontrolės tarybos protokolas. 2014-02-27, Nr. 14-1-7

Virbickas J. 2000. Fish of Lithuania. Vilnius, 192p.

Solovjeva S., 2014. Finding of new mollusc species Rangia cuneata (G.B.Sowerby I, 1831) (Bivalvia: Mactridae) in the Lithuanian coastal waters. Environmental Protection Agency, Lithuania. http://gamta.lt/cms/index?rubricId=d42d35cd-63cd-4800-9cfd-86ef9f305dac (in Lithuanian)

Rakauskas, V., Pūtys, Ž., Dainys, J., Lesutienė, J., Ložpys, L., Arbačiauskas, K. 2013. Increasing population of the invader round goby, *Neogobius melanostomus* (Actinopterygii: Perciformes: Gobiidae), and its trophic role in the curonian lagoon, se baltic sea. acta ichthyologica et piscatoria (2013) 43 (2): 95–108 doi: 10.3750/aip2013.43.2.02

### 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 2013 national report)

Lesutienė J., Arbačiauskas K., Gasiūnaitė Z.. Feeding strategies and elemental composition in Ponto-Caspian peracaridans from contrasting environments: can stoichiometric plasticity promote invasion success? // Freshwater Biology. – 2013, Blackwell Publishing Ltd; Vol. 58, p. 1052-1068, ISSN 1365-2427, http://onlinelibrary.wiley.com/doi/10.1111/fwb.12108/pdf

Olenin S., Artioli Y., Galienne Ch., Holt J., Wakelin S., Butenschon M., Schrum C., Daewel U., Pushpadas D., Cannaby H., Salihoglu B., Zavatarelli M., Clementi E., Allen I. Invasive species: an increasing threat to marine ecosystems under climate change? // Geophysical Research Abstracts. – 2013, EGU General Assembly, Vol. 15, EGU2013-13075

Olenin S., Narščius A., Minchin D., David M., Galil B., Gollasch S., Marchini A., Occhipinti-Ambrogi A., Ojaveer H., Zaiko A.. Making non-indigenous species information systems practical for management and useful for research: An aquatic perspective // Biological Conservation. – 2013, Elsevier; Vol. ?, p. 1-10, ISSN 0006-3207, http://dx.doi.org/10.1046/j.biocon.2013.07.040

Olenina I., Kownacka J., Edler L., Gromisz S., Lotocka M., Ostrowska M., Piwosz K. Non-indigenous species Chaetoceros cf. lorenzianus Grunow 1863 – A new, predominant component of autumn phytoplankton in the southern Baltic Sea // Estuarine, Coastal and Shelf Science. – 2013, Elsevier; Vol. 119, p. 101-111, ISSN 0272-7714.

Rakauskas, V., Pūtys, Ž., Dainys, J., Lesutienė, J., Ložpys, L., Arbačiauskas, K. 2013. Increasing population of the invader round goby, *Neogobius melanostomus* (Actinopterygii: Perciformes: Gobiidae), and its trophic role in the curonian lagoon, se Baltic Sea. aCta Ichthyologica et Piscatoria (2013) 43 (2): 95–108 doi: 10.3750/aip2013.43.2.02

## 3.14 Netherlands

Prepared by A.C. Sneekes, IMARES Wageningen UR

### Overview:

It was reported that Japanese oysters collected in Wadden Sea area in the summer of 2012 were infected with the oyster Herpesvirus OsHV-1 μvar. This virus appears to be responsible for an increased juvenile mortality on Japanese oysters. As Japanese oysters are an important species for aquaculture in the Netherlands further research on the effects caused by the virus could be important.

### 1. Regulations

The Netherlands (via BuRO-TIE, "Team Invasieve Exoten") is using the database NOBANIS since 2008 and exchanges information and data on new exotic species via meetings and directly into the database. However, it is uncertain if the database will continue to exist. This will depend on initiatives that might be started as a result of the new EU regulation on invasive species. Since 1 Januari 2009 the 'Team Invasieve Exoten', TIE, has been created as part of the Dutch Food and Consumer Product Safety Authority (NVWA) and contributes to the implementation of national policy on invasive species. TIE predominantly focuses on invasive species that cause damage to the natural environment, but also to possible negative effects on public health, economy and security. Main activities of TIE include:

- Advisor for the Ministry of Economic Affairs
- Carry out or to have carried out risk assessments and monitoring
- Communication of risks to individuals, land managers, water boards and businesses.

The team strives for an optimal cooperation on international level and takes part in relevant conferences, symposia or workshops nationally and internationally.

### Policy mussel transition

The main purpose of the transition in the mussel industry is that not-intertidal mussel beds in the Wadden Sea are given the opportunity to develop in accordance with Natura 2000 objectives, while the mussel sector can continue to produce undisturbed. In cooperation with industry and environmental organizations, the Ministry of EL&I developed a policy that mussel transports Eastern Scheldt estuary under certain conditions is possible, taking into account the negative impact of invasive alien species ('problem species').

## 2. Intentional:

Synthesis of introductions

Add websites for more details rather than summarizing the amounts etc., e.g. amounts , live imports and exports (to the extent possible). The amount seems to be difficult to obtain in some countries.

## 3. Unintentional:

### New Sightings

General information

Faasse, M, 2013. The North American ostracod Eusarsiella zostericola (Cushman, 1906)

arrives in mainland Europe. BioInvasions Records (2013) Volume 2, Issue 1: 47–50.

http://dx.doi.org/10.3391/bir.2013.2.1.08.

*In sediment samples collected in the Oosterschelde, a marine embayment in the southwest of The Netherlands (southern North Sea), nine specimens of a non-native myodocopid ostracod were found. The ostracods were identifed as the North American species* Eusarsiella zostericola *(Cushman, 1906), previously introduced to southeastern England, probably with imported American oysters.*

### Previous Sightings

Species lists

Range expansions

Faasse, M, 2013. Further dispersal of the sea-spider *Ammothea hilgendorfi* (Böhm, 1879) in the North Sea to The Netherlands. BioInvasions Records (2013) Volume 2, Issue 4: 287–289. http://dx.doi.org/10.3391/bir.2013.2.4.04

*The Pacific brown-banded sea-spider* Ammothea hilgendorfi *has been introduced to Venice (Mediterranean Sea: 1979–1981) and south England (NE-Atlantic: 1978). From the Channel Coast of south England it has spread to the southern North Sea Coast (Blackwater Estuary, Essex). The paper reports further dispersal across the North Sea to the Atlantic coast of the European continent.*

Gittenberger, A., Schrieken, N., Coolen, J.W.P. & E. Gittenberger, 2013. Shipwrecks, ascidians and *Modiolarca subpicta* (Bivalvia, Mytilidae, Musculinae). Basteria 77(4-6): 75-82.

*A large population of* Modiolarca subpicta *is reported upon from a shipwreck in the Dutch part of the Brown Ridge in the central North Sea, where it occurs within individuals of the solitary sea-squirt* Ascidiella aspersa. *This species is not considered to be non-native, but is rarely detected in monitoring.*

*The ovulid gastropod* Xandarovula patula *(Pennant, 1777) was found 14.vi.2011 on the soft coral* Alcyonium digitatum *Linnaeus, 1758 (Dead man's fingers) during a dive in the central North Sea on the wreck 'Jeanette Kristina' on the Dutch Dogger Bank. Later on additional specimens were found, sometimes with egg-capsules, on* A. digitatum *again, at two locations on the Dutch Cleaver Bank. The species has previously been recorded from the Atlantic coast of southern Spain to the western end of The English Channel, with scattered records from the west coasts of Ireland and Britain, as far north as the Orkney's. More recently it has been reported from most Irish coasts, several parts of the Scottish coast and also from some places in the North Sea. We here present the first record of* X. patula *for the Dutch part of the continental shelf. The specimens and their egg-capsules from both the Dogger Bank and Cleaver Bank, indicate that this species is autochthonous in the central North Sea.*

### Nederlandse Faunistische mededelingen

The journal Nederlandse Faunistische Mededelingen ('Dutch Faunistic Notes') publishes papers and short communications on Dutch invertebrates. Volume 41 (2013) was a special issue completely dedicated to the biodiversity of the Dutch part of the North Sea (Oases of marine biodiversity in the North Sea). https://science.naturalis.nl/en/research/publications/nederlandse-faunistische-mededelingen/#nfm41. This volume includes several relevant papers and where possible a summary is given.

Faasse M.A., G.W.N.M. van Moorsel & D. Tempelman 2013. Moss animals of the Dutch part of the North Sea and coastal waters of the Netherlands (Bryozoa). p 1-14

Tempelman D., G.W.N.M. van Moorsel & M.A. Faasse 2013. De molkreeften *Upogebia deltaura* en *U. stellata* en geassocieerde soorten in de Noordzee (Decapoda: Upogebiidae). p15-29

Lewis W. & A. Gittenberger 2013. First record of a settled stomatopod *Platysquilla eusebia* in the North Sea (Malacostraca: Stomatopoda). p31-34

This paper describes the discovery of a settled juvenile specimen of the stomatopod *Platysquilla eusebia* on the Dutch part of the Dogger Bank in the central North Sea. This is the northernmost record in Europe. The species is native to the Mediterranean and to the Atlantic coast from Portugal up to France. Further investigations have to show if the species already forms populations this far north. As the planktonic stages of P. eusebia have already been recorded in prior years, the establishment of the species should not be a problem, providing the circumstances are favourable.

Gittenberger A., N. Schrieken, J.W.P. Coolen & W. Vlierhuis 2013. The juwel anemone *Corynactis viridis*, a new order for the Netherlands (Cnidaria: Corallimorpharia). p35-41

During an expedition with scuba-divers to the Dutch part of the Brown Ridge in the central North Sea in June 2013, two colonies of the jewel anemone Corynactis viridis were found on the wreck Anna Graebe. With the jewel anemone both a new species and a new animal order, the *Corallimorpharia*, are added to the autochthonous fauna of the Netherlands. This species typically occurs in the Mediterranean and along the Atlantic coast from Portugal and the west British Isles up to Shetland. As other records of settled colonies of *C. viridis* in the North Sea were recently reported from Belgian, German and English waters, it is concluded that the jewel anemone, which used to be known as an occasional visitor, should now be considered autochthonous in the North Sea.

Faasse M.A. & A.H.M. Ligthart 2013. De zeepissebed *Uromunna spec*, de eerste waarneming van de familie Munnidae in Nederland (Isopoda). P43-47

Species has been categorized as 2c Exoot: incidentele voortplanting (non-native: incidental reproduction). Species was introduced by man and was able to maintain for less than 10 years (via reproduction).

Lengkeek W., J.W.P. Coolen, A. Gittenberger & N. Schrieken 2013. Ecological relevance of shipwrecks in the North Sea. p49-57

This paper reports on observations made during wreck dive expeditions in 2010-2012, in order to investigate the ecological relevance of shipwrecks on the Dutch Continental Shelf (DCS). Shipwrecks are biodiversity hot spots. The number of species recorded on shipwrecks is similar to the number of species found in soft bottoms of the entire DCS. The soft substrata, however, represent a vastly larger habitat on the DCS than the shipwrecks. Among many other taxa, juvenile and large Atlantic cod, linear skeleton shrimp, goldsinny wrasses and leopard spotted gobies were found in the shipwreck habitats. The presence of these important species and their absence from many other habitats, illustrate that shipwrecks function as key habitats, nurseries, and refugia that are rare or absent anywhere else in the Netherlands. Several non-indigenous species were identified including the titan acorn barnacle *Megabalanus coccopoma*, the acorn barnacle *Balanus perforatus*, the Australasian barnacle *Elminius modestus*, the slipper limpet *Crepidula fornicata*, the Pacific oyster *Crassostrea gigas*, the skeleton shrimp *Caprella mutica*, the small crustacean *Jassa marmorata*, and the marine splash midge *Telmatogeton japonicus*.

Bouma S. & W. Lengkeek 2013. Benthic communities on hard substrata within the first Dutch offshore wind farm (OWEZ). p59-67

This paper is a result of a report: Benthic communities on hard substrata of the offshore wind farm Egmond aan Zee (OWEZ). Including results of samples collected in scour holes. report nr. OWEZ_R_266_T1_20120206_hard_substrata. The report describes results from two surveys and gives a comparison of the 2008 and 2011 surveys and shows similarities and differences in the occurrence of non-indigenous species.

The skeleton shrimp and *Jassa marmorata* were the most abundant non-indigenous species both in 2008 and 2011. No differences in the abundances of these species were found between surveys;

Barnacles were most numerous in the intertidal zone and the shallow subtidal zone. The Australasian barnacle was only found in 2011, but in general no clear differences between the abundances of non-indigenous barnacles in 2008 and 2011 were found;

Pacific oysters were more abundant and larger in 2011 than they were in 2008;

The hairy crab was common both in 2008 and 2011. This species was found on all monopiles in all surveys except for the survey carried out at turbine 13 in February 2008;

The slipper limpet occurred in small numbers both in 2008 and 2011;

The marine splash midge was only found in 2011, not in 2008.

Schrieken N., A. Gittenberger, J.W.P. Coolen & W. Lengkeek 2013. Marine fauna of hard substrata of the Cleaver bank and Dogger bank. p69-78

As most of the seabed in the Dutch part of the North Sea consists of sand, marine fauna that live in association with hard substrata are rarely monitored. Results of a species inventory in June 2011 done by scuba-diving while focusing on a wreck on the Dogger Bank and on rocky bottoms on the Cleaver Bank was reported. This resulted in various new records of species for the Dutch part of the North Sea. This result appeared for a large part linked to the added value of monitoring with scuba-divers.

### Not Seen Species Yet

General Information

Species lists

## 4. Pathogens

Sightings/records

General information

Gittenberger, A. & M. Engelsma, 2013. Oesterherpesvirus OdHV-1 µvar in de Waddenzee. GiMaRIS rapport 2013.04: 10 pp. i.o.v. de Producentenorganisatie van de Nederlandse Mosselcultuur. http://www.gimaris.com/Gimaris_2013_04_oesterherpes.pdf

Research shows that Japanese oysters in the Wadden Sea are infected with Oyster Herpesvirus OsHV-1 µvar. In the Wadden Sea, a UNESCO World Heritage site, young Japanese oysters were collected in the summer of 2012. When tested for the presence of DNA of the OsHV three of the five examined spots proved to be infected. This implies that the virus has settled in the Wadden Sea. Oyster Herpesvirus OsHV-1 µvar was first discovered in Europe in 2008. Since then it appears this virus is responsible for an increased juvenile mortality among young Japanese oysters along the French, English and Irish coasts. The EU advises to take measures to stop further spread of this virus. With the measures the following methods of spread should also be taken into account: shellfish transports, oysters attached to ships, infected oyster larvae in the ocean currents along the European coast. OsHV-1 herpesvirus µvar was found in the Netherlands for the first time in 2010 in the Zeeland Delta; an increased juvenile mortality was seen. How and when the virus was introduced into the Wadden Sea is not known. The oyster herpesvirus can only be detected by DNA testing. Previously the presence of this virus in the Wadden Sea was not investigated, so further research is needed to find out to which extent the virus causes increased mortality among the oysters in the Wadden Sea. The only host for Oyster Herpesvirus is the Japanese oyster. People are not susceptible to the virus, so there is no risk to the public health. (http://www.wageningenur.nl/en/show/Oyster-Herpesvirus-in-Wadden-Sea-the-Netherlands.htm). NOTE: Specific coordinates are not described in the report. However, sample locations are presented in a graph.

## 5. Meetings

The 18th International Conference on Aquatic Invasive Species hosted by Invasive Species Centre (Niagara Falls, Ontario, Canada, April 21-25, 2013) http://www.icais.org/

Non-indigenous species in the Northeast Atlantic (Ostend, Belgium, 20-22 November 2013) http://www.ilvo.vlaanderen.be/NISconference2013

## 6. References and bibliography

### Websites that collect data on non-indigenous species (and used in the Netherlands):

https://www.vwa.nl/onderwerpen/ongewenste-uitheemse-planten/dossier/invasieve-exoten/team-invasieve-exoten

http://www.nobanis.org

http://www.nederlandsesoorten.nl/

http://www.werkgroepexoten.nl/experts.php

### Peer-reviewed or equivalent reports that include ecology, changes in invasive status, etc., unsubstantiated reports are not acceptable (or at a minimum should be noted).

Faasse, M, 2013. Further dispersal of the sea-spider *Ammothea hilgendorfi* (Böhm, 1879) in the North Sea to The Netherlands. BioInvasions Records (2013) Volume 2, Issue 4: 287–289. http://dx.doi.org/10.3391/bir.2013.2.4.04

Faasse, M, 2013. The North American ostracod *Eusarsiella zostericola* (Cushman, 1906) arrives in mainland Europe. BioInvasions Records (2013) Volume 2, Issue 1: 47–50. http://dx.doi.org/10.3391/bir.2013.2.1.08.

Gittenberger, A., Schrieken, N., Coolen, J.W.P. & E. Gittenberger, 2013. Shipwrecks, ascidians and *Modiolarca subpicta* (Bivalvia, Mytilidae, Musculinae). Basteria 77(4-6): 75-82.

Gittenberger, A. & M. Engelsma, 2013. Oesterherpesvirus OdHV-1 μvar in de Waddenzee. GiMaRIS rapport 2013.04: 10 pp. i.o.v. de Producentenorganisatie van de Nederlandse Mosselcultuur. http://www.gimaris.com/Gimaris_2013_04_oesterherpes.pdf

Gittenberger, A. & H. Stegenga, 2013. Risico analyse van uitheemse soorten in de exportgebieden voor Zuid - Noord transporten van de Oosterschelde naar de Waddenzee. ADDENDUM. GiMaRIS rapport 2013.03: 8 pp. i.o.v. Producentenorganisatie van de Nederlandse Mosselcultuur.

Gittenberger, A., 2013. Trend indicator for non-indigenous species. GiMaRIS report 2013.01:15 pp. Issued by RWS Waterdienst, Ministry of Transportation and Water Management, Den Haag, The Netherlands.

Lengkeek, W., Coolen, J., Gittenberger, A. & Schrieken, N., 2013. Ecological relevance of shipwrecks in the North Sea. Nederlandse Faunistische Mededelingen 41: 49-57.

Lewis, W. & A. Gittenberger, 2013. First record of a settled stomatopod *Platysquilla eusebia* in the North Sea (Malacostraca: Stomatopoda). Nederlandse Faunistische Mededelingen 41: 31-34.

Schrieken, N., Gittenberger, A., Coolen, J. & Lengkeek, W., 2013. Marine fauna of hard substrata of the Cleaver Bank and Dogger Bank. Nederlandse Faunistische Mededelingen 41: 69-78.

## 3.15 Norway

Report prepared by Anders Jelmert, IMR, with contributions from A.-L. Agnalt and J. Sundet, IMR.

### Highlights

- No new NIS to Norwegian waters has been reported. Several species have expanded range slightly, and some new sites have been discovered within the known range (*Styela clava, Crassostrea gigas)*
- *Crassostrea gigas*: Rapid growth in 2012-2013. A reef has formed where cold winters have reduced the population previously.
- *Chionoecetes opilio:* No final genetic clarification of the origin of the Snowcrab (It has previously been established that there is a significant genetic distance from the Canada/Greenland stock) (Dale et al., 2013). 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).
- *Paralithodes camtschaticus:* King crab stock still smaller than the peak in 2008,
- (Hjelset et al., 2012), but the estimate for 2013 is slightly larger than for 2012 (0.98 mill ind.,vs.0.8 mill ind., respectively)
- *Homarus americanus*: Six lobsters with suspicious phenotype have been analysed. Two of them were confirmed to be American lobster.

### 1. Regulations:

No new regulations.

### 2. Intentional introductions:

No new alien species (*proper)* having intentionally being introduced, has been reported. Within Norway there is quite widespread translocation of several wrasse species in the aquaculture industry (employed for biological de-lousing of salmon). The species are fished in SE Norway and translocated to W and Middle Norway. Results are in the pipeline, but currently no complete clarification of eventual differences in regional components in the genetically structure of the populations of the various wrasse species. An update on the use of wrasse species as cleaner fish in the salmon industry in "Hardangerfjorden", (Skifesvik et al. 2014) has been published.

### 3. Unintentional:

New sightings

Now new records have been recorded

(From 2012-Reoport):

| | |
|---|---|
| | N 59 14.06 E 10 25.49 |
| | N 59 15.06 E 10 25.81 |
| Gracillaria vermiculophylla | N 59 9.02 E 10 25.49 |
| Husa et al., 2012 | |

A study on findings in BW sampling the Risks of unintentionally introductions with shipping activities to Svalbard has been published (Ware et al. 2014)

### General information:

Further information on the previously reported hybrid of **Lobster hybrid H. americanus(fe) x H. homarus (m):**

2010: Some 10700 larvae hatched

2013: 83 surviving hybrids

- Size range 5-15 cm total length
- Approx 60% have deformities / physical abberations
- Will be kept until eventual fertility can be determined
- No new information on fertility in 2013

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

### Previous Sightings.

### Range expansions:

More observation of Mnemiopsis leidyi in 2013 compared to 2012.(SE Coast of Norway).

Snow Crab: *Chionoecetes opilio.* First observed in Russian sector 1996, 2004 in Norwegian EEZ. Slowly increasing in Norwegian waters, but the large expansion/ population increase takes place in Russian EEZ in the Barents Sea. The largest numbers pr nm trawling is found W of Novaja Semlja, the Central Bank and the Goose Bank. The snow crab appears to spread northward and westward expansion.

Snow crab prefer colder water than red king crab (typically 3-4 °C). Western distribution edge may even retract if the Barents Sea gets warmer. The standing stock biomass has now been estimated to more than 10 times the king crab SSB. As some stray specimens have been recorded close to Svalbard, the snow crab may populate Svalbard/Spitsbergen.

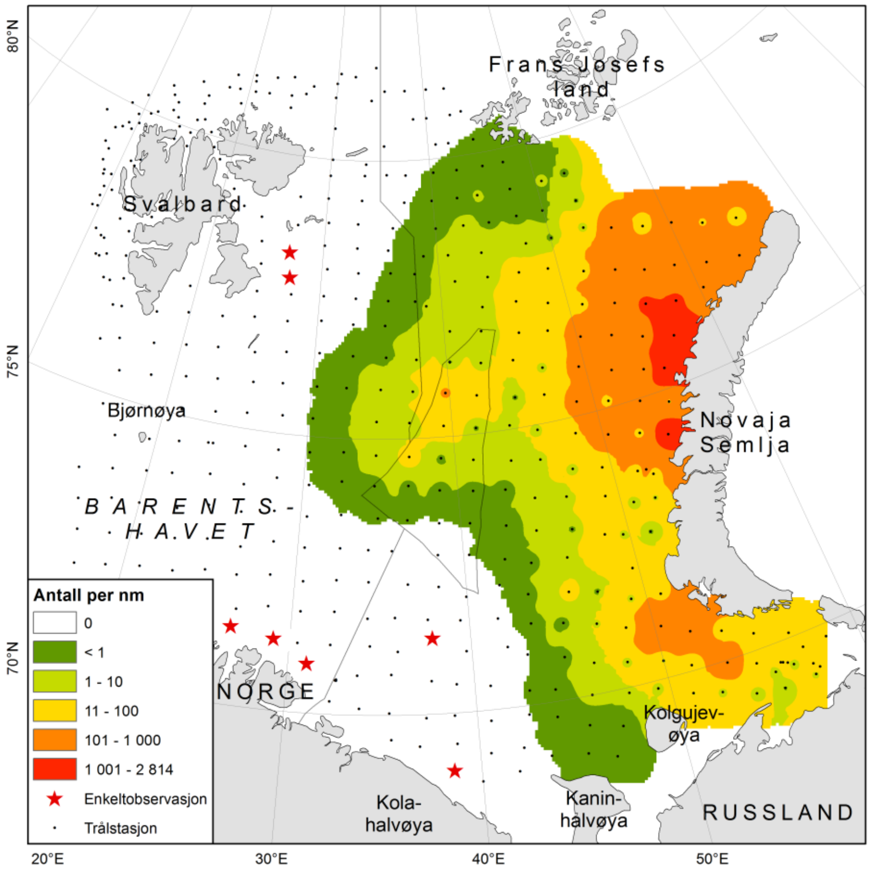


**Figure 1. Distribution of snow crab in the Barents Sea , 2013. Source.**[Jan.h.sundet@imr.no](mailto:Jan.h.sundet@imr.no)

***Pacific oyster,*** *Crassostrea gigas*. At a locality with previous significant reduction in numbers of individuals due to cold winters, new growth was observed in 2013. Densities between 50 and 100 ind/m² was for the first time observed qualifying for classification as a reef. (Bodvin et al. 2013, a,b). Samples for analysis in Denmark, Norway and Sweden (2sites for each country) have been collected, measured, fixed, and is preserved for analysis of parasite/diseases and genetics. Field survey in the Boknafjorden area close to Stavanger revealed scattered localities with small numbers, except in the Hafrsfjord. 58°56'58.8"N 5°54'23.5"E. See Bodvin et al. 2013b) (In Norwegian).

### Erradication programmes:

Pacific oyster, *Crassostrea gigas*: Not formally, but *de facto* in some areas in Arendal municipality

American lobster, *Homarus americanus:* Not formally established or regularly funded (!), but suspect specimen are collected by fishers and are genetically analysed at IMR.

The red king crab, *Paralithodes camtschaticus*: W of 26°E, there is a free fishery for king crab (intended as culling fishery). While other reasons cannot be ruled out, little spread to the SW have been observed

### Not Seen Species Yet:

No observations of *Didemnum vexillum*.

An inventory (littoral and sublittoral) in and nearby the ore exporting harbour Narvik, (68°25'40.7"N 17°23'38.8"E was finalized during summer 2013. No new NIS was recorded (neither range expansion of more southernly distributed NIS, nor new species to Norway. The Narvik harbour has been operating since the 1920ies, and current ballast water volumes is approximately 4 mill tons annually.

## 4. Pathogens

Nothing new to report

## 5. Meetings

Arctic Frontiers, Tromsø, Jan 19-24, 2013

## 6. References and useful literature.

Arctic Frontiers, 2013, Abstract book. file:///C:/Users/AndersJ/Downloads/2013%20Arctic_Frontiers_abstract_book%20(1).pdf

Torjan Bodvin, Frithjof Moy, Anders Jelmert, and Stein Mortensen, 2013. Annual repot on growth and density of Crassostrea gigas in 5 selected localities. (In Norwegian)

http://www.miljodirektoratet.no/Global/dokumenter/tema/hav_og_kyst/HI-rapp%2034-2013%20stillehavs%C3%B8sters.pdf

Geir Dahle,, Ann-Lisbeth Agnalt, Eva Farestveit, Knut Jørstad, Jean-Marie Sevigny, Eric Parent, and Sarah Hardy, 2013 Genetic analysis of snow crab (Chionocetes opilio) in the Barents Sea - where are we? Oral presentation at Arctic Frontiers, 2013

Hjelset, Ann Merete; Nilssen, Einar Magnus; Sundet, Jan Henry. Reduced size composition and fecundity related to fishery and invasion history in the introduced red king crab (Paralithodes camtschaticus) in Norwegian waters. Fisheries Research 2012; Volum 121. ISSN 0165-7836.s 73 - 80.s doi: 10.1016/j.fishres.2012.01.010.

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Rapid Coastal Surveys in Norwegian Waters. Poster *47th European Mar. Biol. Symposium*, Arendal, Norway, 3-7 September 2012

Anne Berit Skiftesvik, Geir Blom, Ann-Lisbeth Agnalt, Caroline M.F. Durif, Howard I. Browman, Reidun M. Bjelland, Lisbeth S. Harkestad, Eva Farestveit, Ole Ingar Paulsen, Merete Fauske, Trond Havelin, Knut Johnsen & Stein Mortensen (2014), Wrasse (Labridae) as cleaner fish in salmonid aquaculture – The Hardangerfjord as a case study, *Marine Biology Research*, 10:3, 289-300, DOI: 10.1080/17451000.2013.810760

Jan H. Sundet and Sergey Bakanev, 2013, Snow crab (*Chionoecetes opilio*) - stock status of the new invasive crab species in the Barents Sea. Oral presentation at the Arctic Frontiers Conference, Tromsø, 2013

Chris Ware, Jørgen Berge, Jan H. Sundet, Jamie B. Kirkpatrick, Ashley D. M. Coutts, Anders Jelmert, Steffen M. Olsen, Oliver Floerl, Mary S. Wisz and Inger G. Alsos

Climate change, non-indigenous species and shipping: assessing the risk of species introduction to a high-Arctic archipelago. *Diversity and Distributions*, Volume 20, Issue 1, pages 10–19, January 2014. Article first published online: 12 AUG 2013 | DOI: 10.1111/ddi.12117

## 3.16 Poland

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### Overview:

Reported in this work new sightings were published in 2013 and 2014, but were found earlier; only new parasites of the Eurasian otter *Lutra lutra* (Linnaeus, 1758) were found on May 2013, in northern Poland (the Elbląg River) (Rolbiecki & Izdebska 2014). These new parasites are: *Oswaldocruzia filiformis* (Goeze, 1782), the acanthocephalan *Acanthocephalus ranae* (Schrank, 1788) and the skin mite from the Demodecidae family. *Demodex sp.* is a new species to science, while *O. filiformis* and *A. ranae* are new parasites for the otter throughout the species range. The recorded helminths are typical parasites of amphibians and reptiles, and their occurrence in the Eurasian otter may result from postcyclic transmission from primary hosts.

### 1.Regulations:

There is no new legislation to report.

### 2. Intentional:

In 2013 deliberate releases of salmon (*Salmo salar*), sea trout (*Salmo trutta morpha trut ta*) and whitefish (*Coregonus lavaretus*) were conducted (Bartel & Kardela, in press).

### 3. Unintentional:

***Evadne anonyx*** G. O. Sars, 1897 (Crustacea, Cladocera) was recorded for the first time in Poland in the Gulf of Gdańsk in the summer of 2006 (Bielecka et al. 2014). Although the species was found at 10 out of 13 stations in rather low densities (not exceeding 6 indiv. m−3), all the developmental stages of *E. anonyx* were present (juveniles as well as adults – parthenogenetic females, gamogenetic females and males) in the plankton material investigated.

*E. anonyx* is an endemic species from the Ponto-Caspian basin (Mordukhai-Boltovskoi 1995). This marine species, originating from the tertiary period, occurs in shallow water plankton (Mordukhai-Boltovskoi 1995). The environmental preferences of *E. anonyx* from the Caspian Sea were described by Aladin (1995), who stated that the salinity and temperature tolerance ranges for *E. anonyx* were from 4 to as much as 30 PSU and from 11.4 to 26.4°C respectively. The author found that this species, which used to be more widespread, was forced to abandon the Aral Sea because of increasing salinity, and the Sea of Azov and Black Sea because of growing contamination. The first published report of *E. anonyx* in the Baltic Sea, from the Gulf of Finland, related to August 2004 (Litvinchuk 2005). According to Rodionova & Panov (2006), however, the first specimens of this species were found in the Primorsk oil terminal area in the Gulf of Finland four years earlier. This information was again corrected, this time by Põllupüü et al. (2008), who found that *E. anonyx* had been observed in the central Gulf of Finland (Tallinn Bay) as early as 1999.

***Echinogammarus trichiatus*** (Martynov, 1932) (Crustacea, Amphipoda) was recorded for the first time in Poland in the lower Oder River, in September 2012 (Rachalewski et a. 2013).

This species, recorded for the first time in Polish waters, was found in Gryfino, in the lowest section of the river. On this site, the newcomer seemed to establish a well developing population: 120 individuals (41 males, 68 females and 11 juveniles). Among the collected females, 27 had brood pouches filled with eggs and two with juveniles. It was determined the maximum sizes of females, males and juveniles as 13, 15 and 7 mm, respectively (Rachalewski et a. 2013).

*E. trichiatus* is indigenous to the basins of the Black Sea and Sea of Azov (Dedju 1967, 1980; Mordukhaj-Boltovskoj 1969). In the western part of the Pontic region it was recorded from the lowest Danube River and its delta, as well as from limans and coastal lakes in Bulgaria and Romania (Mordukhaj-Boltovskoj 1969). The history of its invasion in Europe has already been described by Boets et al. (2012). For the first time outside its native range *E. trichiatus* was found in 1996 in the German section of the Danube River (Weinzierl et al. 1997). Since that time its rapid invasion in Western Europe has been observed. Human-mediated transport most likely facilitated colonization of the upper Danube and Rhine, expanding its spread to adjacent waterways and further on to the east via the Mittelland Canal (Boets et al. 2012). In 2006 the species was found in the "Alte Spree" near Berlin-Spandau (Havel River catchment) and in the Lower-Havel-Waterway (Müller & Eggers 2006). The authors of these records stressed the high possibility that the species would spread eastwards into the Oder and Vistula Rivers' systems.

The most probable vector for the introduction of *E. trichatus* could once again be aquatic transportation. Martens & Grabow (2008) have already shown that *E. trichiatus* was present and could survive outside water for six days among zebra mussel colonies overgrowing the boats' sides. It is supposed that hull fouling could be a prominent vector for the spread of this amphipod invader. Some confusion has been associated with the species name. Cărăusu̯ (1943), apparently not aware of Martynov's (1932) work in which *Echinogammarus trichiatus* was described (as *Chaetogammarus trichiatus*), described *Chaetogammarus tenellus* subspecies *major* and distinguished it from *Ch. tenellus* subsp. *behningi* (Martynov 1919).

***Limnodrilus cervix*** Brinkhurst, 1963 (Annelida, Clitellata) was for the first time recorded in 2010 in the Polish part of the Vistula Lagoon, near the village of Piaski. The specimen of *L.cervix* was collected from the coastal zone, beyond the range of littoral plants on the sandy bottom at a depth of 1–1.5 m. The salinity in this part of the lagoon was 2.8 ± 0.74 PSU (the average for the study period). The oxygen content in the near-bottom water was high (10 ± 0.94 mg $O_2$ $dm^{-3}$ ) and the pH was 7.8. Length of chaetae varied from 57 to 63 μm. The number of chaetae in the anterior dorsal bundles 4–5, rarely 6; in the ventral bundles 3–4, sometimes 5. In the anterior segments their upper tooth was only slightly longer than the lower one, but distinctly thinner; in some segments around the clitellar zone and in the postclitellar region both teeth were very similar in length. The number of chaetae per bundle did not decrease posteriorly (3–5) (Dumnicka et al. 2014).

To date, North American oligochaeteous clitellates have not been found in the Baltic Sea, although they have been reported from brackish waters in the Netherlands (van Haaren & Soors 2013). Usually it is single specimens of Nearctic *Limnodrilus spp*. that have been found in rivers and canals situated near the seashore, especially close to large ports, which allows one to conjecture that they reached European water bodies in the ballast waters of transoceanic ships. Only Kennedy (1965) found abundant specimens of L. cervix in a number of canals in England and Wales; this gave rise to the interpretation that this species could become invasive. To VL L. cervix could have been transported along the European sea shore in small ships from the Netherlands or Belgium, which was the case with the North American species *Rangia cuneata* (Rudinskaya & Gusev 2012), found earlier in these countries. In the 20th century rapid transoceanic shipping enabled many species to cross the Atlantic Ocean, which is why monitoring the macroinvertebrate species composition is necessary, especially in water bodies situated near the seashore.

***Neogobius fluviatilis*** (Pallas, 1814) (Fish, Gobiidae) in the Vistula River estuaries was recorded in June and August 2007 in the middle of the Polish part of the Vistula Lagoon near Tolkmicko and in October 2010 and six times in 2011 (in May, July, August, September and October) in the Vistula Lagoon and in the Vistula River mouth (Gulf of Gdańsk). A total of 388 monkey gobies were reported. Total length (TL) ranged from 3.2 to 15.2 cm, depending on the survey (Lejk et al. 2013).

Earlier this species has been noted in Poland inland waters since the mid-1990s (Danilkiewicz 1996, 1998). So far, there has been no confirmed information of the presence or spread of this species in the Vistula river estuaries.

The monkey goby, *N. fluviatilis*, is common in the rivers entering the Black and Caspian seas as well as in the inshore waters of these basins (Kottelat and Freyhof 2007). The first monkey goby in Poland was collected in the Bug River in 1997 (Danilkiewicz 1998). Later, in 2002, it was noted in the Włocławek Dam Reservoir (Kostrzewa and Grabowski 2002). In 2003, it expanded its range to the Zegrzyński Reservoir (Kostrzewa et al. 2004). In 2003, it was reported in the Vistula River at Tczew and by 2007, *N. fluviatilis* had reached the Vistula outlet to the Baltic Sea (Grabowska et al. 2010). The species has invaded the southern (Piria et al. 2011) and western (van Kessel et al. 2009) regions of Europe. Since 1999, the round goby, *N. melanostomus*, has been reported in this region (Borowski, 1999), and has successfully colonized the Vistula Lagoon (Sapota, 2004). The monkey goby could repeat the settlement success of the round goby. Evidence to support this conclusion is provided by the range, abundance, and reproductive success of this species that was revealed in the current study. These introductions gobies raise questions on their future position in this ecosystem. Both species are highly adaptable (Wandzel 2003; Grabowska et al. 2009), and are capable of competing with indigenous ichthyofauna, especially with juvenile stages. It has also been demonstrated that invasive gobies can be vectors for new parasites (Mierzejewska et al. 2011). On the other hand, the round goby has become an important component of the diets of predatory fish and piscivorous birds. Investigations of the feed base of great cormorants (*Phalacrocorax carbo sinensis* Blumenbach, 1798) inhabiting the Puck Bay area indicate that a large share of their prey comprised round gobies (Bzoma 1998). This species is food component of fish such as cod, pikeperch, and pike (Psuty personal communication). It is assumed that the monkey goby will also be subject to this predation pressure. Evidence is lacking of any negative impact on the condition or abundance of flounder, which shows similar feeding preferences (Karlson et al. 2007). The monkey goby is an eurytopic species breeding in the brackish waters of the Vistula Lagoon, as has been confirmed by the current study, meaning that it is predisposed to inhabit nearly the entire transitional and coastal zones of Polish marine areas.

## 4. Pathogens:

The Eurasian otter *Lutra lutra* (Linnaeus, 1758) is a typical representative of carnivorous mammals from the family of mustelids (Mustelidae) which are closely connected with aquatic ecosystems. Currently, three species of parasites were found in one otter: the nematode ***Oswaldocruzia filiformis*** (Goeze 1782), the acanthocephalan ***Acanthocephalus ranae*** (Schrank 1788) and the skin mite from the Demodecidae family. ***Demodex sp.*** is a new species to science, while *O. filiformis* and *A. ranae* are new parasites for the otter throughout the species range. Furthermore, *A. ranae* was found for the first time in the otter from the area of Poland. The recorded helminths are typical parasites of amphibians and reptiles, and their occurrence in the Eurasian otter may result from postcyclic transmission from primary hosts (Rolbiecki & Izdebska 2014).

The Eurasian otter is a carnivorous mammal (Carnivora) from the Mustelidae family, which occurs throughout most of Europe, Asia, and North Africa. Although the species is rare in Poland, its range covers the whole country. It is an aquatic animal which occurs at the river banks, at the shores of ponds and lakes, but also at saline water bodies, including the Baltic coast (Mason & Macdonald 1986, Sikora 2004, Romanowski et al. 2011).

Only one otter was examined (female, weight: 3.9 kg, body length: 64.1 cm, tail length: 34.2 cm, hind foot length: 7.1 cm). It was a dead specimen found on May 2013, in northern Poland (the Elbląg River, 54°12′N/19°22′E).

One nematode *Oswaldocruzia filiformis* (Goeze, 1782) and one acanthocephalan *Acanthocephalus ranae* (Schrank, 1788) were found in the otter's stomach. A total of 16 *Demodex sp.* specimens were found in the examined skin samples from the head regions (vibrissae and eyelids) and legs. The average size of adults in this species is 221 μm in length and 37 μm in width.

Based on the analysis of morphoanatomic and morphometric traits, it has been determined that the specimens found belong to an unknown species, new to science, which needs to be described according to the criteria adopted in the taxonomy of Demodecidae. Since *O. filiformis* is a new parasite for the entire range of the Eurasian otter, and *A. ranae* was found for the first time in the otter from the area of Poland.

*Oswaldocruzia filiformis* female characteristic [measurements in mm]: body length 19.9, maximum width 0.27. Cephalic vesicle consists of two parts, the anterior part is 0.041 long and 0.063 wide, the posterior part is 0.057 long and 0.055 wide. Distance of the nerve ring from the anterior extremity is 0.156. The excretory pore situated 0.416 away from the anterior extremity. Narrow, lateral alae are present only along the oesophagus. Oesophagus 0.51 × 0.07. Vulva situated 6.9 away from the posterior extremity; distance between sphincters 0.19. Tail conical 0.30 length, with terminal spike 0.016 long. Eggs (measured n=10) 0.083 × 0.055 (0.055-0.094 × 0.051-0.059), SD 0.016 × 0.002 (Rolbiecki & Izdebska 2014).

*Acanthocephalus ranae* female characteristic [measurements in mm]: body length 20.12, maximum width 1.87, the anterior part of the trunk is widened, narrowing posteriorly. Proboscis 0.42 long and 0.23 wide (at the posterior end), 0.27 wide (at center) and 0.16 wide (at the anterior end); the anterior part is rounded with no hooks present; proboscis consists of 14 longitudinal rows, 4-5 hooks in each row. Length of hooks (counted at the anterior end of proboscis): first blade 0.067 (0.066-0.070), SD 0.002, second blade 0.069 (0.066-0.074), SD 0.003, third blade 0.071 (0.066-0.075), SD 0.004, fourth hooks 0.068 (0.066-0.070), SD 0.002, fifth blade 0.043 (0.039- 0.047), SD 0.004; well-developed roots, sometimes invisible (fifth hook situated at the base of the proboscis). If there are 5 hooks in a row, the fifth hook is always much smaller, undeveloped. Proboscis receptacle 0.80 long and 0.24 wide. Neck trapezoidal, 0.15 long, 0.30 wide (at the posterior end). Lemnisci 1.09, 1.09 long and 0.18, 0.15 wide. Eggs (measured n=10) 0.130 × 0.016 (0.073-0.161 × 0.015-0.018), SD 0.030 × 0.002 (Rolbiecki & Izdebska 2014).

## 5. Meetings:

Past year

**III Conference of Carp Breeders (Course), 16-18 January 2013, Katowice, Poland**

**XVth International Colloquium on Amphipoda, 2-6 September 2013, in the Pieniny Mountains in Poland, near Szczawnica, Poland**

Colloquium hosted many aspects of studies upon amphipod crustaceans (systematics, ecology, biogeography, physiology, genetics, ecotoxicology etc.) with special attention to the ongoing taxonomy crisis and cryptic diversity of amphipods.

**13th Meeting of the HELCOM Maritime Group (HELCOM MARITIME 13/2013), 26-28 November 2013, Szczecin, Poland as part of the EU funded HELCOM BALSAM PROJECT - "Baltic Sea Pilot Project: Testing new concepts for integrated environmental monitoring of the Baltic Sea (BALSAM)"**

The Baltic Sea coastal countries cooperate within HELCOM (Helsinki Commission) for a harmonized implementation of the 2004 Ballast Water Management Convention of the International Maritime Organization (IMO) in the Baltic Sea Area.

The Helsinki Convention (Convention on the Protection of the Marine Environment of the Baltic Sea Area), with Denmark, Estonia, European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden as Contracting Parties is a regional Convention on the marine environment of the Baltic Sea Area.

**2 nd International Carp Conference, 12-13 September 2013, Wrocław, Poland**

The earlier Workshop of EU Pond Fish Farmers that was held in Rétimajor, Hungary on the 3rd of September accepted a draft resolution that was discussed during the plenary session of the 2nd International Carp Conference in Wroclaw.

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## 3.17 Portugal

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## Overview

A list of 130 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems, 33 of which were new additions to the 2013 report. The inventory of NIS did not include fish species and freshwater species. Portugal has a law on introduction of exotic 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. A first characterization report was delivered in the aim of the implementation of the Marine Strategy Framework Directive and monitoring programs are currently under development. The illegal fishing of *Ruditapes philippinarum* is a major problem in the Tagus estuary and authorities want to develop specific regulation for this activity. Recent information suggests that the blue crab (*Callinectes sapidus*) has established a population in the Sado estuary but with low census size.

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

Despacho n.º 15264/2013 - Changes the classification of shellfish harvesting areas in the Tagus estuary from class C to class B, emphasizing the importance of *Ruditapes philippinarum* fisheries.

Portaria n.º 14/2014 – Regulates harvest maximum quantities for *Ruditapes philippinarum*.

## 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 130 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems. New additions to the 2013 report are listed in Table 1. New additions for Portuguese mainland and Azores and Madeira islands were considered separately. Species for which there were corrections/changes on the possible introduction vectors, year of first record, current population status at locations where the species were registered and references were also included. 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 did not include fish species and freshwater species. NIS records for the Madeira and Azores islands have increased significantly as a result of comprehensive literature reviews and updates carried out in the islands (e.g. Canning-Clode et al., 2013a; Micael et al., 2014). The blue crab *Callinectes sapidus*, which had been recorded in the Tagus estuary in 1978 (Gaudêncio & Guerra, 1979) but never registered again in that estuary, was observed in the Sado estuary. The present record associated with current and previous anecdotal occurrence reports suggest that the blue crab has established a population in the Sado estuary but with low census size (Ribeiro & Veríssimo, *in press*). The study of Coelho (2014) also confirmed that there is a well-established population of *Eriocheir sinensis* in the Tagus estuary. The project conducted by Marques (2014) showed that the population of the cnidarian *Blackfordia virginica* is well established in the Mira estuary, with very high densities, while in the Guadiana estuary this species seems to have a low size population (Muha, 2013).

**Table 1. List of new NIS registered in Portuguese waters**

| Taxa | Year of first record | Location of first record | Possible introduction vector | Invasion Status | References |
|---|---|---|---|---|---|
| Aiptasia diaphana (Rapp, 1829) | 1994 | Madeira | Fouling | Established | Ocaña, 1994 |
| Alloeocarpa loculosa C. Monniot, 1974 | 1971 | Azores (Terceira) | Ballast water; Fouling | Not Established | Monniot, 1974 |
| Amphibalanus amphitrite (Darwin, 1854) | 2005 | Madeira | Ballast water; Fouling | Unknown | Wirtz, 2006 |
| Antithamnion nipponicum Yamada & Inagaki | 2008 | Mainland Portugal (Armação de Pêra) | Unknown | Established | Berecibar 2011 |
| Antithamnionella spirographidis (Schiffner) E.M. Wollaston | 2007 | Mainland Portugal (Póvoa do Varzim; Barra de Aveiro | Unknown | Unknown | Araújo et al., 2009 |
| Antithamnionella ternifolia (J.D. Hooker & Harvey) Lyle | 1958 | Arrábida) | Unknown | Established | Palminha, 1958 |
| Aplysia dactylomela Rang, 1828 | 1897 | Madeira | Unknown | Established | Watson, 1897 |
| Ascidia interrupta Heller, 1878 | 1990 | Azores (S). Miguel | Ballast water; Fouling | Established | Monniot & Monniot, 1994 |
| Asparagopsis armata Harvey (gametophytic and tetrasporophytic phases) | 1951 | Mainland Portugal (Arrábida; Sesimbra; Vila Nova de Milfontes) | Unknown | Unknown | Palminha, 1958 |
| Asparagopsis armata Harvey (gametophytic and tetrasporophytic phases) | 1974 | Madeira | Unknown | Established | Levring, 1974 |
| Asparagopsis taxiformis (Delile) Trevisan de Saint-Léon (gametophytic phase) | 2000 | Mainland Portugal (Sines) | Unknown | Unknown | Vicêncio, 2009 |
| Austrominius modestus Darwin, 1854 | 2005 | Madeira | Ballast water; Fouling | Established | Wirtz, 2006 |
| Balanus trigonus Darwin, 1854 | 1916 | Madeira | Fouling | Established | Pilsbry, 1916 |
| Balanus trigonus Darwin, 1854 | 2013 | Mainland Portugal (Sado estuary) | Fouling | Established | Inspect |
| Bedeva paivae (Crosse, 1864) | 1994 | Madeira | Ballast water; Fouling | Unknown | Houart & Abreu, 1994 |

| Taxa | Year of first record | Location of first record | Possible introduction vector | Invasion Status | References |
|---|---|---|---|---|---|
| Bonnemaisonia hamifera Hariot (tetrasporophytic phase) | 2003-2008 | Mainland Portugal (Armação de Pêra; Albufeira; Ria Formosa) | Unknown | Established | Berecibar, 2011 |
| Botryllus schlosseri (Pallas, 1766) | 1971 | Azores (São Miguel) | Fouling | Established | Monniot, 1974 |
| Botryllus schlosseri (Pallas, 1766) | 2006 | Madeira | Ballast water; Fouling | Not Established | Canning-Clode et al. 2008 |
| Bugula dentata (Lamouroux, 1816) | 1909 | Madeira | Fouling | Unknown | Norman 1909 |
| Bugula neritina (Linnaeus, 1758) | 2001 | Azores (Faial, Terceira, Graciosa, Flores, S. Miguel) | Fouling | Established | Tempera et al., 2001 |
| Bugula simplex Hincks, 1886 | 1998 | Azores (S. Miguel, Santa Maria | Fouling | Unknown | Morton et al., 1998 |
| Bugula stolonifera Ryland, 1960 | 1998 | Azores (S. Miguel, Santa Maria) | Fouling | Established | Morton et al., 1998 |
| Bugula stolonifera Ryland, 1960 | 2010 | Madeira | Fouling | Established | Canning-Clode et al., 2013a |
| Celleporaria brunnea (Hincks, 1884) | 2012 | Mainland Portugal (Cascais) | Fouling | Unknown | Canning-Clode et al., 2013b |
| Ceramium cingulatum Weber-van Bosse | 2005-2007 | Azores (São Miguel, Terceira, Pico, São Jorge) | Unknown | Unknown | Wallenstein, 2011 |
| Clavelina dellavallei (Zirpolo, 1825) | 1995 | Madeira | Ballast water; Fouling | Established | Wirtz, 1995 |
| Clavelina lepadiformis (O.F. Müller, 1776) | 1995 | Madeira | Fouling | Established | Wirtz, 1998 |
| Clavelina oblonga Herdman, 1880 | 1971 | Azores (Faial) | | Established | Monniot, 1974 |
| Codium fragile subsp. fragile (Suringar) Hariot | 2005 | Mainland Portugal (Sagres; Ria Formosa) | Unknown | Established | Berecibar, 2011 |
| Cordylophora caspia (Pallas, 1766) | 1983 | Mainland Portugal (Santo André lagoon) | Fouling | Established | Cancela da Fonseca, 1989 |
| Corynomorpha prismatica (J.Agardh) J.Agardh | | Azores (São Miguel) | Unknown | | Fredericq et al., 1992 |

| Taxa | Year of first record | Location of first record | Possible introduction vector | Invasion Status | References |
|---|---|---|---|---|---|
| Crambe crambe (Schmidt, 1862) | 2004 | Madeira | Ballast water; Fouling | Established | Duran et al., 2004 |
| Desmacella meliorata Wiedenmayer, 1977 | 1979 | Azores (Faial) | Fouling | Not Established | Boury-Esnault & Lopes 1985 |
| Distaplia corolla Monniot, 1975 | 2004 | Madeira (Porto Santo) | Fouling | Established | Wirtz, 2006 |
| Ectopleura crocea (Agassiz, 1862) | 1989 | Azores (Faial) | Fouling | Established | Cornelius, 1992 |
| Ectopleura crocea (Agassiz, 1862) | 1995 | Madeira | Fouling | Established | Wirtz, 1995 |
| Grallatoria reptans M.A. Howe | 2005-2007 | Azores (São Miguel) | Unknown | Established | Wallenstein, 2011 |
| Grateloupia filicina (J.V. Lamouroux) C. Agarh | 1914 | Azores (São Miguel) | Aquaculture | Established | Gain, 1914 |
| Grateloupia imbricata Holmes 1896 | 2005 | Madeira | Fouling | Established | Ferreira et al., 2012 |
| Grateloupia lanceolata (Okamura) Kawaguchi 1997 | 2006 | Madeira | Fouling | Unknown | Ferreira et al., 2012 |
| Grateloupia turuturu Yamada | 2002 | Madeira | Fouling | Unknown | Ferreira et al., 2012 |
| Grateloupia turuturu Yamada | 1914 | Azores (São Miguel) | Fouling | Established | Grain, 1914 |
| Hexaplex trunculus (Linnaeus, 1758) | 1994 | Madeira | Ballast water; Fouling | Established | Houart and Abreu 1994 |
| Kirchenpaueria halecioides (Alder, 1859) | 1989 | Azores (Faial) | Ballast water; Fouling | Established | Cornelius, 1992 |
| Laeospira berkeleyana (Rioja, 1942) | 1980 | Madeira | Ballast water; Fouling | Unknown | Knight-Jones & Knight-Jones, 1980 |
| Laurencia dendroidea J.Agardh | 2005-2007 | Azores (São Miguel; Graciosa, Pico, São Jorge) | Unknown | Established | Wallenstein, 2011 |
| Ligia oceanica (Linnaeus, 1767) | 1998 | Azores (Pico; S. Miguel; S. Jorge) | Ballast water; Fouling | Established | Morton et al., 1998 |
| Maeotias marginata (Modeer, 1791) | 2002 | Mainland Portugal (Guadiana estuary) | Ballast water; Fouling | Established | Muha et al., 2012 |
| Microcosmus squamiger Michaelsen, 1927 | 2006 | Mainland Portugal (Cascais) | Ballast water; Fouling | Unknown | Turon et al., 2007 |

| Taxa | Year of first record | Location of first record | Possible introduction vector | Invasion Status | References |
|---|---|---|---|---|---|
| Microcosmus squamiger Michaelsen, 1927 | 2006 | Madeira | Fouling | Unknown | Turon et al., 2007 |
| Molgula plana Monniot C., 1971 | 1969 | Azores (São Miguel) | Fouling | Established | Monniot, 1971 |
| Mycale senegalensis Lévi, 1952 | 2010 | Madeira | Fouling | Established | Canning-Clode et al., 2013a |
| Mytilus edulis Linnaeus, 1758 | 1965 | Azores (São Jorge) | Fouling | Established | Morton, 1967 |
| Neosiphonia harveyi (J. Bailey) M.-S. Kim, H.-G. Choi, Guiry & G.W. Saunders | 2005-2007 | Azores (Graciosa) | Fouling | Unknown | Wallenstein, 2011 |
| Neosiphonia sphaerocarpa (Børgesen) M.-S. Kim & I.K. Lee | 2001 | Madeira | Fouling | Established | Haroun et al., 2002 |
| Paraleucilla magna (Klautau, Monteiro & Borojevic, 2004) | 2006 | Azores (Flores) | Fouling | Not Established | Borges et al., 2010 |
| Paraleucilla magna (Klautau, Monteiro & Borojevic, 2004) | 2006 | Madeira | Fouling | Established | Canning-Clode et al., 2013a |
| Parasmittina protecta (Thornely, 1905) | 2010 | Madeira | Fouling | Established | Canning-Clode et al., 2013a |
| Perophora viridis Verrill, 1871 | 1971 | Azores (S. Miguel; Santa Maria; Terceira; Faial) | Ballast water; Fouling | Unknown | Monniot, 1974 |
| Petalonia binghamiae (J.Agardh) K.L.Vinogradova | 1985 | Azores (São Miguel; Terceira) | Fouling | Unknown | Yoneshigue, 1985 |
| Pollia dorbignyi (Payraudeau, 1826) | 1998 | Azores (S. Miguel) | Unknown | Unknown | Morton et al., 1998 |
| Polyclinum aurantium Milne-Edwards, 1841 | 1971 | Azores (São Miguel) | Ballast water; Fouling | Established | Monniot, 1974 |
| Pycnoclavella taureanensis Brunetti, 1991 | 1998 | Madeira | Fouling | Not Established | Wirtz, 1998 |
| Pyura tessellata (Forbes, 1848) | 1971 | Azores (Terceira) | Ballast water; Fouling | Established | Monniot, 1974 |
| Schizoporella pungens Canu & Bassler, 1928 | 2010 | Madeira | Fouling | Established | Canning-Clode et al., 2013a |
| Schizoporella unicornis (Johnston in Wood, 1844) | 2009 | Azores (São Miguel) | Fouling | Established | Vaz-Pinto et al., 2014 |

| Taxa | Year of first record | Location of first record | Possible introduction vector | Invasion Status | References |
|---|---|---|---|---|---|
| Scrupocellaria bertholetti (Audouin, 1826) | 2006 | Madeira | Fouling | Established | Canning-Clode et al., 2013a |
| Spirobis marioni (Caullery & Mesnil, 1897) | 1995 | Madeira | Fouling | Established | Knight-Jones & Knight-Jones, 1995 |
| Spongoclonium caribaeum (Børgesen) M.J.Wynne | 2005-2007 | Azores (São Miguel; Pico) | Fouling | Established | Wallenstein, 2011 |
| Styela canopus (Savigny, 1816) | 2006 | Madeira | Fouling | Established | Canning-Clode et al., 2013a |
| Styela cf. plicata (Lesueur, 1823) | 2010 | Azores (São Miguel) | Ballast water; Fouling | Established | Inspect |
| Tonna pennata (Mörch, 1853) | 1998 | Madeira | Ballast water; Fouling | Unknown | Wirtz, 1998 |
| Truncatella subcylindrica (Linnaeus, 1758) | 1897 | Madeira | Unknown | Established | Segers et al., 2009 |
| Vallicula multiformis Rankin, 1956 | 1998 | Madeira | Unknown | Established | Wirtz, 1998 |
| Watersipora subtorquata (d'Orbigny, 1852) | 2006 | Madeira | Fouling | Unknown | Canning-Clode et al., 2013a |
| Watersipora subtorquata (d'Orbigny, 1852) | 2011 | Azores (São Miguel) | Fouling | Unknown | Inspect |

## 5. Meetings and projects

### Meetings

2013. J. Micael, M. Parente & A.C. Costa. NE Atlantic islands susceptibility to MNIS. Conference Non-indigenous species in the Northeast Atlantic, Ostend, Belgium.

2013. A.C. Costa & J. Micael. Azores susceptibility to Marine Bio-Invasions in the Portuguese Context. Workshop Threats and impacts of exotic and invasive species, Horta, Portugal.

2013. Chainho, P., J. Canning-Clode, A. Amorim, S. Ávila, J. Castro, A. Costa, J.L. Costa, T. Cruz, A. Fernandes, C. Grazziotin-Soares, R. Melo, J. Micael, M. Parente, J. Semedo, T. Silva, D. Sobral, M. Sousa, P. Torres, V. Veloso & M.J. Costa. Distribution trends of non-indigenous species in Portuguese estuaries, coastal areas and islands. 8th International Conference on Marine Bioinvasions, Vancouver, Canada.

2013. Presado, P., Angélico, M.M., Cruz, T., Costa, M.J., Costa, J.L. & Chainho, P. Vertical distribution of *Blackfordia virginica* during a tidal cycle in the Mira estuary. Marine Sciences Symposium, Lisboa, Portugal.

2013. Presado, P., Angélico, M.M., Cruz, T., Medeiros, J.P., Costa, J.L., Silva, G., Azeda, C., Costa, M.J. & Chainho, P. Temporal and spatial variations on the distribution of *Corbicula fluminea* in the Mira estuary. Marine Sciences Symposium, Lisboa, Portugal.

**Projects:**

- Manila clam – Current state of the Tagus estuary population, impacts and fishing management - *Ruditapes philippinarum* was registered in the Tagus estuary in 2000 and its populations have increased greatly along the last 6 years. It is currently the dominant bivalve species in some areas of the Tagus estuary, mainly shallow bays with extensive intertidal areas. The increase in abundance of the Manila clam was simultaneous to a strong reduction of the native congeneric species *Ruditapes decussatus*. The Manila clam occurs in areas identified as below microbiological standards, requiring long-term depuration before consumption. Illegal fishing is a major problem since although it is legal to harvest this species since 2011, there is no specific regulation. Management of harvesting for this species are major issues that will be addressed in the aim of this project funded by national funds for fisheries. Funded by PROMAR. PI: Paula Chainho (CO-FCUL).
- CLEF - The combined impacts of invasion and climate change on coastal ecosystem functioning. 2011-2014, funded by the Portuguese Foundation for Science and Technology (FCT). PI: Francisco Arenas (CIIMAR).
- INVASEA - Shifts from seagrass to seaweed dominated systems. 2010-2013, funded by the Portuguese Foundation for Science and Technology (FCT). PI: Aschwin Engelen (CCMAR).
- Muha, T. 2013. The impact of jellyfish on the estuarine ecosystems: the Guadiana and *Blackfordia virginica* study case. Erasmus Mundus Master thesis. University of Algarve (Portugal).
- Vaz-Pinto, F. 2013. Invasive Marine Macroalgae: Community invasibility, Invasion process, and their ecological role in the ecosystem functioning. PhD. Thesis. Universities of Porto (Portugal) and Vigo (Spain).
- Marques, F. 2014. *Blackfordia virginica* in the Mira estuary: population dynamics and feeding ecology. Master thesis. University of Lisbon (Portugal).
- Coelho, F. 2014. Distribution and abundance of the non-indigenous species *Eriocheir sinensis* in the Tagus estuary. Master thesis. University of Évora (Portugal).

**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

Cacabelos, E., C. Olabarria, R.M. Viejo, M. Rubal, P. Veiga, M. Incera, I. Gestoso, F. Vaz-Pinto, A. Mejia, A.H. Engelen, F. Arenas. 2013. Invasion of *Sargassum muticum* in intertidal rockpools: Patterns along the Atlantic Iberian Peninsula. Marine Environmental Research 90: 18-26.

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Vaz-Pinto, F., Olabarria, C., Gestoso, I., Cacabelos, E., Incera, M. & Arenas, F. 2013. Functional diversity and climate change: effects on the invasibility of macroalgal assemblages. Biological Invasions 15: 1833-1846.

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## 3.18 Russia

Prepared by Elena Ezhova, Laboratory of Marine Ecology, Institute of Oceanology Russian Academy of Sciences, Atlantic Branch (AB IORAS, Kaliningrad), Russia with assistance of Tamara Shiganova (IORAS; information on Regulations) and Eugenia Lange (AB IORAS; information for Gulf of Finland)

### Highlights of the Report:

No new intentional NIS introductions were recorded in 2013.

One new alien species was first reported in the Russian marine coastal waters - cyanobacteria ***Planktolyngbya brevicellularis*** (Curonian Lagoon, Baltic Sea) and one alien species, recorded earlier in the Baltic sea (Russian part of coastal Vistula Lagoon), clam ***Rangia cuneata***, was marked for the first time in open Baltic waters; its appearance here could be regarded as further secondary dispersal by natural vectors. Two bivalve species were first marked in Russian Barentz Sea - ***Abra prismatica*** and ***Gari fervensis***, but its NIS status is less probable than natural range expansion.

In 2013 an inventory of alien biota of Russian SE Baltic area, discovered 40 established species. In recent years several NIS inventories for other Russian marine areas were done: Gulf of Finland (2008, 51 aliens), seas of Far East (2011, 66 aliens), Black Sea (2012, 171 aliens), invasion status is evident not for all listed species and is discussed in related papers.

### 1. Regulations:

In 2013 any new national regulations didn’t appear. In 2012, the Government of Russian Federation ratified International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004). Russian Ecological Strategy (2002), basing on Conventions on Biodiversity (1992) considers the invasions of aquatic alien species as on of most important threats to marine biodiversity and emphasizes an importance of “the development and realization of necessary measures to prevent distribution of alien species, incl. marine environment, and to mitigate its consequences”. However, any concrete national or regional regulations were not developed since 2002 and national strategy for aquatic non-indigenous species is yet absent.

2-4 December 2013, All-Russian Nature Conservation Meeting adopts a resolution, recommended “…**14.1.** to regarded as priorities an analysis of the spread of alien species and genetically modified organisms and the development of appropriate methods of control and reducing the negative impacts of these processes in the Federal Science plan; **14.2** to develop a range of research projects on this theme through grant system in the framework of the federal target program "Research and developments in priority directions of development of scientific-technological complex of Russia in 2014-2020 years. "

### 2. Intentional:

No intentional introduction of species regarded as alien, has been reported. In Russian SE Baltic deliberate releases were conducted: whitefish (***Coregonus lavaretus***) – 150 thous. and pike (***Esox lucius***) up to 100 thous. (information from Zapbaltrybvod, Kaliningrad). In the Gulf of Finland - 300-400 thous. of atlantic salmon (***Salmo salar***), 1-2 year specimens, from Luga, Narva and Nevskyi fish factories (information from GosNIIORH, S.-Peteburg). Results of deliberate releases (international project) of 5 thous. of sturgeon fry (***Acipenser oxyrhynchus oxyrhynchus***) into Lithuanian rivers Sventoji and Neris in 2011-2013 were monitored in the Curonian Lagoon, Russian part, 34 findings were documented (Kolman et al., 2012; Gushchin et al., 2013).

No available data for other region.

## 3. Unintentional:

### New Sighting

- ***Planktolyngbya brevicellularis*** G.Cronberg & Komárek, 1994 is a freshwater filamentous cyanobacterium. *P. brevicellularis*, an inhabitant of eutrophic water bodies, was described in the lakes of southern Sweden in 1994 (Cronberg, Komarek, 1994). The species naturalized in some limnic basins in Northwest Russia: the Lake Peipsi and Narva Reservoir, where 2-22 times exceed abundance of the indigenous species *P. limnetica*. In 1998–2003, P. brevicellularis was domimant species in cyanobacterian community of the Lake Jeziorak Mały (Mazurian Lakeland, northeastern Poland) (Zębek, 2006). During long-term studies of the Curonian Lagoon *P. brevicellularis* was not recorded in 1980–1995 (Olenina, 1996), 1989–2001 (Semenova, Smyslov, 2005). In 2013 *P. brevicellularis* was first marked in the Lagoon in summer-autumn monitoring samples; re-examination of 2001-2011 detected the species was appear first in 2007 and become very abundant (up to 1035 ml.units/$m^3$, 183 mg/$m^3$) in 2011 (Lange, 2013). Possible source of invasion could be Masurian Lakeland, connected with Curonian Lagoon through river-channel waterways.
- ***Rangia cuneata*** (G.B.Sowerby I, 1831) (Bivalvia: Mactridae) was recorded first for the Baltic Sea in the Vistula lagoon, September 2010 as newly settled juveniles (Rudinskaya, Gusev, 2012), now it is represented by a fully established population (Ezhova, 2012), already passed an exponential stage of development, and appearing a high abundance in defined biotopes. In summer 2013 *R. cuneata* was **first recorded** in marine environment of Russian SEB near Russian-Lithuanian border (Gusev & Rudinskaya, in print) and further in northward direction, in Lithuanian EEZ (S.Olenin pers. comm.). In condition of the Vistula Lagoon this warm brackish-water species demonstrates high tolerance to low winter temperatures and long ice-period (not in accordance with Gusev, Rudinskaya , 2013), but a high level of mortality during ice-melting and spring flood, connected with decreasing of several ion concentration in water (Martemyanov, Ezhova, in print). Despite of it, abundant larval recruitment is observed every summer and most probable vector of *R. cuneata* appearance in the sea is secondary larval dispersal from the Vistula Lagoon by northward alongshore currents. The age of the Vistula Lagoon population is ca. 4 year (from autumn 2010), it coincide well with age-size structure and field observation (Ezhova, 2012, Lyatun et al., 2012); the most probable vector of first inoculation is the ballast water fall of Netherland ship, visited Kaliningrad harbour in 2010 (Rudinskaya, Gusev, 2012)
- ***Abra prismatica*** (Montagu, 1808) and ***Gary fervensis*** (Gmelin, 1791), both (Bivalvia: Veneroida) were recorded first for Russian fauna, 600 and 300 km eastward from its extreme known point in the Norwegian waters in 2013, but in samples of 2008 and 2009. *A. prismatica* was found in multiply locations during 2008-2011, different size-age classes were present,

*G.fervensis* - 3 young specimens only. Authors (Deart et al., 2013) consider as most probable vector range expansion by the warm currents.

### Previous Sightings

### Gulf of Finland

- ***Marenzelleria arctia,*** arctic species of spionid polychaete, invaded Gulf of Finland in 2009, defined mass development of deep-water benthos and due to high abundance and level of bioturbation activity, changed totally chemical-physical features in upper bottom layer, leading to sufficient changes in matter turnover (Maximov 2009, 2010, Maximov et al., 2013, 2014). In the Russian part of the Gulf of Finland invasion of polychaetes of *Marenzelleria* genus was recorded in 1996, but till 2009 alien polychaete did not cause the pronounced changes in the bottom communities, its high biomass was occurred in the shallow, above-termocline areas and was defined by ***M. neglecta*** . Since 2009, other species of the genus, ***M. arctia*** occupied deep-water areas in the Gulf of Finland.
- Inventory of alien species, with detailed analysis of records 1970-2007, review of distribution and invasion histories (Orlova et al., 2008) reveals a presence of 51 NIS in the Eastern Gulf of Finland, between them 16 cyanobacteria, 2 higher plants, 1 cnidarian, 7 worms, 3 molluscs, 14 crustaceans, 8 fish. Only 20 species were regarded as established. Annotated lists of 51 recorded NIS and 54 potential but not seen ones are given.

### Southeastern Baltic Sea

- ***Dreissena polymorpha,*** one of the earliest documented alien species in the SE Baltic (Baer, 1824), demonstrates a tendency to increase frequency of occurrence, biomass and abundance both in the Curonian and Vistula Lagoon last 2-3 years. In the Russian part of the Vistula Lagoon *D. polymorpha* beds were absent over the decades. Since 2011 rather dense new population of this bivalve (0-3 year age-groups) exists in the littoral zone of northeaster part of the lagoon (Ezhova, unpubl.).
- ***Evadna anonyx,*** marked from Russian open SEBaltic since 2008 (Shchuka, 2008), was first recorded in the Vistula Lagoon in 2011, since that time species is present constantly but not abundant (Polunina, Rodionova, 2012)
- ***Mnemiopsis leidyi*** was firstly identified in summer samples 2012 and in re-examined samples of 2010-2011. Any changes of abundance during 2010-2012 was not marked (Shchuka, 2012). Firstly in the region several specimens of *M. leidyi* were marked in 2007 (Ezhova, Polunina, unpubl.)
- ***Crustacea: Malacostraca:*** 13 alien species were recorded in previous years in Russian SEB, including coastal lagoons: *Chelicorophium curvispinum*, *Chaetogammarus warpachowskyi*, *Gammarus tigrinus*, *Orchestia cavimana*, *Obessogammarus crassus*, *Pontogammarus robustoides*, *Dikerogammarus haemobaphes*, *Hemimysis anomala*, *Limnomysis benedeni*, *Paramysis lacustris*, *Palaemon elegans*, *Eriocheir sinensis*, *Rhithropanopeus harrisii* (Ezhova et al., 2005, Gusev et al. 2012). All of them were marked in 2013 without evident tendency to increase or decrease. Only ***Orchestia cavimana, Obessogammarus crassus, Pontogammarus robustoides, Palaemon elegans*** forms dense population and dominates in several habitats.

- Analysis of ***alien invertebrate fauna*** of the Russian SE Baltic was done in 2013 (Ezhova et. al., 2013, Ezhova et. al., in print). It was recorded 35 alien invertebrate, 1 fish, 2 microalgae species and 2 macrophyte species in the area. In the Curonian Lagoon 18 species were ever recorded, 12 can be regarded as established ones. In the Vistula Lagoon 27 alien species were recorded, and 26 of them become established. In the Russian waters of the SEB, there are 15 invasive species, all naturalized. 70% of established NIS are represented by species from warm-water regions.

### Black Sea

- **Ballast water** study of zooplankton species in Novorossiysk harbour area was identified 31 species of holoplankton and 15 species of meroplankton. The average density of zooplankton varied from 1.3 up to 60·103 ind $m^{-3}$. It has shown, Mediterranean basin is a donor area of the greatest risk in regard of ballast water NIS transfer (62% of water ballast) (Zvyagintsev et Selifonova, 2008).
- Records of **NIS** dispersed through **Mediterranean Sea (MS).** An extensive inventory work (Shiganova et al., 2012) summarized results of analysis of long-term authors data (1992 – nowadays) and 130 publishing records of Black Sea NIS of Mediterranean origin or coming through MS. Into Black Sea NIS lists 10 phytoplankton, 6 microplankton, 34 macrophyte and 9 fish species are included. Appearance and invasion status of above 100 zoobenthic NIS species is discussed, between them 22 listed as relatively recent newcomers from Mediterranean Sea. Also list of 59 zooplankton species is given, but NIS status most of them is unclear, only ***Acartia tonsa*** and ***Oithona brevicornis brevicornis*** are reminded as evidently established and mass species. The last one could reach up to 17 600 ind $m^{-3}$ (Selifonova, 2009), its population is expands and occupies niche after *O. nana* extinction. Ship ballast is recognized as most important vector of penetrations and naturalization of NIS through MS, which supported by climate warming.

### Seas of Russian Far East

- An **annotated list of 66 NIS** being on various stages of acclimatization in the Far-Eastern seas of Russia is presented for the first time (Zvyagintsev et al., 2011). NIS in the Russian waters of the Sea of Japan have been studied in the recent decades, but the data on those species in the Sea of Okhotsk and the Bering Sea were scarce. Marine bioinvasion in Russian Far East are studied in frame of Target academic program "Biological safety of Far Eastern Seas of RF" and international cooperation inside PICES (WG 21: Non-Indigenous Aquatic Species). NIS records in Russian Far East are included in PICES NIS Atlas and database (Lee II, H. and Reusser, D. A., 2012 a,b)

  (http://www.pices.int/members/working_groups/wg21.aspx).

## 4. Pathogens

No new records of pathogens are known.

## 5. Meetings:

**The IV International Symposium "Invasion of alien species in Holartic", Borok – 4. September, 22-28th, 2013,** http://www.ibiw.ru/upload/112368.pdf

The symposium was attended by more than 150 specialists from 13 countries and 30 cities of the Russian Federation; 127 reports were presented during 6 thematic sessions:

- invasion in freshwater ecosystems;
- invasion in marine ecosystems;
- the role of global climatic and anthropogenic processes in biological invasions;
- information systems for monitoring of invasive process;
- mathematical modelling of the processes associated with the invasions of alien species
- invasion in terrestrial ecosystems

Symposium sums up main results of invasion study in Russia and the neighboring countries during last 5 years.

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## 3.19 Spain

Prepared by Gemma Quilez-Badia, WWF Mediterranean Programme Office

### Overview:

Royal Decree 630/2013, of August 2, regulating the Spanish Catalog of alien invasive species is in place. Although the official Spanish Catalog of invasive alien species has been extended to 183 species, some species from the previous catalog have disappeared. Moreover, the List of 264 plants and animals considered as "potentially invasive species" in the previous decree has been removed.

Regarding new sightings, ***Chiton cumingsii***, the Scaly chiton, was reported in Las Palmas Port (Gran Canaria, Canary Islands) in August 2012. The ployplacophoran ***Tonicia atrata***, was identified from material taken in three locations of the Bay of Biscay (N Spain, Atlantic coast) in January 1978, July 1985 and May 2010. Specimens had been preserved and misidentified as *Ch. angulata*. This is the first record for both species (*C. cumingsii* and *T. atrata*) in European waters and the first evidence of their presence outside their native range. ***Ensis directus***, the American razor clam, was recorded for the first time in the waters of the Iberian Peninsula in two locations of the southwest Bay of Biscay in 2011. Twenty-four living specimens of ***Mercenaria mercenaria***, the hard clam or quahog, collected in Asturias (N Spain) in January 1978 were recently examined and identified as *M. mercenaria*; making this the first record of the species in the Iberian Peninsula. In January 2011, *M. mercenaria* was found again close to the 1978 location. ***Theora lubrica***, the Asian semele, was recorded for the first time in the Atlantic Ocean, specifically in four sites in the Bay of Biscay, on 6 October 2010 and 21 May 2010.

With regards to previous sightings, the scleractinian coral ***Oculina patagonica*** it is now spread throughout all the Spanish Mediterranean coast, from Algeciras to Catalonia and Balearic Islands. The tropical hydroid ***Sertularia marginata*** was detected in the Chafarinas Islands (Alborán Sea, Western Mediterranean) in 2007 and in a shipwreck off Sancti Petri (Cádiz, Atlantic coast of the Strait of Gibraltar) in 2012. This species had previously been reported in the 1980's in the Canary Islands, in the north coast of the Iberian Peninsula, and in the Gulf of Cádiz. Specimens of the polychate ***Branchiomma bairdi*** were obtained from Mazarrón harbour (Murcia, Spain) and Las Palmas harbour (Gran Canaria, Canary Islands) in May 2012. But previous records (from 2006) of *B. boholense* reported from Mar Menor Lagoon (SE Spain), had been misidentified and were actually *B.bairdi*. Two specimens of the spionid ***Paraprionospio coora*** were identified from two stations in the SE Bay of Biscay, in 2010 and in 2012. *P. coora* had previosuly been reported in 1995 from Valencia (E Spain) as *P. pinnata*. The caprellid amphipod ***Caprella scaura*** was recorded for the first time in the Iberian Peninsula in July 2005 in Roses Bay (Girona, NE Spain). Now its extensive distribution along the Spanish Mediterranean coast (including the Balearic Islands) and the Strait of Gibraltar has been confirmed. *C. scaura* is also present in the Canary Islands. Two established populations of ***Paracaprella pusilla*** were found for the first time in the Mediterranean, in Mallorca and Ibiza, in 2011 and 2012, respectively. Previously, in 2010, and for the first time in European coastal waters, *P. pusilla* had been found in a marina in Cádiz (SW Spain).

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

**Royal Decree 630/2013, of August 2, regulating the Spanish Catalog of alien invasive species.**

The official Spanish catalog of invasive alien species has been extended to 183 species (from 140 in the previous decree), although some species, such as *Undaria pinnatifida* (Harvey) Suringar, 1873, have disappeared from the catalog. Moreover, the list of 264 plants and animals considered as "potentially invasive species" in the previous decree has been removed, and although some of these species have been moved to the new catalog, like *Acrothamnion preissii* ((Sonder) E.M.Wollaston 1968), *Lophocladia lallemandi* ((Montagne) F.Schmitz 1893), or *Womersleyella setacea* ((Hollenberg) R.E.Norris 1992), others have disappeared. This is the case for *Crassostrea gigas* (Thunberg, 1793) or *Ruditapes philippinarum* (Adams & Reeve, 1850), among others (see "Marine species formerly listed" below).

The inclusion of a species in the catalog, in accordance with Article 61.3 of the Law 42/2007 of the Spanish Natural Heritage and Biodiversity, entails a general prohibition of the possession, transportation, traffic and trade of live or dead specimens, their remains and propagules, including foreign trade.

The new catalog, however, may be revised at any time and leaves the Autonomous Communities the authority to determine which additional alien species shall be fought to prevent them from spreading. The inclusion or exclusion of a species from the catalog will be done by the Ministry of Agriculture, Food and Environment, at the initiative of the Autonomous Communities, the cities of Ceuta and Melilla, or the Ministry itself.

Out of the 183 species included in the Spanish Catalog (which is not specific for marine or aquatic species), 29 are marine species including 1 brackish (see "Marine species in the current catalog" below). Note that the name of the species listed below are shown as they appear in the published decree.

### Marine species in the current catalog:

### Algae:

*Acrothamnion preissii* (Sonder) Wollaston.

*Asparagopsis armata* (Harvey, 1855).

*Asparagopsis taxiformis* ((Delile) Trevisan de Saint-Léon, 1845).

*Caulerpa racemosa* ((Forssk.) J.Agardh, 1873).

*Caulerpa taxifolia* ((M.Vahl) C.Agardh, 1817).

*Codium fragile* ((Suringar) Hariot, 1889).

*Gracilaria vermiculophylla* ((Ohmi) Papenfuss 1967).

*Grateloupia turuturu* (Yamada, 1941).

*Lophocladia lallemandii* ((Montagne) F. Schmitz 1893).

*Sargassum muticum* ((Yendo) Fensholt, 1955).

*Stypopodium schimperi* ((Buchinger ex Kützing) Verlaque & Boudouresque, 1991).

*Womersleyella setacea* (Hollenberg) R. E. Norris 1992.

**Plants:**

*Spartina alterniflora* Loisel.

*Spartina densiflora* Brongn.

*Spartina patens* (Ait.) Muhl.

**Molluscs:**

*Crepidula fornicata* (Linnaeus, 1758).

*Limnoperna securis* (Lamarck, 1819).

*Potamocorbula amurensis* (Schrenck, 1861).*

**Annelida:**

*Ficopomatus enigmaticus* (Fauvel, 1923).

**Cnidaria:**

*Cordylophora caspia* (Pallas, 1771).**

*Rhopilema nomadica* (Galil, 1990).*

**Ctenophores:**

*Mnemiopsis leidy* (A. Agassiz, 1865).

**Crustaceans:**

*Carcinus maenas* (Linnaeus, 1758). (For the Canary Islands)

*Dyspanopeus sayi* (S. I. Smith, 1869).

*Eriocheir sinensis* (Milne-Edwards, 1853).

*Percnon gibbesi* (H. Milne Edwards, 1853).

*Rhithropanopeus harrisii* (Gould, 1841).

#### Fish:

*Fundulus heteroclitus* (Linnaeus, 1766).

*Pterois volitans* (Linnaeus, 1758).*

Species with (*) are species that are still not present in the natural environment of Spain, although some, like *Pterois volitans* (Linnaeus, 1758), existed in the aquarium trade. Species with (**) are cryptogenic species.

#### Marine species formerly listed:

#### Algae:

*Polysiphonia morrowi* (Harvey, 1857).

#### Parasites:

*Anguillicola crassus* (Kuwahara, Niimi & Itagaki 1974).

*Pseudodactylogyrus anguillae* (Yin & Sproston, 1948).

#### Custaceans:

*Balanus improvisus* (Darwin, 1854).

#### Molluscs:

*Crassostrea gigas* (Thunberg, 1793).

*Ruditapes philippinarum* (Adams & Reeve, 1850).

#### Cnidarians:

*Haliplanella lineata* (Verrill, 1870).

#### Crustaceans:

*Callinectes sapidus* (M. J. Rathbun, 1896).

### 2. Intentional:

Synthesis of introductions

### 3. Unintentional:

#### New Sightings (see “SPAIN National Data Report 2014”)

***Chiton cumingsii*** (Frembly, 1827), the Scaly chiton, originally from Peru to Chile (Leloup, 1956), was reported for the first time in European waters, constituting the first evidence of its presence outside its native range (Arias and Anadón, 2013). *Ch. cumingsii* was identified from material taken in Las Palmas Port (Gran Canaria, Canary Islands) (28º06’N, 15º25’W) in August 2012 (Arias and Anadón, 2013). The most plausible vector of introduction for *C. cumingsii* in the Canary Islands would be “biofouling” on the ship’s hulls due to its proximity to a port area (Arias and Anadón, 2013).

***Tonicia atrata*** (Sowerby, 1840), a ployplacophoran from southern Chile (Schwabe et al., 2006), including the Magellan Strait and the Falkland Islands (Sirenko, 2006), was reported for the first time in European waters, constituting the first evidence of its presence outside its native range (Arias and Anadón, 2013). Preserved specimens in the collections of the Department of Biology of Organisms and Systems (Zoology), University of Oviedo, Spain, previously identified as *Ch. angulata* from Atlantic coastal waters of the Iberian Peninsula and Canary Islands collected throughout the last decades, were re-examined. *T. atrata* was identified from material taken in the Bay of Biscay (N Spain, Atlantic coast): Eo estuary (43º28′N, 7º03′W) in January 1978; Sado estuary (43º28′N, 7º03′W) in July 1985; and Avilés Port (43°33′N, 5°55′W) in May 2010 (Arias and Anadón, 2013). *T. atrata* might have been introduced to the Iberian Peninsula as larvae and/or juveniles co-transported within commercial bivalve cultures, because the two estuaries where it is present are locations of intensive mariculture with high traffic of exotic aquaculture species (Arias and Anadón 2012; Arias et al. 2012).

***Ensis directus*** (Conrad, 1843), the American razor clam or American jackknife clam, originally from North America, was recorded for the first time in the waters of the Iberian Peninsula (southwest of the Bay of Biscay) (Arias and Anadón, 2012). Live specimens of *E. directus* were found in three locations in 2011: Otur sandy beach (43.16º N, 2.15º W), Musel Port of Gijón (43.32º N, 5.42º W), and Villaviciosa estuary (43.31º N, 5.23º W). In the latter, *E. directus* was the only Solenaceae that could be found, but in the past the native species *Ensis arcuatus* (Jeffreys, 1865) and *Ensis siliqua* (Linnaeus, 1758) were commonly found (Ortea 1974, Anadón et al. 1997). Therefore, if *E. directus* populations were to become very large it could compete with and/or displace other native *Ensis* species like in the case of *E. arcuatus* and *E. siliqua* in the Villaviciosa estuary (Arias and Anadón, 2012). The most likely means of introduction of *E. directus* to Musel Port is ballast water, and its subsequent spread along the coast of the Bay of Biscay is probably a result of larvae drifting with water currents (Arias and Anadón, 2012).

***Mercenaria mercenaria*** (Linnaeus, 1758), the hard clam or quahog, originally from North America (from the Gulf of St. Lawrence in Canada through the northern Gulf of Mexico to Texas), was recorded for the first time in the waters of the Iberian Peninsula (southwest of the Bay of Biscay) (Arias and Anadón, 2012). The first collection of this species in the Bay of Biscay occurred in January 1978 in Video Cape (43.13º N, 5.27º W; Asturias, N Spain). Twenty-four living specimens were collected, deposited and preserved in the collection of the Department of Biology of Organisms and Systems at the University of Oviedo, Spain. Recent examination of these specimens identified them as *M. mercenaria* (Arias and Anadón, 2012). Thirty-tree years later, in January 2011, *M. mercenaria* was found again near Video Cape in a sandy cove (Arias and Anadón, 2012). *M. mercenaria*'s introduction is at least partly due to aquaculture, as near Video Cape there is a shellfish farm that experimented with *M. mercenaria* during the 1970s. The species is now reproducing in the Bay of Biscay and has become part of the local benthic fauna (Arias and Anadón, 2012).

***Theora lubrica*** (Gould, 1861), the Asian semele, native to the east coast of Asia - from Japan south to Singapore and Indonesia -, was recorded for the first time in the Atlantic Ocean, specifically in two sites in the Nervión Estuary (43º18′51″N, 02º59′26″W and 43º18′36″N, 02º58′45″W) and two other sites in the Pasajes Port (43º19′09″N, 01º54′43″ W and 43º19′13″ N, 01º54′33″ W) – both in the Bay of Biscay - on 6 October 2010 and 21 May 2010, respectively (Adarraga and Martínez, 2011). *T. lubrica* can have positive effects, such as processing contaminated sediments by filtering (bioturbation) and providing a supplementary food source (Ruth, 2005). But the negative impacts can be the possible alteration of habitats and biogeochemical cycles by liberating nitrogenous compounds from bottom sediments (Yamada and Kayama, 1987).

In addition, these organisms can accumulate discharged contaminants and pathogens to harmful levels, which can affect species population levels, and in turn, impact on community and ecosystem structures. These toxic substances can also adversely affect the health of any organism feeding on them (Chen & Chend, 1999; Champ, 2000; Morrison et al., 2000; Baudrimont et al., 2005). Nevertheless, the effects of *T. lubrica* in the Nervión Estuary and Pasajes Port are still uncertain (Adarraga and Martínez, 2011). The ports of Bilbao and Pasajes are part of the 28 Port Authorities of State ownership in Spain, 5th and 16th respectively in the ranking of total port traffic. For this reason, ship activity is the most likely mechanizm of introduction of *T. lubrica* to the Basque coast, either via ballast water or sediments (Adarraga and Martínez, 2011). Among these, the larval transport in ballast tanks is the widely proposed mechanizm for the introduction and spread of *T. lubrica* (Climo, 1976; Balena et al., 2002, in Bogi and Galil, 2007).

### Previous Sightings (see Annex 4)

The scleractinian coral ***Oculina patagonica*** (de Angelis, 1908) it is now spread throughout all the Spanish Mediterranean coast, from Algeciras to Catalonia and Balearic Islands (Rubio-Portillo et al., 2014 and references therein). The first record of *O. patagonica* is from 1972 in the Port of Alicante, E Spain, where it was only observed in areas highly affected by humans (Zibrowius and Ramos, 1983), but later reports have discovered large populations in natural habitats (Ballesteros et al., 2008; Coma et al., 2011; Fine et al., 2001; García-Raso et al., 1992; Ramos-Esplá, 1985). It is now present under very different environmental conditions (i.e. wide range of water salinity, UV radiation, turbidity and hydrodynamism; also in areas exposed to domestic and industrial pollution as harbours) (Rubio-Portillo et al., 2014). Anthropogenic disturbances (Bax et al., 2003) and even native sea urchins grazing activity, which creates open spaces that enhance coral settlement and survival (Coma et al., 2011), can facilitate the expansion of the coral. A shift from macroalgal to coral dominance has been observed, and this change in the dominant trophic group may affect ecosystem function (Serrano et al., 2012).

The tropical hydroid ***Sertularia marginata*** (Kirchenpauer, 1864) was detected in the Chafarinas Islands (35.1833° N, 2.4333° W) (Alborán Sea, Western Mediterranean) in 2007 and in a shipwreck off Sancti Petri (36º24.57′N; 6º14.15′W) (Cádiz, Atlantic coast of the Strait of Gibraltar) in 2012 (González-Duarte et al., 2013). Two populations with 35 colonies (several of them fertile) were detected in Chafarinas, while a dense population with 69 colonies (most of them fertile) was detected in Sancti Petri (González-Duarte et al., 2013). This species had previously been reported in the 1980′s in the Canary Islands (Izquierdo et al., 1990), in the north coast of the Iberian Peninsula (García Corrales et al., 1980), and in the Gulf of Cádiz (i.e. in Caños de Meca (36°11′N; 6°1′W) and in Roche (36°11'48"N; 6º8′30″W) in 1990) (Medel Soteras et al., 1991), close to the Strait of Gibraltar and to Sancti Petri – the location where it was found in 2012. Due to the limited dispersion capacity of *S. marginata* and the history of its records, it is hypothesized that the likely arrival and spread was by anthropogenic vectors (González-Duarte et al., 2013).

Specimens of the polychate ***Branchiomma bairdi*** (McIntosh, 1885) were obtained in the shallow waters of the Mazarrón harbour (37°36′N, 1º31′W, Murcia, Spain) and on the rocky shores of Las Palmas harbour (28°6′N, 15°25′W, Gran Canaria, Canary Islands) in May 2012 (Arias et al., 2013). In addition, these authors also reviewed previous existing records along the Mediterranean Sea and found out that *B. boholense* reported in 2006 from Mar Menor Lagoon (SE Spain) (Román et al., 2009), had been misidentified and was actually *B.bairdi*. This species seems to be particularly abundant in confined areas and areas subject to anthropogenic impacts, such as harbours and marinas, where the species represent an early fouling colonizer (Arias et al., 2013).

Two specimens of the spionid ***Paraprionospio coora*** (Wilson, 1990) were identified from two stations in the SE Bay of Biscay (i.e. in Deba-Zumaia, 43º24′N 02º18′W, and in Bermeo, 43º21′N 02º42′W), one in 2010 and one in 2012, respectively (Martínez and Adarraga, 2013). *P. coora* had previosuly been reported in 1995 from Valencia (E Spain) as *P. pinnata* (Redondo and San Martín 1997, in Martínez and Adarraga, 2013). In the absence of marine farming areas near the area where the species has been collected, the most likely pathway for introduction is through the ballast water of a ship (Martínez and Adarraga, 2013).

The caprellid amphipod ***Caprella scaura*** (Templeton, 1836) was recorded for the first time in the Iberian Peninsula in July 2005 in the brackish waters of the Roses Bay (Girona, NE Spain), where it had been introduced by means of ship fouling (Martínez and Adarraga, 2008). Now its extensive distribution along the Spanish Mediterranean coast (including the Balearic Islands) and the Strait of Gibraltar has been confirmed (Ros et al. 2014a). *C. scaura* is also present in the Canary Islands. Specifically, it was found in 2009 in Santa Cruz de Tenerife (28º29'58"N, 16º11'48"W), associated with aquaculture tanks (Guerra-García et al., 2011); and in 2011 in Lanzarote (Puerto del Carmen, 28º55′16″N 13º40′27″W, and Marina Rubicon, 28º51′25″N 13º48′54″W), likely introduced within the hull-fouling community on recreational craft (Minchin et al., 2012). *C. saura* has been observed to displace native caprellids, such as *C. equilibra* in the harbour of Cádiz (Guerra-García et al., 2011) and it could both directly and indirectly impact marine foodwebs by changing the quantity, form and availability of these nutrients to other organisms. *C. scaura* plays an important role in the energy flow through foodwebs in introduced areas by accumulating pollutants and transmitting them to higher trophic levels (Ros et al., 2014b).

Two established populations of ***Paracaprella pusilla*** were found for the first time in the Mediterranean in Mallorca (Port of Palma, 39º34'N 2º38'E) and Ibiza (38º54′N 1º26′E) during a survey of caprellid amphipods from marinas along the Balearic Islands (Western Mediterranean Sea) which was carried out between November 2011 and August 2012 (Ros et al., 2013). Previously, in 2010, and for the first time in European coastal waters, a well-established population of *P. pusilla* had been found in a marina in Cádiz (36º32′29″N, 6º17′61″W) (SW Spain) (Ros and Guerra-García, 2012). *P. pusilla* feeds mainly on crustacean preys, predominantly harpacticoid copepods, therefore, it can compete with other animals that feed on copepods, such as fish larvae. Although, on the other hand, caprellids can also constitute an important food item for adult fish (Ros et al., 2014b). Ship fouling has been assumed to be the most probable vector for the introduction of the species to both Cádiz and the Balearic Islands (Ros and Guerra-García, 2012; Ros et al., 2013).

## 4. Pathogens

Sightings/records

General information

## 5. Meetings

Past year

Future meetings

## 6. References and bibliography


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## 3.20 Sweden

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### Overview

One specimen of the Japanese/Asian shore crab *Hemigrapsus sanguineus* was found on the Swedish west coast by a crab-fishing child in 2012 and confirmed in 2013, by photo identification. The round goby, *Neogobius melanostomus*, can now be considered established in several areas in Sweden. It has spread rapidly and is commonly found in areas where it was first recorded just a few years ago.

### 1. Regulations

In 2012 it was decided by the Swedish parliament that Sweden should have a number of new environmental quality standards and one of them concerns non-indigenous species. The text is based on the EU commission on the Marine Strategy Framework Directive and deals with "no major harm to the environment by invasive species".

In 2014 there will be a revision of the regulations for moving and releasing species.

### 2. Intentional

Not investigated.

### 3. Unintentional

#### New Sightings

One specimen of the Japanese/Asian shore crab *Hemigrapsus sanguineus* was found on the Swedish west coast by a crab-fishing child in 2012 (Lapposand beach, Hönö). The species was confirmed from a photograph taken by the father and sent, in 2013, to taxonomic experts (Berggren 2013). The experts revisited the same shore in 2013, but this is the only confirmed record so far in Sweden.

### Previous Sightings

#### a) Invertebrates

The findings of Conrad's false mussel, *Mytilopsis leucophaeata*, found in 2011 in the cooling water outlet tunnel of reactor 1 at Forsmark nuclear power plant, southern Bothnian Sea, are now published (Florin *et al.* 2013). At the following monitoring in the artificially heated area outside the power plant they saw a rapid increase of the mussel density but the distribution is still limited to the area with heated cooling water from the power plant.

The results from the monitoring programs for the Bothnian Sea and the Bothnian Bay on the northern part of the Swedish east coast are not ready for 2013 yet. Ida Wendt and her colleagues doing monitoring in the Bothnian Sea reported that nothing spectacular has been found.

*Marenzelleria cf viridis* is found in more locations on the southwest coast of Sweden, but not in higher abundances (Peter Göransson, pers. com).

#### b) Fish

The round goby, *Neogobius melanostomus*, can now be considered established in several areas in Sweden. It has spread rapidly and is now commonly found in areas where it was first recorded just a few years ago. It is continually reported by recreational anglers in Gothenburg and Visby and by fishers in Karlskrona. It is also found for the first time within the regular monitoring for fish (Florin pers. Com and web reference for Round goby).

The HELCOM project ALIENS III also found the round goby in several locations around Gothenburg.

During a study made by the Swedish University of Agricultural Sciences, round goby were sighted in three new locations, Torhamn, Bråviken och Muskö (figure below and web reference for Round goby).

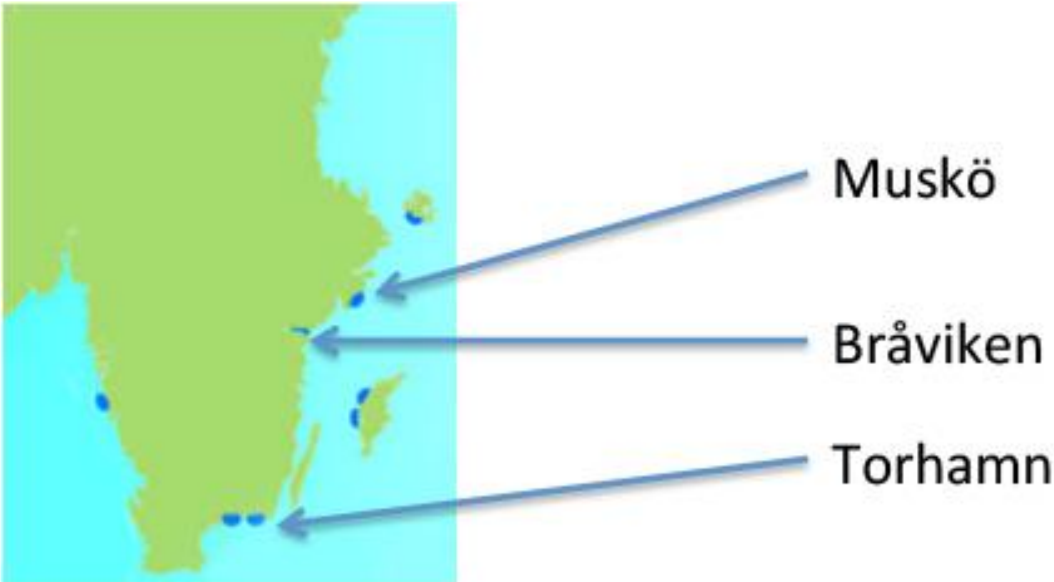


**Figure of records of *Neogobius melanostomus* in Swedish waters. Modified from "Havet 2011" by Ann-Britt Florin.**

## 4. Pathogens

*Marteilia refringens*, the ene type that goes on *Mytilus edulis*, was first found near a mussel farm on Orust, on the west coast of Sweden, in 2009. A monitoring scheme was launched and since then it has been found in both wild and farmed mussels in the investigated area, but not in oysters, *Ostrea edulis* (Alfjorden 2013).

## 5. Meetings

Scandinavian Network on Oyster Knowledge and management (SNOK) had a workshop in Copenhagen the 28-29 of May 2013. A risk assessment report was produced by participants of the meeting concerning the impacts of dispersal of *Crassostrera gigas* in different habitats and climate conditions (Dolmer *et al.* 2014).

Environmental monitoring and detection of invasive species – current challenges", International workshop on invasive species, both terrestrial and aquatic, held in Uppsala, Sweden, 4-6 September 2013.

## 6. Miscellaneous information

There are monitoring outside the Swedish nuclear power plants and in one of them they found Conrad's false mussel (se text above) and in the other, at Ringhals nuclear power plant on the west coast of Sweden, they found three already established species at their diving transect, made especially to investigate the presence of macro-non-indigenous species: *Sargassum muticum, Crassostrea gigas, Dasia Baillouviana*. (Fagerholm *et al.* 2014)

A national research project is granted research money to develop indicators for D2 non-indigenous species for the Marine Strategy Framework Directive: "Främmande arter i svenska hav: bedömningsgrunder för God Ekologisk Status. Johan Näslund, AquaBiota Water Research."

A PhD. thesis was presented in September 2013 where toxic anti fouling compound were tested also on non-target species as *Acartia tonsa*. Effects on mortality and egg production were studied for three biocides, DCOIT, medetomidine and TPBP. Inhibition of egg production occurred at the same concentration as mortality for the first two. TPBP affected the egg production at concentrations lower than lethal concentrations (Wendt 2013).

Freshwater/brackish water species: The number of found larvae of *Dreissena polymorpha* in an expanded area of the Göta canal system suggested a significant number of adult mussels up steams (in lake Glan and Roxen) and the authors suggest that the possibility for the mussels to disperse further is high (Svensson & Lundberg 2013). The canal system is connected to the only location in the sea, Bråviken, where *D. polymorpha* has been reported this century in Sweden.

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# 3.21 United Kingdom

Compiled by Gordon H. Copp (Centre for Environment, Fisheries & Aquaculture Science - Lowestoft) and Paul Stebbing (Cefas-Weymouth), with contributions from Lyndsay Brown (Marine Scotland-Science), Elizabeth Cook (Scottish Association for Marine Science), Jenni Kakkonen (Orkney Islands Council Marine Services), Andy Lowler (Cefas-Lowestoft), Jan Maclennan (Natural England), Chris Nall (University of Highlands and Islands), Rachel Shucksmith (NAFC Marine Centre) and Gabrielle Wyn (Natural Resources Wales – NRW)

## Highlights:

Institutes throughout the UK are progressing with a number of monitoring programmes and biosecurity projects. These include the Cefas-led marine pathways project (Marine non-indigenous species monitoring and risk management) which is a collaboration between Defra, Natural England, Natural Resources Wales, Scottish Natural Heritage, Marine Scotland, Irish Sea Fisheries Board, Cefas, Bangor University, Marine Biological Association and Cornish Wildlife Trust. A monitoring and recording system for marine invasive non-native species in Orkney has been developed and the North Atlantic Fisheries College (NAFC) Marine Centre in Shetland has been undertaking invasive species monitoring at Shetland's ports, marinas and aquaculture sites since 2012. Biosecurity plans are being developed for Shetland which will provide supplementary guidance to that already contained in Shetland Islands' Marine Spatial Plan and the Scottish Association of Marine Science has collaborated with the Firth of Clyde Forum and Scottish Natural Heritage to produce guidance for biosecurity planning for sites and operations. Cefas as progressing with work examining the potential use of molecular tools in monitoring for non-native species from environmental DNA that is shed into the water column. Various projects examining methods of controlling non-native species have been progressing over the last year. These include control methods for *Dressena polymorpha*, *Pacifastacus leniusculus*, *Dikerogammarus villosus*, *Hydrocotyle ranunculoides*, *Lagarosiphon major* and *Dikerogammarus haemobaphes*. Measures investigated so far include hot water, chemical control, semiochemicals, biological control agents, male sterilisation and physical control and removal. Four species of macroalgae previously unrecorded in the UK have been identified during 2013. These are *Chrysymenia wrightii, Griffithsia schousboei, Dictyota cyanoloma* and *Gracilaria vermiculophylla*, which were all recorded from the south coast of England. A recording of the non-native bryozoan Bugula simplex in northern Scotland during summer 2012 constituted the most northern UK record to date. This record became available in 2013. A new version of the decision support tool, the Fish Invasiveness Scoring Kit (FISK), has been published online for free download. Defra continue to support negotiations on the forthcoming EU invasive alien species strategy.

## Regulations

No new regulations were introduced in 2013.

## Intentional introductions

### Fish

Summaries of imports of salmonid eggs into the UK can be found in Finfish News for England and Wales (http://www.cefas.co.uk/publications/finfish-news.aspx) and Marine Scotland Science publications for Scotland (http://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 (http://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. Stock for on growing was 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 Canadian/American lobsters being captured in pots set in the wild.

There are continued low level attempted introductions of crayfish, which are illegal to keep in the UK under national legislation, through the aquarium trade.

## Unintentional introductions

### New sightings –

A member of the public reported to have captured (and subsequently released back to the water) a Chinese mitten crab (*Eriocheir sinensis*) on the beach at Easton Bavents in Suffolk during the week of 22 April 2013. This is the first report of the species in this area of England.

Various reports on the internet in 2013, compiled by the Atlantic Salmon Trust (http://www.atlanticsalmontrust.org/latest-news/sturgeon-in-uk-rivers.html), indicate that sturgeons have been captured around the UK. Specifically, a European sturgeon (*Acipenser sturio*), said to have been 0.914 m long, was reported to have been captured near Pembroke Dock, South Wales on August 2. European sturgeons are classed as vagrants in the UK, which means that they may migrate into British waters but do not spawn here. Second, a Siberian sturgeon (*Acipenser baerii*) of 4.536 kg was landed from the River Thames at Greenhithe, near Dartford, Kent, on 2 November 2013.

The non-native red algae *Chrysymenia wrightii, Griffithsia schousboei* and the brown algae *Dictyota cyanoloma* have been found in Falmouth by Francis Bunker. *Gracilaria vermiculophylla* (red alga) has been found recently southern England by the Marine Biological Association. *Asterocarpa humilis* ascidian was found at Holyhead and Milford Haven (Wales) in 2012 by Rohan Holt.

The non-native bryozoan *Bugula simplex* was recorded during a non-native species survey in the north of Scotland by the Environmental Research Institute (University of the Highlands and Islands) in summer 2012. This is the most northern record in the UK to date. Results have been available within the last year.

### Previous sightings –

### Invertebrates

No new species of non-native invertebrates have been reported for either marine or inland waters during 2013.

### Fish

No new species of non-native fish have been reported for either marine or inland waters during 2013.

### Species not yet reported or observed

## Pathogens –

### Sightings/records

High level mortalities in common carp have been investigated. The causative agent was identified as a carp edema like virus (CEV-like). Clinical signs include lethargy, enophthamlia, and skin erosion, with hyperplasia and gill necrosis similar to that found in clinical koi herpesvirus (KHV) disease.

Prolonged high temperatures during the summer of 2013 resulted in an elevated number of cases of koi herpesvirus (KHV) disease, with 15 new designations being made.

Unusual mortalities were reported in Pacific oysters in North Norfolk in May 2013, following a protracted period of cold weather over winter 2012 - 13. Clinical signs included green lesions in the adductor muscle, and higher than normal mortality after depuration. An investigation by Cefas FHI identified a previously unidentified species of Mikrocytos, *M. mimicus.*

Bonamia ostreae has been found in the New Zealand dredge oyster (*Ostrea chilensis*) a non-native to the UK.

### General information

In a Government-funded project, Marine Scotland Science (MSS) is assessing the risk of transporting non-native species to Scotland via biofouling on vessels has now finished. A manuscript has been submitted for peer review – 'Native and non-native marine biofouling species present on commercial vessels using Scottish dry docks and harbours'. For further information contact Lyndsay Brown (lyndsay.brown@scotland.gsi.gov.uk)

MSS are also progressing with the genetic study of UK *Didemnum* populations. Samples were collected from seven sites (Largs, Fairlie Pier, Hunterston, Darthaven, Gosport, Holyhead and Kent). PCR products obtained confirmed that all samples were *Didemnum vexillum*. The sequences showed a low level of genetic variation. A paper detailing the work will be submitted for publication shortly. For further information contact Lyndsay Brown (lyndsay.brown@scotland.gsi.gov.uk)

The Scottish Association for Marine Science (SAMS) hosted the Association of Scottish Shellfish Growers Workshop on Marine Biosecurity in relation to NNS (October 2013) as part of Firth of Clyde Forum project and also coordinated a workshop with Robin Payne on Marine Biosecurity at an SNH Sharing Good Practice Event, Battleby, (November 2013).

SAMS current collaborations/projects 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 submitted and is awaiting publication.

2. Scottish Natural Heritage and Marine Scotland -

Invasive Non-Native Species Early Warning System. This project is in progress. Various sampling methods have been trialled and samples are now awaiting analysis.

3. Scottish Aquaculture Research Forum and Scottish Natural Heritage - Pacific Oyster Scotland Survey. This survey will be running from February to October 2014. For further information contact Elizabeth Cook (Elizabeth.Cook@sams.ac.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. 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. Fouling marine non-native species known to be in Scotland were targeted in these surveys. Nine of the targeted species were found during the surveys: *Austrominius modestus*, *Botrylloides violaceus*, *Caprella mutica*, *Codium fragile ssp. fragile*, *Corella eumyota*, *Heterosiphonia japonica*, *Neosiphonia harveyi*, *Schizoporella japonica* and *Tricellaria inopinata*. The non-native bryozoan *Bugula simplex* which was not targeted was also found and this constituted the first confirmed Scottish record. The surveys provided sixty new locality records and extended the northward national range for most of the non-native species found. The number of non-native species found in the surveyed harbours/ marinas was positively associated with the presence of floating structure and the vessel activity indices: number of vessels and perimeter of quayside. For further information contact Chris Nall (Chris.Nall@uhi.ac.uk)

5. Adrian Macleod has published his PhD 'The role of Marine Renewable Energy structures and biofouling communities in promoting self-sustaining populations of Non-Native Species' which is available on request. For further information contact Adrian Macleod (Adrian.Macleod@sams.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*. To date results have demonstrated that water at ≈40°C is effective at reducing the risk of translocation of all species tested to date. Other work has included a fact finding mission to New Zealand to gather information on the sustainable implementation of effective biosecuirty campaigns. Reports from this work are expected to be available by mid-2014- for further information contact Paul Stebbing (paul.stebbing@cefas.co.uk).

Subsequent to finding *Dikerogammarus haemobaphes* in the River Severn (England) in 2012, Defra requested a review from Cefas on potential control and eradication methods (Rimmer *et al.* 2013). The report reviewed a range of potential control mechanizms including chemical control, semiochemicals, biological control agents (including pathogens and predators), male sterilisation, physical control (such as trapping, restriction barriers and habitat modification) and possible bio-security measures to reduce the risk of spread.

In 2013 Defra commission a report quantifying the scale of trade and use of non-native species to support negotiations on forthcoming EU invasive alien species strategy (Parrot *et al.* 2013). The report included contributions from AHVLA, Cefas, Fera and the Forestry Commission.

Work is being conducted by Cefas examining methods of controlling invasive species of crayfish started in 2013. There are several different strands to this work looking at different forms of control including: male sterilisation, biocidal control and physical removal. The initial male sterilisation report (funded by Natural England) has been produced (Stebbing & Rimmer 2014), the biocide work (funded by Defra and being conducted in collaboration with Fera) will be completed by May 2014, and the trapping work (funded by Defra) will be completed in March 2015. For further information contact Paul Stebbing (paul.stebbing@cefas.co.uk).

A new version of the decision support tool, the Fish Invasiveness Scoring Kit (FISK), which was first made available upon request in 2012, was published online for free download (http://www.cefas.defra.gov.uk/4200.aspx) on 31 October 2013. FISK v2 is a complete revision of this decision-support tool, including improvements to the questions, guidance and user interface to make this screening tool applicable to virtually all climatic zones. A special section of the journal '*Risk Analysis*', published in August 2013, contains papers that summarize applications of FISK (Copp 2013), describe the revisions to FISK (Lawson *et al.* 2013) and provide details on application of FISK v2 in Australia (Vilizzi & Copp 2013), Finland (Puntila *et al.* 2013), Iberia (Ameida *et al.* 2013). Elsewhere, an application of FISK v2 in four Balkans countries also appeared in 2013 (Simonović *et al.* 2013), with one for Turkey due for publication in 2014.

The marine pathways project, which started 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 coordinated 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. Results will be delivered throughout the life of the project, which will end in March 2015. For further information contact Hannah Tidbury (hannah.tidbury@cefas.co.uk) or Paul Stebbing (paul.stebbing@cefas.co.uk).

Work is being conducted by Cefas examining the potential use of molecular tools in monitoring for marine non-native species as well as the detection of selected freshwater fish (*Pseudorasbora parva, Lepomis gibbosus, Leucaspius delineatus, Pimphales promelas*) from the DNA they shed into the water – 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. Meta-barcoding will be conducted to cross validate the material that is being used for testing PCR is positive/ negative; demonstrate the number of closely related species in the sample, proving that the PCR primers designed are not cross amplifying; and demonstrate the ability of metabarcoding to ID many species at once, without having to preselect an assay, in an open-ended, non-bias manner. It is hoped that this work will assist in the development of monitoring programme under the MSFD with a rapid turnaround time. Result from this study should be available in April 2014. For further information on the detection of marine species, contact Paul Stebbing (paul.stebbing@cefas.co.uk), and for freshwater fish contact Gordon H. Copp (gordon.copp@cefas.co.uk)

As part of the Orkney Islands Council's proposed Revised Ballast Water Management Policy in 2012, a baseline survey for marine non-native species in Scapa Flow and Loch of Stenness has been planned. The 'Monitoring and Recording System for Marine Invasive Non-Native Species; Scapa Flow and Loch of Stenness' report outlined the survey methods to be used during baseline survey and during monitoring phase. The baseline survey for non-native species in Scapa Flow and Loch of Stenness was conducted in 2013. Phase 1 survey was completed in February, March and April 2013 when 14 sites were visited and 33 samples collected. Phase 2 surveys were completed in July, August and September 2013 when 14 sites were visited and 55 samples were collected. During Phase 1 survey three non-native species were recorded; Japanese skeleton shrimp *Caprella mutica*, Jenkin's spire shell *Potamopyrgus antipodarum* and red seaweed (*Bonnemaisonia hamifera*). All of these have been recorded in Orkney previously. At the time of writing only Phase 1 results were available. For further information contact Jenni Kakkonen (Jenni.Kakkonen@orkney.gsx.gov.uk).

The North Atlantic Fisheries College (NAFC) Marine Centre in Shetland has been undertaking invasive species monitoring at Shetland's ports, marinas and aquaculture sites since 2012. This has included both rapid assessment surveys and the use of settlement panels. Information leaflets and identification guides have also been produced and distributed providing information to various marine users on the main invasive non-native species (INNS) risks in Shetland, and how to prevent the introduction and spread of INNS. Leaflets have been compiled for the aquaculture industry, divers, ports and harbours, marinas, and marine users. These are publically available on the NAFC Marine Centre web page (http://www.nafc.ac.uk/non-native-species-in-shetland.aspx).

The NAFC Marine Centre is also in the process of compiling a Biosecurity Plan for Shetland, a document which will provide supplementary guidance to that already contained in Shetland Islands' Marine Spatial Plan (Fourth Edition) (www.nafc.ac.uk/smsp.aspx). The Biosecurity Plan will provide information on biosecurity legislation, a description of existing and potential biosecurity risks to the islands, assessment of likely methods of introduction, management and control advice, pathway analysis, and what steps are currently being taken to reduce and mitigate invasive non-native species populations in Shetland. Additionally, a section will be included which provides sectorial specific guidance in order to make operating under best practice guidelines a simple, straightforward task for both commercial and recreational marine users. Funding for this work has been provided by the NAFC Marine Centre and Marine Scotland. For further information contact Rachel Shucksmith (Rachel.Shucksmith@uhi.ac.uk) or Katrina MacIver (marineplan@uhi.ac.uk).

## Meetings

### Past year (2013)

Canadian Conference for Fisheries Research (Windsor, Canada; 3–5 January 2013)

24th USDA Interagency Research Forum on Invasive Species (Annapolis, Maryland. USA; 8–11 January 2013)

Kansas Natural Resource Conference (KNRC) - Under Attack: Invasive Species in Kansas (Wichita, Kansas, USA: 24–25 January 2013)

Invasive Species in the Panhandle Workshop: Identification, Control and Safety (Milton, Florida, USA; 6 March 2013)

British Ecological Society Symposium on Non-native Species Management (University of Worcester; 25 March 2013)

Freshwater Invasives – Networking for Strategy (Galway, Ireland; 8–11 April 2013) (www.finsconference.ie)

18th International Conference on Aquatic Invasive Species – ICAIS (Niagara Falls, Canada; 21–25 April 2013)(http://www.icais.org/)

Great Lakes Panel on Aquatic Nuisance Species (Duluth, Minnesota, USA: 7–8 May 2013)

Invasive Species Ireland, Annual Meeting. May 2013

Invasive Alien Predators - Policy, Research and Management in Europe (Luleå, Sweden; 16–18 June 2013)

13th International Conference on Ecology (Intecol) (London, 18–23 August 2013)

International Conference on Marine Bioinvasions (University of British International Conference on Marine Bioinvasions (University of British Columbia, Canada; 20–22 August, 2013)

Invasion of alien species in Holarctic. Borok-4 (Borok, Russia; 22–28 September 2013)

Alien Alert – Expert Workshop (Brussels, Belgium; 30 September–1 November 2013)

2nd International Congress on Biological Invasions (ICBI): Biological Invasions, Ecological Safety and Food Security (Qingdao, China; 23–27 October 2013)

Conference on Non-indigenous species in the Northeast Atlantic (Ostend, Belgium; 20–22 November 2013)

### Meetings in 2014

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

Canadian Conference for Fisheries Research (Yellowknife, Canada; 3–5 January 2014)(http://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)

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## 3.22 United States

Submitted by James T. Carlton, Paul Fofonoff, and Judith Pederson

### Highlights

One new species, *Panulirus versicolor*, the Painted Spiny Lobster has been found in a single location in the state of Georgia as a single specimen. Several species have been shown to expand their ranges including, the red alga *Heterosiphonia japonica* northward to Maine, the brown alga *Colpomenia perigrina* (southward), the rhizocephalan barnacle (parasite) *Loxothylacus panopaei,* two shrimp *Palaemon elegans and P. macrodactylus,* the bryozoan *Tricellaria inopinata,* and the lion fish, *Pterois volitans/miles.* One transient, *Palaemon floridanus* was along with two warm water species *Melita palmata* and *Aiptasiogeton eruptaurantia* have been observed in New England waters, of which *M. palmata* and *A. eruptaurantia* may be established.

### 1. Regulations:

There have been no new regulations since the Non-Indigenous Species Act of 1996 and the Non-indigenous Aquatic Nuisance Prevention Control Act of 199. The President's Executive Order of 1999 is still in effect.

The Lacey Act continues to be amended, but fails to keep pace with new introduction.

In 2008, it was amended to include new language on plants and it continues to ban specific species, primarily endangered animals and their parts. Aquatic species, such as fish and shellfish are listed and include the Chinese mitten crab and European green crab, and quagga and zebra mussels by name. Other species include fish, snakes, mammals and plants.

### 2. Intentional:

Synthesis of introductions

The Animal and Plant Health Inspection Service (APHIS) continues to regulate imports of plants and animals. Unfortunately, fish (freshwater and marine) and shellfish (freshwater and marine) are lumped into statistics that include live, frozen, minced, dried, and processed. Imports reflect the World Organization for Animal Health (OIE) recommendations and alerts to prevent epizootic transfers.

# 3. Unintentional Introductions

## New Sightings

*Panulirus versicolor* (Painted Spiny Lobster [Indo-West Pacific])- Brunswick, Georgia (South Brunswick River; 8/2012, 31°08'07"N, 81°31'50"W, 1 specimen, aquarium release or ballast water) (Page, 2013)

## Previous Sightings

## Range Expansions

### Algae

*Heterosiphonia japonica* (Rhodophyta) was first found off Rhode Island in 2009, and is now established from Cape Elizabeth Maine to Southold, Long Island/New York (Long Island Sound) by 2012 (Newton et al. 2013). This Western Pacific species has been collected, but not established, as far north as Mahone Bay, Nova Scotia (Savoie and Sunders 2013). At some locations, it occurs at high abundances, especially north of Cape Cod. Coastal dispersal is assumed to occur largely by drifting.

*Colpomenia perigrina* has been moving southward and found in southern Massachusetts (Marshfield and Plymouth, MA) and in Buzzard Bay, Massachusetts.

### Invertebrates

**Cnidaria: Hydrozoa** (hydroids and hydromedusae)

*Blackfordia virginica (*Cnidaria, Hydrozoa), medusa and hydroid. The previous known range of this putative Black Sea species was from New York Harbour to South Carolina. The inconspicuous hydroid was collected in Baltimore, Maryland and Norfolk, Virginia in 1999 (Ruiz et al. 2014), but there have been few recent collections of medusa from US waters. A recently-published study extended the southern US range of this hydrozoan to Louisiana (Lake Pontchartrain) (6/9/09, Harrison et al. 2013, 30 05 34.430N, 89 46 37.630W). Harrison et al. also collected medusae from Delaware Bay (2009) and Chesapeake Bay (2010, Virginia), and from San Francisco Bay. North American populations had a very low genetic diversity, compared to that of 30 other hydrozoans, supporting the hypothesis that this species is introduced to North America (Harrison et al. 2013).

### Annelids

### Polychaetes

*Neodexiospira brasiliensis* (Annelid, Polychaeta). This Indo-West Pacific or Western Pacific species has been reported in three locations in Massachusetts and Rhode Island during a 2013 survey. However it is likely that it has been present for some time, but only recently reported. It appears to have a worldwide distribution and is often found on *Sargassum muticum* in the UK, but also is found on *Zostera marina* blades.

### Crustacea

### 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. Newly established populations of *M. coccopoma* north of Cape Canaveral, Florida, found in 2006-2009, died out, or greatly declined in the severe winter of 2009-2010, but recovered dramatically by 2011-2012 (Crickenberger and Moran 2013). Established populations of *Megabalanus coccopoma* were found in Corpus Christi, Texas. However, molecular analyses of *Megabalanus* spp. found in Tampa and Pensacola Bays, Florida, indicate that these specimens belonged to at least one unidentified species (Cohen et al. 2014).

*Loxothylacus panopaei.* This Gulf of Mexico rhizocephalan barnacle is a parasite of native panopeid crabs, including *Eurypanopeus depressus* and *Rhithropanopeus harrisii*. In 1964, it was found infesting native crabs in Chesapeake Bay, where it may have been introduced with oysters from the Gulf. In later surveys, it was found in northern Florida, Georgia, and North Carolina. In 2012, *L. panopaei* was found infecting *E. depressus* in Hempstead Harbour, Long Island Sound, New York, a range extension of about 300 km (Freeman et al. 2013).

### Isopods

*Ianiropsis serricaudis.* This Asian isopod, noted in previous reports, is now known to occur from Maine to New Jersey (Hobbs et al., 2014, submitted). It has become one of the most abundant isopods along the New England coast, often occurring by midsummer the millions in fouling communities among bryozoans and ascidians (sea squirts) on floating pontoons.

### Crabs

*Eriocheir sinensis* (Chinese Mitten Crab) A single shed exoskeleton was found along the Sawkill River, a Hudson River tributary, in Annandale New York , on August 19, 2013, and an adult crab was sighted near Poughkeepsie on Oct. 28. These are the first sightings of Mitten Crabs in the Hudson River since 2010 (Schmidt et al. 2013; Stanne et al. 2013). Populations of this crab are apparently established in the Hudson River estuary and tributaries, probably since 2005 (Schmidt et al. 2009).

### Shrimp

*Palaemon macrodactylus***.** This Asian shrimp was first collected in 2001 in New York City, and continues to expand along the Atlantic coast. Unpublished records are in hand from the Gulf of Maine (Boston area) to New Jersey and Chesapeake Bay. A paper summarizing these and other records is in preparation (Carlton et al., 2014).

*Palaemon elegans*. This European shrimp was first collected in 2010 in the greater Boston, Massachusetts region, and also continues to expand. Unpublished records are in hand from Maine to Buzzards Bay (at the southern [western] end of the Cape Cod Canal, Massachusetts]. A paper summarizing these and other records is in preparation (Carlton et al., 2014).

*Penaeus monodon*. This large Asian Tiger shrimp, once widely used in aquaculture, has been appearing in shrimp catches since 2006, and now occurs on the US coast from North Carolina to Texas. There have been at least 129 records in US waters since 2013 (USGS Non-indigenous Aquatic Species Program 2014), but Louisiana has stopped processing records, and other states can be expected to do so, as occurrences become more frequent. From 2006 to 2012, 981 individual shrimp were reported, mostly by commercial fishers. Some of these shrimps were juveniles, <160 mm, suggesting that breeding populations occur off the Atlantic and Gulf coasts (Fuller et al. 2014, in review)

### Bryozoa

*Tricellaria inopinata*. As previously reported, this Pacific Ocean bryozoan was first reported from Woods Hole, Massachusetts, on Cape Cod based upon collections first made in 2010 (Johnson et al., 2012). It has since been reported north to the Gulf of Maine (Boston and other locations), and now occurs south to Rhode Island (Rapid Assessment Survey August 2013, discussed below) and into Long Island Sound (J. T. Carlton and others, 2013 collections).

### Fish

*Pterois volitans/miles* (Lionfish) have not greatly expanded their range in US waters in 2013, over 2012, but their abundance has greatly increased, particularly in the Gulf of Mexico. In 2013, at least 238 specimens were reported, with 184 coming from the Gulf of Mexico. Lionfish were first recorded in the Gulf in 2006 on the west coast Florida, and now have extended their range to Texas and Mexico, and appear to be increasing their abundance in the northwestern Gulf (USGS Non-indigenous Aquatic Species Program 2014). A recent study of the biology of Lionfish, taken off the coast of Alabama, found that feeding and reproductive characteristics were similar to those reported for Atlantic waters (Brown-Peterson and Hendon 2013). Albins and Hixon (2013) have reviewed the impacts of Lionfish on Caribbean reefs, and sketched a ‘worst-case scenario’ in which *Pterois* becomes the dominant predator on the reef, due to the removal of sharks and other top predators. Lionfish predation, combined with uncontrolled fishing , could greatly reduce fish diversity, simplifying foodwebs, reducing herbivory, and encouraging alga growth. They recommend developing lionfish removal efforts, encouraging fisheries for lionfish, while improving management of native fish (Albins and Hixon 2013).

*Cromileptes altivelis* (Humpback Grouper; Panther Grouper) is an Indo-Pacific fish often kept in aquaria. It has been reported at least 8 times on the Atlantic and Gulf coasts of Florida from 1984 to 2012 (USGS Non-indigenous Aquatic Species Program 2014). It is not known to have established populations, but a modelling study, incorporating physical and biological data, has indicated that successful breeding and recruitment of this fish is possible in the Florida Keys, near Cape Canaveral, and near Myrtle Beach, North Carolina. The authors suggest that this model would be useful in detection and early response to this and other invasions (Johnston and Purkis 2013).

### Rapid Assessment Survey August 2013, Maine to Rhode Island

A Rapid Assessment Survey (RAS) was again conducted by the Massachusetts Office of Coastal Zone Management and the Massachusetts Institute of Technology (MIT) Office of Sea Grant to assess the relative abundance and biodiversity of native and introduced species on floating docks (pontoons) in marinas along the New England Coast. The previous RAS was conducted in 2010, the report of which was released in March 2013 (McIntyre et al., 2013).

A report of the 2013 RAS is in preparation and expected for early 2014 release. New records were found of hydroids, sea anemones, bryozoans, shrimp, gammarid amphipods, ascidians, algae, and other taxa. Some of these constitute range expansions of previously documented invasions (such as the bryozoan *Tricellaria*, above), some are southern U.S. species newly or recently detected in New England (examples below), and others, such as certain bryozoans, may represent new records for New England (but may represent greater taxonomic resolution, rather than new invasions).

Of great interest was the discovery of 1 (one) specimen of the European gammarid amphipod ***Melita palmata*** in Boston, but a return visit to retrieve more specimens in September 2013 did not produce additional specimens. Two native southern U.S. species were newly detected in southern New England waters: the sea anemone ***Aiptasiogeton eruptaurantia*** (numerous individuals at one station in Rhode Island) and the Florida grass shrimp ***Palaemon floridanus*** (one specimen at one station in Massachusetts). Subsequent investigation revealed that the anemone had been seen at the Rhode Island station since 2011.

***Palaemon floridanus*** is regarded as a transient summer arrival, and is not considered as an established species. The status of ***Aiptasiogeton*** as a permanent addition to the New England fauna are uncertain, but will continue to be monitored. The status of ***Melita palmata*** in the Gulf of Maine is unknown, but monitoring will continue in 2014, soon after the cessation of the inexorable New England winter of 2013-2014.

### Species Not Seen Yet or No Longer Observed

In 2012, we reported that the European anemone, *Sagartia elegans* and it remains unseen despite continued searches in the one location where it had been found. Its disappearance has coincided with the closure of a nearby coal-powered electric plant.

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# Annex 4. List of new species and range expansions of alien species as reported in National Reports

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 04-07-2013 | Ammothea | hilgendorfi | (Böhm, 1879) | Pycnogonida | Hinder Bank area | 51°41'N | 2°52' E | single | Southern North Sea | 04-07-2013 | shipping | | Kerckhof unpubl. |
| Canada | 31-10-2012 | Ascidiella | aspersa | Muller, 1776 | tunicate | Lunenburg Harbour; Railway wharf | 44.37525 | -64.30687 | Observed | south shore Nova Scotia, Lunenburg harbour | 2012 | unknown | unknown | |
| Canada | 30-11-2013 | Ascidiella | aspersa | Muller, 1776 | tunicate | Lunenburg Harbour; Railway wharf | 44.37525 | -64.30687 | Established | | | unknown | | |
| Canada | 30-11-2013 | Ascidiella | aspersa | Muller, 1776 | tunicate | Corkum's Island | 44.36113 | -64.33362 | Established | | | unknown | | |
| Canada | 30-11-2013 | Ascidiella | aspersa | Muller, 1776 | tunicate | Lunenburg Harbour, Fisheries Museum wharf | 44.3754 | -64.3105 | Established | | | unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 23-10-2007 | Botrylloides | violaceus | Oka, 1927 | Urochordata | Belleoram | N 47.527194 | W 055.409167 | 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 | Decrease water quality and hydrodynamics, compete with indigenous species and impact aquaculture and other marine activities | McKenzie et al., 2010; Deibel et al., 2014 |
| Canada | 17-11-2013 | Botrylloides | violaceus | Oka, 1927 | Urochordata | Codroy | N 47.8812 | W 059.398233 | 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 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 2004 | Botrylloides | violaceus | Oka, 1927 | Ascidiacea | Borden | 46.24993 | -63.7031 | Established | Borden (within Gulf Region) | 2004 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | |
| Canada | 2006-10-00 | Botrylloides | violaceus | Oka, 1927 | Ascidiacea | Cape Tormentine | 46.13179 | -63.77321 | Established | Borden (within Gulf Region) | 2004 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | DFO tunicate diving survey, station 2-southwestern breakwater; Botrylloides violaceus of medium density, well established in rock crevasses of low water areas |
| Canada | 01-11-2013 | Botrylloides | violaceus | Oka, 1929 | tunicate | St. Andrews Biological Station | 45.0823 | -67.0847 | Established and spreading | | | unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 2013-09-18 | Botrylloides | violaceus | Oka, 1927 | Ascidiacea | Chance Harbour | 45.67947 | -62.58035 | Reported | Borden (within Gulf Region) | 2004 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | DFO AIS monitoring program |
| Canada | 2001 | Botrylloides | violaceus | Oka, 1927 | tunicate | Lunenburg and Mahone Bays | | | First report | South shore, Nova Scotia | 2001 | unknown | | |
| Canada | 30-11-2013 | Botrylloides | violaceus | Oka, 1927 | tunicate | Dingwall | 46.9032 | -60.4604 | Established | | | unknown | | |
| Canada | 30-11-2013 | Botrylloides | violaceus | Oka, 1927 | tunicate | West Head | 43.45813 | -65.6546 | Established | | | unknown | | |
| Canada | 1940's | Botryllus | schlosseri | Savigny, 1816 | Urochordata | Argentia | N 47.292 | W 053.990417 | First record | Quebec | 1900 (Carver, Mallet & Vercaemer, 2006b) | Anthropogenic | | US Navy, 1951; Callahan et al., 2010; Ma, 2010; McKenzie et al., 2010 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 1975 | Botryllus | schlosseri | Savigny, 1816 | Urochordata | St Pauls Inlet | N 49.847821 | W 057.781275 | Unknown | Quebec | 1900 (Carver, Mallet & Vercaemer, 2006b) | Anthropogenic | | Hooper, 1975 |
| Canada | 10-10-2013 | Botryllus | schlosseri | Savigny, 1816 | Urochordata | Foxtrap | N 47.5129 | W 052.9986 | Established, expanding | Quebec | 1900 (Carver, Mallet & Vercaemer, 2006b) | Anthropogenic, Shipping Traffic, Movement of Fishing Gear | Decrease water quality and hydrodynamics, compete with indigenous species and impact aquaculture and other marine activities (e.g. heavy fouling and overgrowth) | Carver, Mallet & Vercaemer, 2006b; Deibel et al., 2014 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 17-11-2013 | Botryllus | schlosseri | Savigny, 1816 | Urochordata | Codroy | N 47.8812 | W 059.398233 | Single specimen observed | Quebec | 1900 (Carver, Mallet & Vercaemer, 2006b) | Anthropogenic, Shipping Traffic, Movement of Fishing Gear | | S. Caines, pers comm |
| Canada | 2001 | Botryllus | schlosseri | (Pallas, 1766) | Ascidiacea | St. Peters Bay | 46.42989 | -62.698 | Established | St. Peters Bay (within Gulf Region) | 2001 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | |
| Canada | 2013 | Botryllus | schlosseri | (Pallas, 1766) | Ascidiacea | North Lake | 46.46613 | -62.07199 | Established | St. Peters Bay (within Gulf Region) | 2001 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 2013 | Botryllus | schlosseri | (Pallas, 1766) | Ascidiacea | Conway Narrows | 46.65518 | -63.91164 | Established | St. Peters Bay (within Gulf Region) | 2001 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | |
| Canada | 1970's | Botryllus | schlosseri | Pallas, 1761 | tunicate | Lower Bay of Fundy | | | First report | Lower Bay of Fundy, New Brunswick | 1970's | unknown | | |
| Canada | 01-11-2013 | Botryllus | schlosseri | Pallas, 1763 | tunicate | St. Andrews Biological Station | 45.0823 | -67.0847 | Established | | | unknown | | |
| Canada | 1980's | Botryllus | schlosseri | Pallas, 1761 | tunicate | Atlantic Coast and Bras D'Or lake | | | First report | Atlantic Coast and Bras D'Or lake | 1980's | unknown | | |
| Canada | 30-11-2013 | Botryllus | schlosseri | Pallas, 1761 | tunicate | Dingwall | 46.9032 | -60.4604 | Established | | | unknown | | |
| Canada | 30-11-2013 | Botryllus | schlosseri | Pallas, 1761 | tunicate | West Head | 43.45813 | -65.6546 | Established | | | unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 02-11-2006 | Caprella | mutica | Schurin, 1935 | Amphipoda | Presque Harbour | N 47.411717 | W 054.498250 | First record | Prince Edward Island | 1998 (Turcotte & Sainte-Marie, 2009) | Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear | Negative impacts on mussel spat, on food chain structure in native species, on community biodiversity , and direct competition with native caprillids | Turcotte & Sainte-Marie, 2009; McKenzie et al., 2010 |
| Canada | 11-09-2013 | Caprella | mutica | Schurin, 1935 | Amphipoda | Burin | N 47.030889 | W 055.174333 | Unknown | Prince Edward Island | 1998 (Turcotte & Sainte-Marie, 2009) | Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear | | P. Sargent, pers comm |
| Canada | 30-11-2013 | Caprella | mutica | Schurin, 1935 | Amphipod | Dingwall | 46.9032 | -60.4604 | Established | | | unknown | unknown | |
| Canada | 30-11-2013 | Caprella | mutica | Schurin, 1935 | Amphipod | Ship Harbour | 44.8124 | -62.872 | Established | | | unknown | unknown | |
| Canada | 2003 | Caprella | mutica | Schurin, 1935 | Amphipod shrimp | Passamaquoddy Bay | | | First report | Lower Bay of Fundy, New Brunswick | 2003 | unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 01-11-2013 | Caprella | mutica | Schurin, 1937 | Amphipod shrimp | St. Andrews Biological Station | 45.0823 | -67.0847 | Established | | | unknown | | |
| Canada | 28-08-2007 | Carcinus | maenas | Linnaeus, 1758 | Decapoda | North Harbour | N 47.85486 | W 054.10026 | First record | Digdeguash River, Passamaquoddy Bay | 1951 (Klassen & Locke, 2007) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with, and prey on, native crustaceans and bivalves | Klassen & Locke, 2007; Blakeslee et al., 2010; McKenzie et al., 2010 |
| Canada | 07-07-2013 | Carcinus | maenas | Linnaeus, 1758 | Decapoda | Port Saunders | N 50.647042 | W 057.276222 | Established, expanding | Digdeguash River, Passamaquoddy Bay | 1951 (Klassen & Locke, 2007) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with, and prey on, native crustaceans and bivalves, destruction of eelgrass habitat | |
| Canada | 12-08-2013 | Carcinus | maenas | Linnaeus, 1758 | Decapoda | Pools Cove | N 47.68209 | W 055.430145 | Established, expanding | Digdeguash River, Passamaquoddy Bay | 1951 (Klassen & Locke, 2007) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with, and prey on, native crustaceans and bivalves, destruction of eelgrass habitat | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 1996-00-00 | Carcinus | maenas | (Linnaeus, 1758) | Crustacea | Georgetown | 46.167 | -62.533 | Established | Auld's Cove, NS (within Gulf Region) | 1994 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with, and prey on, native crustaceans and bivalves, destruction of eelgrass habitat | |
| Canada | 1951 | Carcinus | maenas | Linnaeus, 1758 | Crustacea | Passamaquoddy Bay | | | | Lower Bay of Fundy, New Brunswick | | unknown | | |
| Canada | 01-11-2013 | Carcinus | maenas | Linnaeus, 1759 | Crustacea | Mary's Point | 45.7102 | -64.6677 | | | | unknown | | |
| Canada | 1953 | Carcinus | maenas | Linnaeus, 1758 | Crustacea | Minas Basin and St. Mary's Bay | | | First Report | Bay of Fundy shores | 1953 | | | |
| Canada | 27-07-2013 | Carcinus | maenas | Linnaeus, 1758 | Crustacea | Ingonish, MacLeods Point | 46.68 | -60.35 | Established | | | | | |
| Canada | 04-07-2013 | Carcinus | maenas | Linnaeus, 1758 | Crustacea | Wedgeport | 43.71468 | -65.9696 | Established | | | | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 19-09-2012 | Ciona | intestinalis | Linnaeus, 1767 | Urochordata | Burin | N 47.031 | W 055.172936 | First record | Grand Manan Island | Stimpson , 1852 | Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear | negatively impact water quality, compete with native species for food and space, and impact aquaculture and boating | Carver, Mallet & Vercaemer, 2006a; Sargent et al., 2013 |
| Canada | 10-09-2013 | Ciona | intestinalis | Linnaeus, 1767 | Urochordata | Marystown | N 47.167 | W 055.015194 | Established | Grand Manan Island | Stimpson , 1852 | Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear | | |
| Canada | 01-10-2013 | Ciona | intestinalis | Linnaeus, 1767 | Urochordata | Little Bay | N 47.163 | W 055.112194 | Established | Grand Manan Island | Stimpson , 1852 | Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 22-09-2005 | Ciona | intestinalis | (Linnaeus, 1767) | Ascidiacea | St. Mary's Bay | 46.14695 | -62.52 | Established | St. Mary's Bay, PEI (within Gulf Region) | 2005 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | DFO Stewartship monitoring; Ciona confirmed at Souris marina on 22 Sept. |
| Canada | 1997 | Ciona | intestinalis | Linnaeus, 1767 | tunicate | Lunenburg Bay | | | First Report | South shore, Nova Scotia | 1997 | unknown | | |
| Canada | 30-11-2013 | Ciona | intestinalis | Linnaeus, 1767 | tunicate | Dingwall | 46.9032 | -60.4604 | Established | | | unknown | | |
| Canada | 30-11-2013 | Ciona | intestinalis | Linnaeus, 1767 | tunicate | Clark's Harbour | 43.4447 | -65.6351 | Established | | | unknown | | |
| Canada | 1850 | Ciona | intestinalis | Linnaeus, 1767 | tunicate | Bay of Fundy | | | First report | Lower Bay of Fundy, New Brunswick | | unknown | | |
| Canada | 01-11-2013 | Ciona | intestinalis | Linnaeus, 1769 | tunicate | St. Andrews Biological Station | 45.0823 | -67.0847 | Established | | | unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 22-08-2012 | Codium | fragile | (Suringar) Hariot, 1889 | Algae: Chlorophyta | Spanish Room | N 47.195 | W 055.075 | First record, single specimen collected | Mahone Bay, NS | 1989-1991 (Bird,1993) | Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear | Displacement of native kelps, heavy biofouler, impacts to aquaculture | Matheson et al., 2014 |
| Canada | 30-08-2013 | Codium | fragile | (Suringar) Hariot, 1889 | Algae: Chlorophyta | Arnolds Cove | N 47.756 | W 053.988 | Established | Mahone Bay, NS | 1989-1991 (Bird,1993) | Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear | Displacement of native kelps, heavy biofouler, impacts to aquaculture | |
| Canada | 23-09-2013 | Codium | fragile | (Suringar) Hariot, 1889 | Algae: Chlorophyta | Pilley's Island | N 49.477 | W 055.725 | Established | Mahone Bay, NS | 1989-1991 (Bird,1993) | Anthropogenic, Shipping Traffic, Movement of Fishing & Aquaculture Gear | Displacement of native kelps, heavy biofouler, impacts to aquaculture | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 2005 | Codium | fragile | (Suringar) Hariot, 1889 | Chlorophyta | Brudenell | 46.172776 | -62.547863 | Reported | Caribou (within Gulf Region) | 2002 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with or smother eelgrass beds, relocation of molluscs by drifting | DFO CAMP station 2, Aitken Pt. (June) |
| Canada | 2013-06-19 | Codium | fragile | (Suringar) Hariot, 1889 | Chlorophyta | Tatamagouche | 45.76097 | -63.1882 | Reported | Caribou (within Gulf Region) | 2002 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with or smother eelgrass beds, relocation of molluscs by drifting | DFO CAMP |
| Canada | 1989 | Codium | fragile | | Alga | Mahone Bay | | | First report | South shore, Nova Scotia | 2012 | unknown | | |
| Canada | 29-Nov-2013 | Didemnum | vexillum | Kott, 2002 | tunicate | Minas Basin | n/a | n/a | First report | Minas Basin | 2013 | unknown | | |
| Canada | 31-10-2013 | Diplosoma | listerianum | Milne-Edwards, 1841 | tunicate | Lunenburg Harbour, Fisheries Museum wharf | 44.3754 | -64.3105 | First report | south shore Nova Scotia, Lunenburg harbour | 2012 | unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 2013 | Heterospi phonia | japaonica | Yendo, 1920? | Alga | Lunenburg | | | First report | South shore, Nova Scotia | 2012 | unknown | | |
| Canada | 2002 | Membran ipora | membranac ea | Linnaeus, 1767 | Bryozoa | Bonne Bay | N 49.50576 | W 57.91666 | First report | Nova Scotia | 1990's (Burridg e, 2012) | Unknown/N atural Dispersal/Ra fting | Destruction of kelp bed habitat | R Hooper, pers comm; McKenzie et al., 2010 |
| Canada | 18-10-2012 | Membran ipora | membranac ea | Linnaeus, 1767 | Bryozoa | Little St Lawrence | N 46.922131 | W 055.360794 | Established, Widespread | Nova Scotia | 1990's (Burridg e, 2012) | Unknown/N atural Dispersal/Ra fting | Destruction of kelp bed habitat | |
| Canada | 1992 | Membran ipora | membranac ea | Linaeus, 1767 | Bryozoa | Mahone and St. Margaret's Bays | | | First Report | South shore, Nova Scotia | 1992 | unknown | | |
| Canada | 30-11-2013 | Membran ipora | membranac ea | Linaeus, 1767 | Bryozoa | Venus Cove | 45.6153 | -61.3901 | Established | | | unknown | | |
| Canada | 30-11-2013 | Membran ipora | membranac ea | Linaeus, 1767 | Bryozoa | Clark's Harbour | 43.4447 | -65.6351 | Established | | | unknown | | |
| Canada | 01-11-2013 | Membran ipora | membranac ea | Linaeus, 1769 | Bryozoa | St. Andrews Biological Station | 45.0823 | -67.0847 | Established | | | unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada | 1998 | Styela | clava | Herdman, 1881 | Ascidiacea | Montague/Brudenell | 46.17488 | -62.5786 | Established | Montague/Brudenell (within Gulf Region) | 1998 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | PEI DFARD |
| Canada | 15-11-2013 | Styela | clava | Herdman, 1881 | Ascidiacea | Egmont Bay | 46.557 | -64.083 | Reported | Montague/Brudenell (within Gulf Region) | 1998 (within Gulf Region) | Anthropogenic, Shipping Traffic, Ballast Release | Compete with molluscs and other filter-feeders for food, impede mollusc growth and marketability | PEI DFARD |
| Canada | 31-10-2012 | Styela | clava | Herdman 1881 | tunciate | Halifax Harbour; BIO Jetty | 44.68187 | -63.61187 | First report | Halifax Harbour | 2012 | unknown | | |
| Canada | 31-10-2012 | Styela | clava | Herdman 1882 | tunciate | Lunenburg Harbour, Fisheries Museum wharf | 44.3754 | -64.3105 | First report | | | unknown | | |
| Canada | 01-11-2013 | Styela | clava | Herdman 1883 | tunciate | Venus Cove | 45.6153 | -61.3901 | Established | | | unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 19.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Baltic Proper, Baltic Sea | 58.500897 | 21.913339 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 21.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Baltic Proper, Baltic Sea | 58.182114 | 22.092945 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 23.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Baltic Proper, Baltic Sea | 57.979371 | 21.997448 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 23.06.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.520282 | 25.513535 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 26.06.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.450059 | 24.604236 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 28.06.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.399577 | 27.771832 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 28.06.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.403793 | 27.921678 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 29.06.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.46643 | 26.857972 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 1.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.525075 | 24.903912 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 2.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.44456 | 27.319122 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 4.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.549554 | 26.600115 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 4.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.556598 | 26.350994 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 5.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.611492 | 25.973318 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 9.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.625578 | 25.521251 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 9.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.615119 | 25.779524 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 12.08.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.351346 | 24.176729 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 20.08.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.455207 | 24.572456 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 20.08.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Finland, Baltic Sea | 59.459444 | 24.582067 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 17.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Riga, Baltic Sea | 58.371162 | 22.980259 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 23.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Riga, Baltic Sea | 57.939815 | 22.107969 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 23.07.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | Gulf of Riga, Baltic Sea | 57.915973 | 22.062522 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 10.08.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | West Estonian Archipelago Sea, Baltic Sea | 58.769166 | 23.545037 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 10.08.2013 | Palaemon | elegans | Rathke 1837 | Crustacea | West Estonian Archipelago Sea, Baltic Sea | 58.76621 | 23.456526 | established | Baltic Sea: Gulf of Finland, Gulf of Riga, Baltic Proper | 2011 | ballast water | competition with native P. adspersus, predation on benthic invertebrates | Kotta & Kuprijanov, 2012; Kuprijanov unpublished (www.elegans.edu.ee) |
| Estonia | 15.11.2013 | Hemimysis | anomala | G.O. Sars, 1869 | mysid | Gulf of Finland, Baltic Sea | 59.5023 | 24.80858 | unknown | Baltic Sea: Gulf of Riga | 2009 | intentional introduction | unknown | Kotta & Kotta, 2010; benthos database of Estonian Marine Institute |
| Estonia | 04.10.2013 | Eriocheir | sinensis | H. Milne Edwards, 1853 | crab | Gulf of Finland, Baltic Sea | 59.449411 | 24.613892 | not established | Baltic Sea | 1926 | seconday invasion from North Sea | | benthos database of Estonian Marine Institute |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.27657 | 24.28224 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.26488 | 24.31678 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.25736 | 24.3882 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.28818 | 24.44143 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.30107 | 24.38726 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.31438 | 24.33201 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.33858 | 24.41944 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.32422 | 24.49057 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |
| Estonia | 16.05.2013 | Laonome | armata | Bick and Kotta sp. nov. | polychaete | Pärnu Bay, Gulf of Riga, Baltic Sea | 58.32138 | 24.50323 | established | Species described by finding in the Baltic Sea, Pärnu Bay | 2012 | shipping activities | sediment morphology and chemistry, new ecological relationships, displacing or disassembling native communities | Kotta et ta. (under review) |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 2013 | Neogobius | melanostomus | Pallas 1811 | Pices | Lahepera Bay, Gulf of Finland, Baltic Sea | 59.379833 | 24.1267666 | established | Baltic Sea: Puck of Bay | early 1990s | ballast water | diet competition with demersal fish | R. Eschbaum, unpubl. |
| Estonia | 2013 | Neogobius | melanostomus | Pallas 1811 | Pices | Lahepera Bay, Gulf of Finland, Baltic Sea | 59.37185 | 24.1332 | established | Baltic Sea: Puck of Bay | early 1990s | ballast water | diet competition with demersal fish | R. Eschbaum, unpubl. |
| Estonia | 2013 | Neogobius | melanostomus | Pallas 1811 | Pices | Lahepera Bay, Gulf of Finland, Baltic Sea | 59.370033 | 24.136333 | established | Baltic Sea: Puck of Bay | early 1990s | ballast water | diet competition with demersal fish | R. Eschbaum, unpubl. |
| Estonia | 2013 | Neogobius | melanostomus | Pallas 1811 | Pices | Lahepera Bay, Gulf of Finland, Baltic Sea | 59.3983 | 24.1726333 | established | Baltic Sea: Puck of Bay | early 1990s | ballast water | diet competition with demersal fish | R. Eschbaum, unpubl. |
| Estonia | 2013 | Neogobius | melanostomus | Pallas 1811 | Pices | Lahepera Bay, Gulf of Finland, Baltic Sea | 59.399817 | 24.173917 | established | Baltic Sea: Puck of Bay | early 1990s | ballast water | diet competition with demersal fish | R. Eschbaum, unpubl. |
| Estonia | 2013 | Neogobius | melanostomus | Pallas 1811 | Pices | Lahepera Bay, Gulf of Finland, Baltic Sea | 59.40185 | 24.175767 | established | Baltic Sea: Puck of Bay | early 1990s | ballast water | diet competition with demersal fish | R. Eschbaum, unpubl. |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | 2013 | Neogobius | melanostomus | Pallas 1811 | Pices | Lahepera Bay, Gulf of Finland, Baltic Sea | 59.3776666 | 24.198333 | established | Baltic Sea: Puck of Bay | early 1990s | ballast water | diet competition with demersal fish | R. Eschbaum, unpubl. |
| Estonia | 2013 | Neogobius | melanostomus | Pallas 1811 | Pices | Lahepera Bay, Gulf of Finland, Baltic Sea | 59.34795 | 24.1988166 | established | Baltic Sea: Puck of Bay | early 1990s | ballast water | diet competition with demersal fish | R. Eschbaum, unpubl. |
| France | 06.06.2011 | Heterosiphonia | japonica | Yendo, 1920 | Rhodophyta | Cancavale - la Rance* | 48°36'17.03 N | 2°01'01,48W | locally invasive | Roscoff | 1984 | shellfish aquaculture | | Derrien-Courtel & Le Gal 2013 |
| France | 06.06.2006 | Heterosiphonia | japonica | Yendo, 1920 | Rhodophyta | Ouessant - Ar For'ch Vihan* | 48°26'58.79 N | 5°08'34,82W | locally invasive | Roscoff | 1984 | shellfish aquaculture | | Derrien-Courtel & Le Gal 2013 |
| France | 06.06.2011 | Heterosiphonia | japonica | Yendo, 1920 | Rhodophyta | Bonen du Four* | 47°18'18,00 N | 2°39,01,00W | locally invasive | Roscoff | 1984 | shellfish aquaculture | | Derrien-Courtel & Le Gal 2013 |
| France | 16.08.2013 | Carcinus | maenas | Linnaeus, 1758 | Crustacea | Grand Etang de Miquelon | 47°04’04.5 N | 56°22’52.4W | 1 male | Grand Etang de Miquelon | 21.08.2013 | | | Sellier et al., 2014 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 04.06.2012 | Hemigrapsus | sanguineus | De Haan, 1835 | Crustacea | Dunkirk harbour* | 50°03.318' N | 2°22.106'E | 231 individuals | Le Havre | 1999 | | predation on mussels and/or juvenile oysters, interspecific competition with indigenous species e.g. Carcinus maenas | Gothland et al., 2013 |
| France | 07.07.2012 | Hemigrapsus | sanguineus | De Haan, 1835 | Crustacea | Gatteville-phare* | 49°41.673' N | 1°16.038'E | 295 individuals | Le Havre | 1999 | | predation on mussels and/or juvenile oysters, interspecific competition with indigenous species e.g. Carcinus maenas | Gothland et al., 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 27.07.2012 | Hemigrapsus | sanguineus | De Haan, 1835 | Crustacea | Granville outside harbour* | 49°49.962' N | 1°36.563'E | 2 individuals | Le Havre | 1999 | | predation on mussels and/or juvenile oysters, interspecific competition with indigenous species e.g. Carcinus maenas | Gothland et al., 2013 |
| France | 2013 | Undaria | pinnatifida | Harvey (Suringar), 1873 | Algae | near Cap Fréhel | 48°51,04 N | 2°59.05′ W | / | | | wakame farming | | Leveque & Viard 2013 |
| France | 02.01.2008 | Caulerpa | taxifolia var. distichophylla | (Sonder) Verlaque, Huisman & Procacini | Algae | Punta Braccetto (Ragusa, Sicily) | 36°48' N | 14° 27' E | | Gulf of Iskerendum, Turkey | 2006 | unknown - secondary dispersal most likely maritime traffic | | Jongma et al., 2013 |
| France | 01.06.2007 | Paranthura | japonica | Richardson, 1909 | Crustacea | Arcachon Bay* | 44°40'N | 01°10'W | 1 individual | | 2007 | shellfish aquaculture | | Lavesque et al., 2013 |
| France | 01.10.2008 | Paranthura | japonica | Richardson, 1909 | Crustacea | Arcachon Bay - mussel bed* | 44°39'N | 01°07'W | 12 individuals | | 2007 | shellfish aquaculture | | Lavesque et al., 2013 |
| France | 01.09.2009 | Paranthura | japonica | Richardson, 1909 | Crustacea | Arcachon Bay - Zostera bed* | 44°40'N | 01°11'W | 4 individuals | | 2007 | shellfish aquaculture | | Lavesque et al., 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 01.08.2012 | Grandidierella | japonica | Stephensen, 1938 | Crustacea | Arcachon Bay - intertidal zone | 44°40'N | 01°10'W | large numbers | Marennes-Oléron | 2012 | shellfish aquaculture | | Lavesque et al., 2014 |
| France | 10.10.2013 | Grandidierella | japonica | Stephensen, 1938 | Crustacea | Arcachon Bay - intertidal zone | 44°40'N | 01°10'W | large numbers | Marennes-Oléron | 2012 | shellfish aquaculture | | Lavesque et al., 2014 |
| Greece | June 2008 | Asparagopsis | taxiformis | | | | | | | | | | | Tsiamis K., Economou-Amilli A., Katsaros C. & Panayotidis P., 2013. |
| Greece | June 2008 | Caulerpa | racemosa | | | | | | | | | | | Tsiamis K., Economou-Amilli A., Katsaros C. & Panayotidis P., 2013. |
| Greece | March 2013 | Caulerpa | racemosa | | | | | | | | | | | Panayotidis P. & Tsiamis K., 2013. |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greece | March 2013 | Caulerpa | racemosa | | | | | | | | | | | Panayotidis P. & Tsiamis K., 2013. 20-years occurrence of the invasive alga Caulerpa racemosa var. cylindracea in Greece. CIESM 2013 congress |
| Greece | May 2013 | Caulerpa | racemosa | | | | | | | | | | | Panayotidis P. & Tsiamis K., 2013. |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greece | May 2013 | Caulerpa | racemosa | | | | | | | | | | | Panayotidis P. & Tsiamis K., 2013. 20-years occurrence of the invasive alga Caulerpa racemosa var. cylindracea in Greece. CIESM 2013 congress |
| Greece | May 2013 | Caulerpa | racemosa | | | | | | | | | | | Panayotidis P. & Tsiamis K., 2013. |
| Greece | June 2013 | Caulerpa | racemosa | | | | | | | | | | | Panayotidis P. & Tsiamis K., 2013. |
| Greece | June 2013 | Caulerpa | racemosa | | | | | | | | | | | Panayotidis P. & Tsiamis K., 2013. |
| Greece | June 2013 | Caulerpa | racemosa | | | | | | | | | | | Panayotidis P. & Tsiamis K., 2013. |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greece | June 2008 | Codium | fragile | | | | | | | | | | | Tsiamis K., Economou-Amilli A., Katsaros C. & Panayotidis P., 2013b. |
| Greece | June 2008 | Colpomenia | peregrina | | | | | | | | | | | Tsiamis K., Economou-Amilli A., Katsaros C. & Panayotidis P., 2013b. |
| Greece | March 2013 | Halophila | stipulacea | | | | | | | | | | | Gerakaris V. & Tsiamis K., 2013. |
| Greece | June 2008 | Stypopodium | schimperi | | | | | | | | | | | Tsiamis K., Economou-Amilli A., Katsaros C. & Panayotidis P., 2013b. |
| Greece | September 2010 | Megabalanus | coccopoma | | | | | | | | | | | Polychronides et al in Siokou et al., 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greece | August, 2012 | Melicertus | hathor | | | | | | | | | | | Kapiris & Dogrammatzi in Siokou et al., 2013 |
| Greece | March 2013 | Xanthias | lamarckii | | | | | | | | | | | Corsini Foka et al., 2013 |
| Greece | July-August 2012 | Percnon | gibbesi | | | | | | | | | | | Pirkenseer, 2013 |
| Greece | July 2012 | Percnon | gibbesi | | | | | | | | | | | Pirkenseer, 2013 |
| Greece | August 2012 | Percnon | gibbesi | | | | | | | | | | | Pirkenseer, 2013 |
| Greece | 09.10.2013 | Alepes | djedaba | | | | | | | | | | | Golani et al., 2013 |
| Greece | 21.10.2013 | Alepes | djedaba | | | | | | | | | | | Golani et al., 2013 |
| Greece | 2012 | Farfantepenaeus | aztecus | | | | | | | | | | | Nikolopoulou et al., 2013 |
| Greece | 2010 | Fulvia | fragilis | | | | | | | | | | | Manousis et al., 2013 |
| Greece | 09.03.1991 | Dipolydora | blakei | | | | | | | | | | | Radashevsky & Simboura, 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greece | 26.04.1991 | Dipolydora | blakei | | | | | | | | | | | Radashevsky & Simboura, 2013 |
| Greece | 2011 | Chama | pacifica | | | | | | | | | | | Crocetta & Russo, 2013 |
| Greece | January 2011 | Centropages | furcatus | | | | | | | | | | | Siokou et al., 2013 |
| Ireland | August 2013 | Craspedacusta | sowerbyi | Lankester, 1880 | hydrozoa | Lough Derg, Shannon River | 52o 54.20'N | 08o 31.44'W | Established | Lough Derg | July 2013 | unknown | unknown | Doyle et al., in prep. |
| Ireland | September 2012 | Botrylloides | violaceus | Oka, 1927 | tunicate | Sketrick Island, Strangford Lough | 54o 29.20'N | 05o 38.47'W | Present | Strangford Lough | September 2012 | vessel hulls | Fouling species | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Bugula | neritina | (Linneaus, 1758) | bryozoan | Carrickfergus Marina | 54o 42.59’N | 05o 48.66’W | Established | Belfast Lough | September 2012 | vessel hulls | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Didemnum | vexillum | Kott, 2002 | tunicate | Ballydorn Marina | 54o 29.44’N | 05o 38.88’W | Established | Strangford Lough | September 2012 | culture activities | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Gracilaria | vermiculophylla | (Ohmi) Papenfuss | rhodophyte | Dundrum Bay | 54o 15.58'N | 05o 49.12'W | Established | North Irish Sea | September 2012 | natural spread | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Perophora | japonica | Oka, 1927 | tunicate | Carlingford Marina | 54o 03.10’N | 06o 11.47’W | Present | Carlingford Lough | August 2012 | vessel hulls | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Perophora | japonica | Oka, 1927 | tunicate | Sketrick Island narrows | 54o 29.41’N | 05o 38.57’W | Present | Strangford lough | September 2012 | unknown | unknown | Minchin & Nunn, 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ireland | September 2012 | Tricellaria | inopinata | d'Hondt & Occhipinti Ambrogi, 1985 | bryozoan | Portrush pontoon | 55o 12.25'N | 06o 39.29'W | Present | North Coast | August 2012 | unknown | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Watersip ora | subtorquata | (d'Orbigny, 1852) | bryozoan | Ardglass Marina | 54o 15.41'N | 05o 36.22'W | Present | North Irish Sea | Septemb er 2012 | vessel hulls | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Aplidium | glabrum | (Verrill, 1871) | tunicate | Ballycastle Marina | 55o 12.40'N | 06o 14.29'W | Present | North Coast | August 2012 | unknown | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Bugula | fulva | Ryland, 1960 | bryozoan | Rathlin Island pontoon | 55o 17.51'N | 06o 11.59'W | Present | North Coast | August 2012 | unknown | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Bugula | fulva | Ryland, 1960 | bryozoan | Carlingford Lough | 54o 03.10'N | 06o 11.47'W | Present | North Irish Sea | Septemb er 2012 | unknown | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Bugula | simplex | Hincks, 1886 | bryozoan | Rathlin Island pontoon | 55o 17.51'N | 06o 11.59'W | Present | North Coast | August 2012 | unknown | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Chondrac anthus | acicularis | (Roth) Fredericq | rhodophyte | Mahee island narrows | 54o 29.77'N | 05o 38.66'W | Established | Strangfor d Lough | Septemb er 2012 | unknown | unknown | Minchin & Nunn, 2013 |
| Ireland | September 2012 | Undaria | pinnatifida | (Harvey) Suringar | phaeophyte | Carrickfergus Marina | 54o 42.59'N | 05o 48.66'W | Probably established | Carrickfe rgus Marina | Septemb er 2012 | vessel hulls | Fouling species | Minchin & Nunn, 2013 |
| Ireland | March 2014 | Mercenar ia | mercenaria | (Linnaeus, 1758) | bivalve | Cork Harbour | 51o 49.50' N | 08o 16.02'W | unknown | off Whitegat e terminal | March 2014 | unknown | unknown | Stiofan Creavan pers.comm. |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ireland | April 2010 | Corbicula | fluminea | O.F. Müller, 1774 | bivalve | Barrow Estuary | 52o 29.21' N | 06o 56.01'W | established | St Mullins, Barrow River | April 2010 | unknown | trophic dominance | Caffrey et al., 2011 |
| Israel | 1999 | Cylichna | villersii | (Audouin, 1826) | Mollusca | Ashdod | | | Expanding | | | Canals | | Bogi & Galil, 2013b |
| Israel | 2005 | Elysia | grandifolia | Kelaart, 1858 | Mollusca | Nahariya | | | Local | | | Canals | | Pasternak & Galil, 2012 |
| Israel | 2008 | Lucifer | hanseni | Nobili, 1905 | Crusatacea | Ashdod | | | Expanding | | | Canals | | De Grave et al 2012 |
| Israel | 2010 | Actaea | savignii | (H. Milne Edwards, 1834) | Crusatacea | Haifa | 32°49'55.20 " | 34°58'1.20" | Single Record | | | Canals | | Karhan et al 2013 |
| Israel | 2010 | Pseudorh aphitoma | iodolabiata | (Hornung and Mermod, 1928) | Mollusca | Haifa | 32°51′09″ | 35°01′23″ | Single Record | | | Canals | | Bogi & Galil, 2012 |
| Israel | 2011 | Monotyg ma | watsoni | (Hornung & Mermod, 1927) | Mollusca | Haifa | | | Rare | | | Canals | | Bogi & Galil, 2013a |
| Israel | 2012 | Vanderho rstia | mertensi | Klausewitz, 1974 | Osteichthyes | Haifa | 32854.632 | 35801.034 | Single Record | | | Canals | | Goren et al 2013 |
| Israel | 2012 | Matuta | victor | (Fabricius, 1781) | Crusatacea | Haifa | | | Expanding | | | Canals | | Galil & Mendelson, 2012 |
| Israel | 2013 | Saron | marmoratu s | (Olivier, 1811) | Crusatacea | Nahariya | | | Rare | | | Canals | | Rothman et al 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Israel | 2013 | Gymnothorax | reticularis | Bloch, 1795 | Osteichthyes | Rosh Hanikra | 33°02' | 35°04' | Single Record | | | Canals | | Stern & Goren 2013 |
| Israel | 2013 | Parupeneus | forsskali | (Fourmanoir & Gueze, 1976) | Osteichthyes | Haifa | | | | | | Canals | | Sonin et al 2013 |
| Italy | 2010 | Grateloupia | minima | P. Crouan et H. Crouan, 1867 | Rhodophyta, Gigartinales | Taranto | 40°25'80''N | 17°11'30''E | A few specimens | Mar Piccolo, Taranto | 2010 | aquaculture | | Cecere et al., 2011 |
| Italy | 01.05.2008 | Grateloupia | yinggehaiensis | H.W.Wang et R.X.Luan, 2012 | Rhodophyta, Halymeniales | Venice | 45°25'08''N | 12°15'42''E | expanding | Venice | 2008 | aquaculture | | Wolf et al., 2013 |
| Italy | May 2008 | Uronema | marinum | Womersley, 1984 | Chlorophyta, Chaetophorales | Po delta lagoons | 45°00'N | 12° 28'E | established | North Adriatic Sea | 2008 | aquaculture | | Sfriso et al., 2014 |
| Italy | 2013 | Pelagia | benoveci | Piraino, Aglieri, Scorrano and Boero (in press) | Cnidaria, Scyphozoa | North Adriatic Sea: Trieste Venice | 45°20'-45°5 N | 13° 02'E | prolonged bloom of hundred of individuals | North Adriatic Sea | 2013 | ship ballast | | Piraino et al., in press |
| Italy | 04.06.2010 | Paranthura | japonica | Richardson, 1909 | Crustacea Isopoda | La Spezia | 44°06'N | 9° 49'E | A few specimens | Ligurian Sea | 2010 | aquaculture | | Marchini et al., in press |
| Italy | 24.05.210 | Paranthura | japonica | Richardson, 1909 | Crustacea Isopoda | Olbia | 40°55'N | 9° 30'E | A few specimens | Tyrrhenian Sea | 2010 | aquaculture | | Marchini et al., in press |
| Italy | 09.07.2012 | Paranthura | japonica | Richardson, 1909 | Crustacea Isopoda | Lagoon of Venice | 45°12' – 45°28'N | 12° 15' – 12*25'E | established | North Adriatic Sea | 2012 | aquaculture | | Marchini et al., in press |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Poland | May 2013 | Oswaldocruzia | filiformis | (Goeze, 1782) | parasite | Elbląg River | 19°22′E | 54°12′N | | | | | parasite | Rolbiecki, L., Izdebska, J.N, 2014. |
| Poland | May 2013 | Acanthocephalus | ranae | (Schrank, 1788) | parasite | Elbląg River | 19°22′E | 54°12′N | | | | | parasite | Rolbiecki, L., Izdebska, J.N, 2014. |
| Poland | May 2013 | Demodex sp. | | | parasite | Elbląg River | 19°22′E | 54°12′N | | | | | parasite | Rolbiecki, L., Izdebska, J.N, 2014. |
| Russia | Summer 2013 | Rangia | cuneata | (G.B.Sowerby I, 1831) | bivalve | Southeastern Baltic Sea | 55.232500 | 20.881667 | expanding | Russia, Vistula Lagoon | Baltic Sea (V.L.): Sept 2010 | ballast water (Vistula Lagoon), currents (Russian EEZ) | competition, alteration of habitat and foodweb | Gusev, Rudinskaya, in print |
| Russia | Summer-autumn 2013 | Planktolyngbya | brevicellularis | Cronberg et Komarek, 1994. | cyanobacteria | Baltic Sea, Curonian Lagoon | 55.152417 | 20.861533 | established | Russia, Curonian Lagoon | Curonian Lagoon: July 2007 | river-channel system | blooming | Lange, 2013 |
| Russia | 03-06-2008 | Abra | prismatica | (Montagu, 1808) | bivalve | Barents Sea | 69.199617 | 35.252017 | expanding | Russia, Barents Sea | Barents Sea, Russia: 03-06-2008 | range expansion | | Deart et al., 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Russia | 02-06-2009 | Gari | fervensis | (Gmelin, 1791) | bivalve | Barents Sea, Guba Yarnyshnaya | 69.145167 | 36.007333 | rare | Russia,Barents Sea, Guba Yarnyshnaya | Barents Sea, Russia: 02-06-2009 | range expansion | competition | Deart et al., 2014 |
| Spain | 1992-2011 | Oculina | patagonica | de Angelis, 1908 | Cnidarian, Anthozoan | All Mediterranean coast from Algeciras to Catalonia and Balearic Islands | | | established | Alicante Port, E Spain (Mediterranean coast) | 1972 | Shipping | A shift from macroalgal to coral dominance has been observed and this change in the dominant trophic group may affect ecosystem function. | Zibrowius and Ramos, 1983; Rubio-Portillo et al., 2014 |
| Spain | 2007 | Sertularia | marginata | Kirchenpauer, 1864 | Cnidarian, Hydrozoan | Chafarinas Islands (N African coast) (Mediterranean coast) | 35.1833° N | 2.4333° W | two populations (with 35 colonies, several fertile) | Gulf of Biscay (Atlantic coast) | <1980 | anthropogenic vectors | | González-Duarte et al., 2013 |
| Spain | 2010 | Sertularia | marginata | Kirchenpauer, 1864 | Cnidarian, Hydrozoan | Sancti Petri, (Gulf of Cádiz) (Atlantic coast) | 36º24.57’N | 6º14.15’W | one dense population (with 69 colonies, most fertile) | Gulf of Biscay (Atlantic coast) | <1980 | anthropogenic vectors | | González-Duarte et al., 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2012 | Branchiomma | bairdi | McIntosh, 1885 | Polychaete | Mazarrón harbour, Murcia, SE Spain (Mediterranean coast) | 37°36′N | 1º31′W | established | Mar Menor (Murcia, SE Spain) (37º42'N, 00º47'W) Mediterranean coast | 2006 | Hull fouling | Can influence local communities, including alteration of the turbulence and boundary layer features for larvae, provision of space for settlement, bio-irrigation or nutritional supply, or incorporation of plant material providing an extra habitat for invertebrates. | Arias et al., 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2012 | Branchiomma | bairdi | McIntosh, 1885 | Polychaete | Las Palmas Harbour, Gran Canaria, Canary Islands | 28°6′N | 15°25′W | established | Mar Menor (Murcia, SE Spain) (37º42'N, 00º47'W) Mediterranean coast | 2006 | Hull fouling | Same as above | Arias et al., 2013 |
| Spain | 1995 | Paraprionospio | coora | Wilson, 1990 | Polychaete | Between cape San Antonio (38º48′N 00º08′W) and Valencia Harbour (39º27′N 00º19′W)(Mediterranean coast) | | | casual | Between cape San Antonio (38º48′N 00º08′W) and Valencia Harbour (39º27′N 00º19′W)(Mediterranean coast) | 1995 | Ballast water | No indication of an effect has yet been found. | Redondo and San Martín, 1997 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2010 | Paraprion ospio | coora | Wilson, 1990 | Polychaete | SE Bay of Biscay (Atlantic coast) | 43º24´N | 02º18´W | two specimens | Between cape San Antonio (38º48'N 00º08'W) and Valencia Harbour (39º27'N 00º19'W)( Mediterr anean coast) | 1995 | Ballast water | No indication of an effect has yet been found. | Martínez and Adarraga, 2013 |
| Spain | 2012 | Chiton | cumingsii | Frembly, 1827 | Mollusc | Las Palmas Port, Gran Canaria, Canary Islands | 28º06'N | 15º25'W | | Las Palmas Port, Gran Canaria, Canary Islands, 28º06'N, 15º25'W | 2012 | Hull-fouling | | Arias and Anadón, 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2011 | Ensis | directus | Gould in Binney & Gould, 1870 | Mollusc | Otur sandy beach (43.16ºN, 2.15ºW), Musel Port of Gijón (43.32ºN, 5.42º W), and Villaviciosa estuary (43.31º N, 5.23º W), Asturias (N Spain) Atlantic coast | | | spreading | Otur sandy beach (43.16ºN, 2.15ºW), Musel Port of Gijón (43.32ºN, 5.42º W), and Villaviciosa estuary (43.31º N, 5.23º W), Asturias (N Spain) Atlantic coast | 2011 | Ballast water to Musel Port, then subsequent spread through larvae drifting with water currents | Can compete with and/or displace other Ensis species. Clam population in the Villaviciosa estuary has become large enough that local fishers are beginning to harvest large specimens for human consumption and small specimens for fishing bait (surf casting). | Arias and Anadon, 2012 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2011 | Mercenaria | mercenaria | Linnaeus, 1758 | Mollusc | Video Cape (Asturias, N Spain) Atlantic coast | 43.13 ºN | 5.27º W | established | Video Cape (43.13 ºN, 5.27º W) (Asturias, N Spain) Atlantic coast | 1978 | Directly or indirectly through aquaculture | M. mercenaria has reproduced in the Bay of Biscay and has become part of the local benthic fauna | Arias and Anadon, 2012; Arias 2012 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2010 | Theora | lubrica | Gould, 1861 | Mollusc | Nervion Estuary and Pasajes Port, SE Bay of Biscay (Atlantic coast) | 43º18′51″N 02º59′26″W, 43º18′36″N 02º58′45″W, 43º19′09″N 01º54′43″W, and 43º19′13″N 01º54′33″W | | established | Nervion Estuary and Pasajes Port, SE Bay of Biscay (Atlantic coast) | 2010 | Shipping | Processing contaminated sediments by filtering (bioturbation) and providing a supplementary food source. Possible alteration of habitats and biogeochemical cycles. Accumulation of contaminants and pathogens to harmful levels. These toxic substances can also adversely affect the health of any organism feeding on them. | Adarraga and Martínez, 2011 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 1978 | Tonicia | atrata | Sowerby, 1840 | Mollusc | Eo estuary (between Galicia and Asturias), Bay of Biscay, Atlantic coast | 43º28′N | 7º03′W | | Eo estuary (43º28′N, 7º03′W) (between Galicia and Asturias), Bay of Biscay, Atlantic coast | 1978 | Aquaculture | | Arias and Anadón, 2013 |
| Spain | 1985 | Tonicia | atrata | Sowerby, 1840 | Mollusc | Sado estuary (between Galicia and Asturias), Bay of Biscay, Atlantic coast | 43º28′N | 7º03′W | | Eo estuary (43º28′N, 7º03′W) (between Galicia and Asturias), Bay of Biscay, Atlantic coast | 1978 | Aquaculture | | Arias and Anadón, 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2010 | Tonicia | atrata | Sowerby, 1840 | Mollusc | Avilés Port, Asturias, Bay of Biscay, Atlantic coast | 43°33′N | 5º55′W | | Eo estuary (43º28′N, 7º03′W) (between Galicia and Asturias), Bay of Biscay, Atlantic coast | 1978 | Aquaculture | | Arias and Anadón, 2013 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2009-2011 | Caprella | scaura | Templeton, 1836 | Crustacean | From SW Spain (Atlantic coast) to NE Spain (Mediterranean coast), including the Balearic Islands | | | established | Roses Bay (42o16'00'' N 3o10'59'' E), Catalonia, Mediterranean coast | 2005 | Fouling | Has been observed to displace the native Caprella equilibra in the harbour of Cádiz. Could change the quantity, form and availability of these nutrients to other organisms. Plays an important role in the energy flow through foodwebs in introduced areas by accumulating pollutants and transmitting them to higher trophic levels. | Martinez and Adarraga, 2008; Guerra-García et al., 2011; Ros et al., 2013a, 2014a |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2009 | Caprella | scaura | Templeton, 1836 | Crustacean | Santa Cruz de Tenerife, Canary Islands | 28º29'58"N | 16º11'48"W | established | Roses Bay (42o16'00'' N 3o10'59'' E), Catalonia, Mediterranean coast | 2005 | Aquaculture | Same as above | Guerra-García et al., 2011 |
| Spain | 2011 | Caprella | scaura | Templeton, 1836 | Crustacean | Puerto del Carmen (28º55′16″N 13º40′27″W) and Marina Rubicon (28º51′25″N 13º48′54″W) of Lanzarote, Canary Islands | | | probably established | Roses Bay (42o16'00'' N 3o10'59'' E), Catalonia, Mediterranean coast | 2005 | Hull fouling | Same as above | Minchin et al., 2012 |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 2011 | Paracaprella | pusilla | Mayer, 1890 | Crustacean | Palma Harbour, Mallorca, Balearic Islands (Mediterranean coast) | 39º34' N | 2º38'E | established | Harbour of Cádiz (36º 31'N, 6º 17'W), SW Spain, Atlantic coast | 2010 | 2ary introduction with recreational boat fouling | Competes with the animals that feed on copepods, such as fish larvae. In turn, caprellids constitute an important food item for adult fish. | Ros et al., 2013a |
| Spain | 2012 | Paracaprella | pusilla | Mayer, 1890 | Crustacean | Ibiza, Balearic Islands (Mediterranean coast) | 38º54'N | 1º26'E | established | Harbour of Cádiz (36º 31'N, 6º 17'W), SW Spain, Atlantic coast | 2010 | 2ary introduction with recreational boat fouling | Same as above | Ros et al., 2013a |
| Sweden | 2012 | Hemigrapsus | sanguineus | De Haan 1853 | Crustacean | West coast of Sweden | 57°40'50"N | 11°38'39"E | one single specimen found | West coast of Sweden | summer, 2012 | unknown | unknown | Berggren 2013 |
| UK | 2013 | Chrysymenia | wrightii | (Harvey) Yamada, 1932 | Red algae (Rhodophyta) | Falmouth | Currently unknown | Currently unknown | First record | English Channel, S North Sea | 2013 | Currently unknown | | |

| Country | Date | Genus | Species | Namer and date | Taxon | Location name | Latitude | Longitude | Population status | Region of 1st record | Date of 1st record | Likely vector | Likely impacts | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UK | 2013 | Dictyota | cyanoloma | Tronhom, De Clerck, Gomez Garreta and Rull Lluch, 2010 | Brown algae (Phaeophyta) | Falmouth | Currently unknown | Currently unknown | First record | English Channel, S North Sea | 2013 | Currently unknown | | |
| UK | 2013 | Griffithsia | schousboei | Montagne, 1839 | Red algae (Rhodophyta) | Falmouth | Currently unknown | Currently unknown | First record | English Channel, S North Sea | 2013 | Currently unknown | | |
| UK | 2013 | Gracilaria | vermiculophylla | Papenfuss, 1967 | Red algae (Rhodophyta) | Southern UK Currently no other info) | Currently unknown | Currently unknown | First record | English Channel, S North Sea | 2013 | Currently unknown | | |
| UK | 2012 | Asterocarpa | humilis | Heller, 1878 | Tunicata, Ascidiacea | Holyhead and Milfod Haven | Currently unknown | Currently unknown | First record | Irish Sea, off northwest coast of Wales | 2012 | Currently unknown | | |

# Annex 5. Draft alien species alert report on *Ensis directus*

**Current Status of Invasions by the Marine Bivalve *Ensis directus***

Prepared at the meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO), Klaipeda, Lithuania, 19–21 March 2014.

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With Editorial Review by members of WGITMO

**Table of Contents**

# 1 Introduction

The North American bivalve mollusc *Ensis directus* (Conrad, 1843) (Bivalvia, Pharidae) is native to the northwestern Atlantic coasts from southern Labrador to northern Florida (Bousfield 1960, Swennen et al. 1985, Abbott and Morris, 2001, Theroux and Wigley, 1983, Turgeon et al. 2009, Vierna et al. 2013). This species has been introduced outside its native range with the first confirmed record from the German Bight in 1979 (von Cosel et al. 1982). Thereafter, a subsequent secondary range expansion took place, and the species is currently known to occur from Spain to Norway, including the UK (e.g. Mühlenhardt-Siegel et al. 1983, Essink 1985, 1986, Kerckhof and Dumoulin 1987, Luczak et al. 1993, Rasmussen 1996, Eno et al. 1997, Brattegard and Holthe 1997, Severijns 2000, 2002, 2004, Wolff 2005, Dauvin et al. 2007, Houziaux et al. 2011, Arias and Anadon 2012, Dannheim and Rumohr 2012, Witbaard et al. 2013) and in the western Baltic (Gürs et al. 1993). The most recent expansion was to the Bay of Biscay (Arias and Anadon 2012) from where it may be expected to spread further.

*Ensis directus* has all characteristics of a successful "r" strategist invader, including a high reproductive capacity, short generation times and rapid growth. Its expansion is principally due to natural dispersal. It usually occurs in clusters and has wide environmental tolerances (Dannheim and Rumohr 2012). Moreover, its native predators (e.g. the snail *Polinices heros* and the nemertean *Cerebratulus lacteus*) are absent in Europe (von Cosel 2009). Although *E. directus* is common in its native range, it is not nearly as abundant in its introduced range. Further, its exceptional colonization success in Europe is likely to be related to its use of underutilized tidal habitats, which are characterized by exposure to physical disturbance as a consequence of wave action and strong tidal currents. It seems that *E. directus* is one of the few larger benthic invertebrates able to tolerate the unstable sands in the tidal zone (Dekker and Beukema 2012).

Although there is a high annual variability of *E. directus* densities, the species has become a prominent component of the macrobenthos in shallow subtidal sands in Europe. This review describes the current status of the species outside its native range.

## 2 Identification

*Ensis directus* (Danish: Amerikansk knivmusling, Dutch: Amerikaanse zwaardschede, English: American razor clam, Atlantic jackknife clam, French: couteau droit, couteau américain, German: Amerikanische Schwertmuschel, Amerikanische Scheidenmuschel, Norwegian: amerikaknivskjell) has also been described with the synonyms *Solen ensis* Gould, 1841, *Solen directus* Conrad, 1843, *Solen ensis* var. *americanus* Gould and Binney, 1870, and *Ensis americanus* (Gould, 1870) (von Cosel 2009).

Known in its native area known as *Ensis directus* (Conrad, 1843), the name also used when the species was first observed in Europe (von Cosel et al. 1982), *E. directus* is also known by some scientists as *Ensis americanus*, based on a fossil (Miocene) and possibly extinct species (van Urk 1972). However, not all taxonomists agree that the fossil species is different from the current bivalve, so both names are in use (e.g. van Urk 1980, Armonies and Reise 1999, Jensen 2010). Von Cosel et al. (1982) and von Cosel (2009), in discussing this issue again, provided ample evidence of the use of the name *E. directus*, as at least the greater part of the differences between the Miocene and the recent form, cited by Van Urk (1972), fall within the variation of the recent form. Also, after a careful comparison of the Miocene fossil material and recent shells, Dall (1900) was "unable to find any constant character with which they can be discriminated". This view is followed by such authoritative taxonomic databases as the the World Register of Marine Species (WoRMS), von Cosel and Gofas (2013) and the Check List of European Marine Mollusca (CLEMAM 2014) (Table 1).

**Table 1 The taxonomic status of *Ensis directus* (Source: World Register of Marine Species 2014).**

| Class | Bivalvia |
|---|---|
| Subclass | Heterodonta |
| Order | Euheterodonta |
| Superfamily | Solenoidea |
| Family | Pharidae |
| Genus | Ensis |
| Species | directus |

*Ensis directus* is characterized by elongated (razor-shaped) shells, both valves are connected by a hinge in the anterior end. This hinge has few and very small "teeth" and an elastic ligament. The shell shape is best described as slightly curved to almost straight and it grows typically to 16–17 cm in length and 2,5 to 2.8 cm in width (Figure 1). In Europe, the maximum shell length so far observed is 18.7 cm, and this was in Belgian waters (Vanhaelen 1993). North American specimens can achieve lengths of up to 25 cm (von Cosel 2009, Abbott and Morris 2001).

From the inside, the posterior adductor muscle scar is very close to the pallial sinus (only 2–3 mm distance), and the anterior adductor muscle edges can also be seen (von Cosel et al. 1982, Voigt 1999, Jensen 2010) (Figure 2).

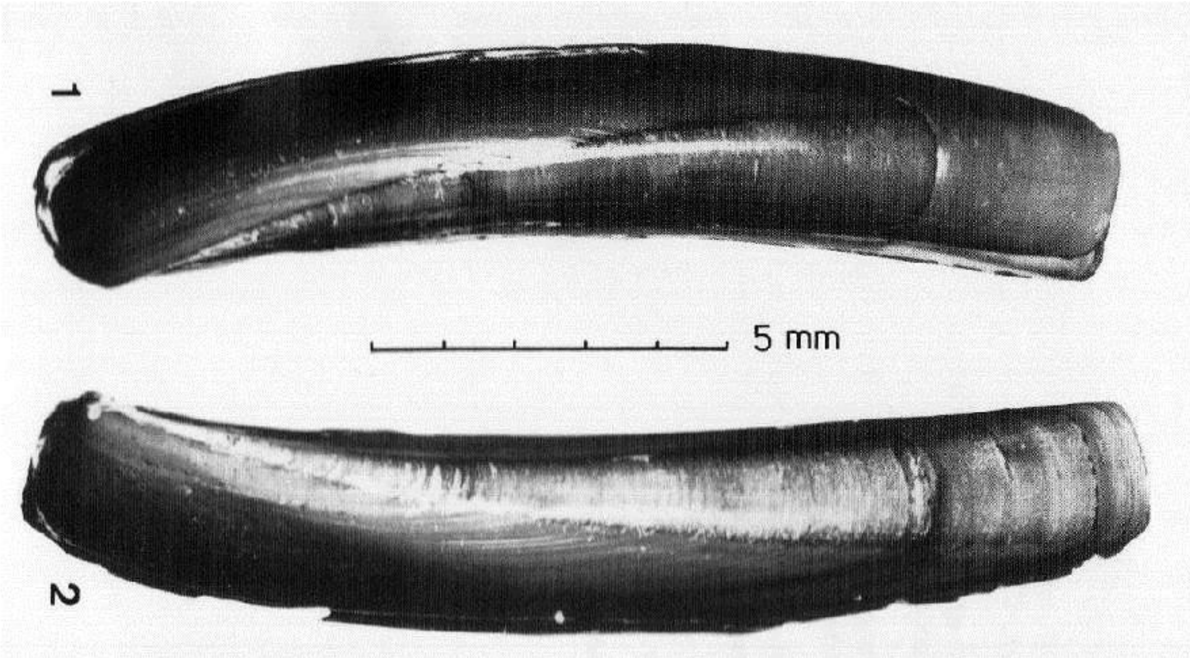


**Figure 1.** ***Ensis directus*** **shells (source: Mühlenhardt-Siegel et al. 1983).**

The dorsal and ventral margins are almost parallel. The anterior end is rounded, the posterior end is truncate. The pallial sinus is not symmetrical, the dorsal half is indented. At its upper part *E. directus* has its innermost point below the dorsal pallial sinus (von Cosel et al. 1982, von Cosel 2009). Besides the characteristic shape and size (Figure 1), this makes adult *E. directus* easily distinguishable from most native bivalves. In the European populations, that point is situated more ventrally, almost in mid-shell height (von Cosel 2009). Although apparently easily distinguishable, *E. directus*, especially the straight shaped specimens, can be and have been confused with native *Ensis magnus* (formerly known as *E. arcuatus*), however an internal inspection of the shells reveals clear differences. Compared with *E. magnus,* the pallial sinus in *E. directus* has a wide and shallow shape that forms a distinct wave (please see no. 7 on Figure 2). The anterior adductor depression muscle scar is much shorter, and the posterior adductor muscle scar is situated much closer to the pallial sinus.

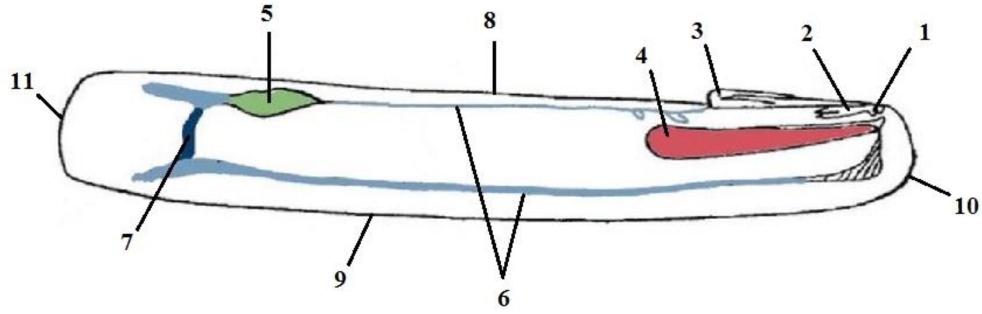


**Figure 2. *Ensis directus*, pallial sinus a feature to distinguish it from *Ensis magnus* (Severijns 2002). Legend: 1. Vertical teeth of hinge. 2 Horizontal teeth. 3 Hinge ligament. 4 Anterior of muscle scar. 5. Posterior muscle scar. 6. Pallial line. 7. Pallial sinus. 8. Dorsal surface. 9. Ventral surface. 10. Anterior. 11 Posterior.**

The shell of *Ensis directus* is wider and usually curved, or partly so, not as curved as in *Ensis ensis*. It seems that one of the important features for identification in the field is the pallial sinus, which is more easily seen when the shell is dry (Vertical teeth of hinge. 2 Horizontal teeth. 3 Hinge ligament. 4 Anterior of muscle scar. 5. Posterior muscle scar. 6. Pallial line. 7. Pallial sinus. 8. Dorsal surface. 9. Ventral surface. 10. Anterior. 11 Posterior.

). In young individuals marks are indistinct and difficult to see (Jensen 2010).

While adult *E. directus* can easily be distinguished from native species, specialist advice is required to identify juveniles. As for many bivalves, larval stages (pelagic veliger) are difficult to identify to species level (Voigt 1999). To solve taxonomcal uncertainties, a multiplex PCR technique using specific primers may be used for the identification of *Ensis* spp. by different sizes of the species-specific amplicons separated in an electrophoresis. This method provides a simple, reliable and rapid identification of *Ensis* spp. (Fernández-Tajes et al. 2010).

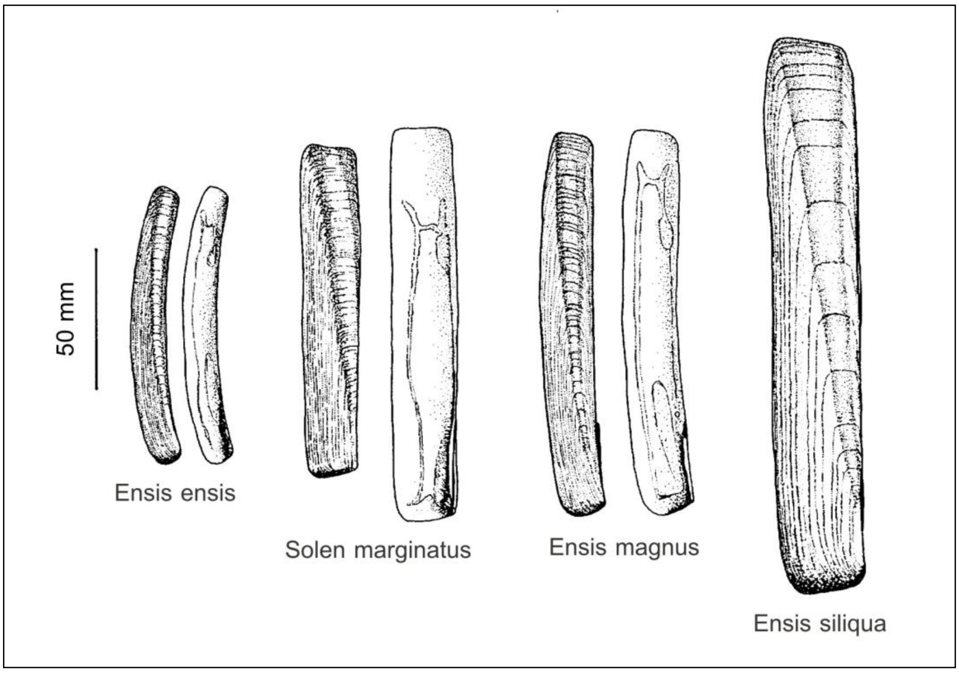


**Figure 3. Native European bivalves with a similar shape as *Ensis directus* (source: Hayward and Ryland 1996, Voigt 1999).**

# 3 Biology in the native range

The northern distribution limit in the native range of *Ensis directus* is in Labrador (60 °N), and it extends southwards along the North American east coast to South Carolina (34°N) (Bousfield 1960, von Cosel et al. 1982, Swennen et al. 1985, Coan et al. 2000) and even further to northern Florida (Abbott and Morris 2001, Theroux and Wigley 1983, Turgeon et al. 2009). Vierna et al. (2013) demonstrated that this species occurs as far south as northeastern Florida. However, the northern limit of the species' native range is currently unclear because it is unknown whether *E. directus* and *E. terranovensis* co-occur off Canadian and northeastern US waters (Vierna et al. 2013). Baqueiro et al. (2004) record *E. directus* for Yucatan.

The free-swimming larvae are produced in spring. The juveniles settle on clean fine sands with small amounts of silt in the lower zone of the intertidal areas, where they filter-feed on plankton and detritus.

The larval phase lasts 10 to 27 days (von Cosel 2009). The spat survival is limited to areas below the level of mean low tides (Beukema and Dekker 1995) but older clams may be found in the low intertidal areas.

*Ensis directus* are known to burrow rapidly deep into the sediment when disturbed. This behaviour makes it difficult to capture them alive and undamaged (Drew 1907, Trueman 1967). Valve movements during burrowing cause change in viscosity of the sediment surrounding the clam, which reduces drag and facilitates the rapid penetration to depths greater than expected by the muscular strength of the clam (Winter et al. 2012). The species has a unique burrowing strategy to move in sediment whereby the "foot" is used to manipulate its position in the sediment (Figure 4). Jung et al. (2011) describes a burrowing model that uses deformations of the *E. directus* body to cyclically loosen and re-pack the surrounding sediment to manipulate burrowing drag locally (Figure 4).

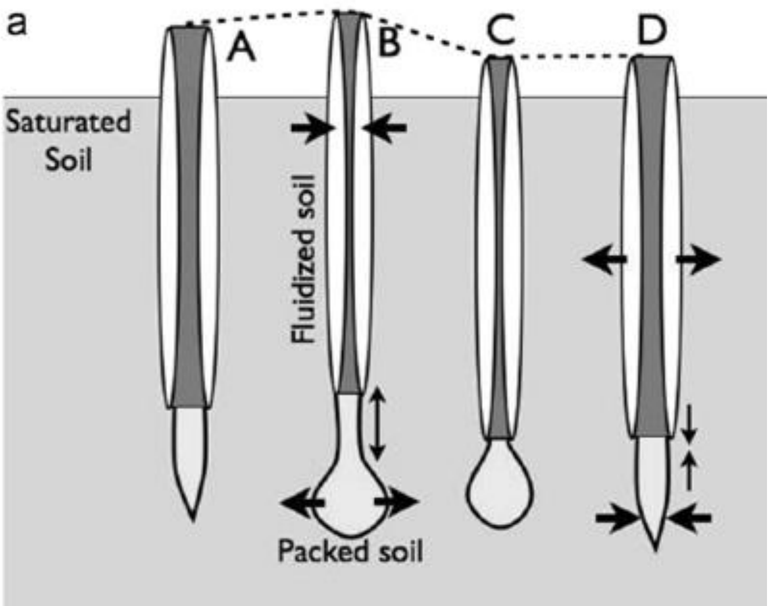


**Figure 4. Burrowing strategy of *Ensis directus* in sediment (Modified from Jung et al. 2011).**

The relatively short siphons indicate that their usual position in the sediment is near the surface. At low tide, *E. directus* are frequently found with the posterior end sticking out of the sediment by a few centimetres (Swennen et al. 1985).

## 3.1 Natural history

The preferred habitat of *E. directus* within its native range includes the gently sloping subtidal region on low gradient shifting sands (Gosner 1979), but it can also be found in mud and gravel. In eastern Canada, the identified subtidal clam beds are primarily located in depths of 5–8 m where currents are typically low to moderate (Kenchington et al. 1998) but it has also been found down to 100 m depth (Theroux and Wigley 1983). In North America, *E. directus* is known to be pollution-sensitive (Callier et al. 2008).

The species shows large annual temperature tolerances, but low winter temperatures seem to limit its development (Essink 1994). Its salinity tolerance ranges from 7 to 32 psu (Maurer et al. 1974) and so occurs in both marine and estuarine areas (Beukema and Dekker 1995). *E. directus* shows a limited tolerance to reduced oxygen conditions (Schiedek and Zebe 1987).

In its native range, *E. directus* is a preferred prey of the sea star *Leptasterias polaris* (Thompson et al. 2005). Large carnivorous snails may may also prey on *E. directus*, including moon snails *Polinices* spp. (Clements et al. 2013) and whelks *Busycon* spp. *Ensis directus* may further be affected by the predatory nemertean *Cerebratulus lacteus* (Thompson et al. 2005, von Cosel 2009, McDermott 1976) as well as several bird species, including sea gulls (Cadée 2000a).

## 3.2 Growth rate

There is little information available on the shell-growth of *Ensis directus* within its natural range. Kenchington et al. (1998) evaluated *E. directus* as a potential aquaculture species, and characterized the species as being relatively fast-growing. In an experimental setup, they found juvenile *E. directus* in the size-range of 7–9 mm three months post fertilization (*op cit*).

## 3.3 Reproduction

*Ensis directus* are dioecious (Loosanoff and Davis 1963), but males and females cannot be distinguished externally. Males release sperm into the water, and the sperm enters the females through the inhalant siphon. The eggs are fertilized in the interior of the gill and the newly-fertilized zygotes develop into larvae, which are then released in the water. The zygotes develop into trochophores as naked pear-shaped, translucent free-swimming larvae, which develop further into lightly-shelled ‘D’ veliger larvae that become more rotund with age to form the umbonate stage. The final larval stage is a pediveliger, which is capable of swimming and crawling with a “foot”. The planktonic stage of *E. directus* lasts 10 to 27 days, resulting in its dispersal by currents over long distances. After the larval stage, young individuals settle onto sandy or muddy habitats and begin their development into adults. Most *E. directus* achieve sexual maturity in their first year. Reproduction occurs between May and September, according to rising water temperatures (Sullivan 1948, Kenchington et al. 1998, von Cosel 2009). Unprovoked spawning occurs at temperatures ranging from about 15° to 22° C, at 30 °C spawning seldom takes place unless triggered by the presence of sperm (Loosanoff and Davis 1963).

The settlement of *E. directus* takes place once larvae attain ~210 µm. At 24 °C this often occurrs only about 10 days after fertilization. However, some larvae remain swimming until they reach a much larger size before undergoing metamorphosis, which may extend up to 27 days after fertilization and at this time has a powerful velum and a well-developed foot (Loosanoff and Davis 1963).

The species is relatively long-lived for a bivalve with estimated ages (based on shell morphology) of up to 20 years (von Cosel 2009).

# 4 Non-native distribution

In Europe, *E. directus* occurs in clean, muddy and coarse sand with shell debris, being found in exposed as well as more sheltered environments. It can bury in sediments to a depth of up to 50 cm (Richards 1938, Armonies and Reise 1999, Tulp et al. 2010). However, it prefers wave- and current-swept cleaner sands (Beukema and Dekker, 1995) with small amounts of silt (Kennish et al. 2004, Dauvin et al. 2007).

## 4.1 European records

The first strong year-class in Europe (German Bight, Elbe-Estuary) was documented in 1979 (Figure 5) and presumed to have arrived as larvae transferred in the ballast water of ships from the east coast of the USA, most probably during 1978 (von Cosel, et al. 1982, Mühlenhardt-Siegel et al. 1983, van Urk 1987). However, in 1977 a few small *Ensis* spp. were found on tidal flats in the Dutch Wadden Sea near Terschelling, but the species identification of these specimens is unclear (Beukema and Dekker 1995). The 1977 findings may have been the first European record, but the first taxonomically confirmed European record is from the German Bight found in summer and autumn of 1979 (Mühlenhardt-Siegel et al. 1983, Dekker and Beukema 2012). Swennen et al. (1985) also assumed that the introduction of *E. directus* into Europe took place before 1978, but that the first strong year-class in Europe originated only in 1979.

Since its early records, the species had spread rapidly in the North Sea region with a range expansion along the coasts of Germany and west coast of Denmark. It reached the Ems-Estuary (Dutch and German border) in 1981, Texel and Schiermonnikoog (the Netherlands) and the complete Dutch coast in 1982. In the Dutch southern Delta area (Eastern Scheldt), first records were reported in the early 1990s (P. van Avesaath pers. comm.). The first Danish records were in 1982 from along the Kattegat and east coast (Knudsen 1989, Jensen 2010). The entrances to the Great Belt and the Sound were reached in 1988, and the entrance to Little Belt in 1994 (Knudsen 1997, K. Jensen pers. comm.) and it was also found in the Limfjord near Nyköbing and Fur Island, along the north coasts of Fyn and Zealand as well as in the Flensborg Fjord near Sonderburg (K. Jensen pers. comm.). The first record of the Belgian coast was in 1986 (Kerckhof and Dumoulin 1987, Kerckhof et al. 2007). It was also observed in Sweden in 1982 and Norway in 1989 (Brattegard and Holthe 1997, Ovcharenko et al. 2009, Jensen 2010). In the United Kingdom it was first recorded in 1989 (Howlett 1990, Eno et al. 1997, Palmer 2003, Minchin et al. 2013); and on Southend on Sea (Essex, United Kingdom), it was reported to be one of the most common living bivalves on the shore in 1995 (Ovcharenko et al. 2009). At present, *E. directus* is know from the east coast of the United Kingdom stretching from the Humber and the Wash (Palmer 2003, 2004, Ashelby 2005) to the east coast of Kent (Killeen 2003). Additional records from the United Kingdom indicate the spread of *E. directus* to the Firth of Forth near Edinburgh in 2000 (Smith 2000), in Angle Bay, the western part of Milford Haven (South Wales) in 2002 (Killeen 2003) and in several locations of Liverpool Bay in 2011 (Dansey 2011).

Adults were also reported from France from 1991, with the first record close to Dunkerque (Gravelines) in the southern region of the North Sea (Luczak et al. 1993), in Boulogne and Hardelot in 1992 and 1993 respectively, then in 1996 and 1998 in the Bay of Somme and Bay of Seine (Dewarumez et al. 2011). By the 1990s, *E. directus* had spread along the coasts of the English Channel (Davoult et al. 1999), with a progressive and continuous expansion along the northern French coastline to Normandy (Severijns 2000). The species is now commonly found along the northern French coastline and in several parts of the English Channel (e.g. Rye Bay), but it has not yet been observed along the Brittany coastline (e.g. Bay of Saint Malo) (OBPNB 2010).

Arias and Anadon (2012) reported *E. directus* from the southwestern Bay of Biscay, with findings in three localities in 2011. Moreover, with an overlapping distribution with shellfish rearing areas, further spread might be facilitated by commercial shellfish transfers.

Estimates of the spread of the clam from the German Bight, where it was first recognized, vary from 125 km per year northwards and against the direction of residual currents flows at 75 km per year westwards (Armonies 2001).

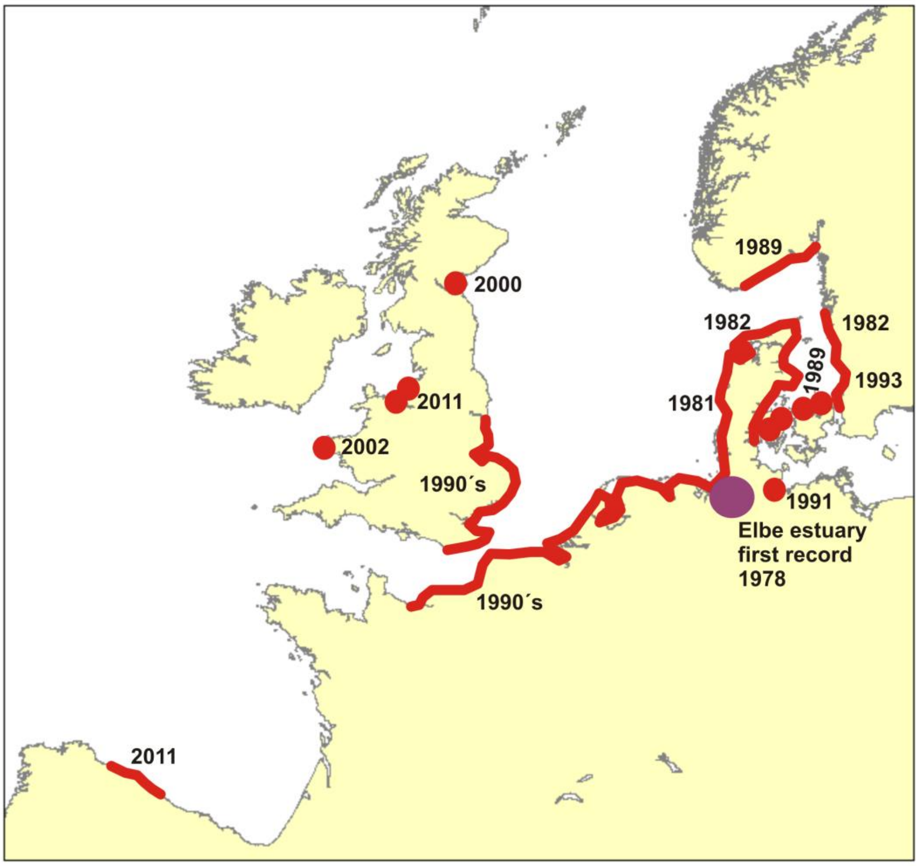


**Figure 5. *Ensis directus* distribution in Europe, also indicating the confirmed first record in the Elbe estuary (Germany) (for references see text).**

**Figure 6. Massive *Ensis directus* shells washed ashore near Skallingen, west coast of Denmark in 1983 (left and bottom right, source: Mühlenhardt-Siegel et al. 1983) and in 2005 along the west coast of the German Sylt Island (top right, source: Stephan Gollasch).**

### 4.1.1 Natural history in the recipient region

In the Netherlands, *Ensis directus* was observed to have a long lag phase. These high densities may be found over a period of >2 years – the exponential phase (Hummel and Wijnhoven 2013). The species is very abundant and juvenile densities can amount to several tens or hundreds·m$^{-2}$ (Beukema and Dekker 1995, Witbaard et al. 2013). Dense populations (thousands of individuals·m$^{-2}$) have been reported by Essink (1994) (Figure 6). Mass developments in the Wadden Sea have occurred in different years during which the biomass and production values reaching as high as >10 g AFDW·m$^{-2}$ (Beukema and Dekker 1995, Armonies and Reise 1999) and it is among the dominating biomass species in the Dutch Wadden Sea (Compton et al. 2013). At maximum, the species reached a biomass of >100 g AFDW·m$^{-2}$ (Figure 7) (Dekker and Beukema 2012).

The population development of *E. directus* has been remarkable in the Wadden Sea, especially around the low watermark at spring tides (i.e. the transition zone of intertidal and subtidal parts), where the clam increased in biomass from 0 to locally ≈ 90% of the total macrozoobenthic biomass (Dekker and Beukema 2012). Since 2002, *E. directus* has been the most common mollusc species in the Dutch coastal zone (Tulp et al. 2010).

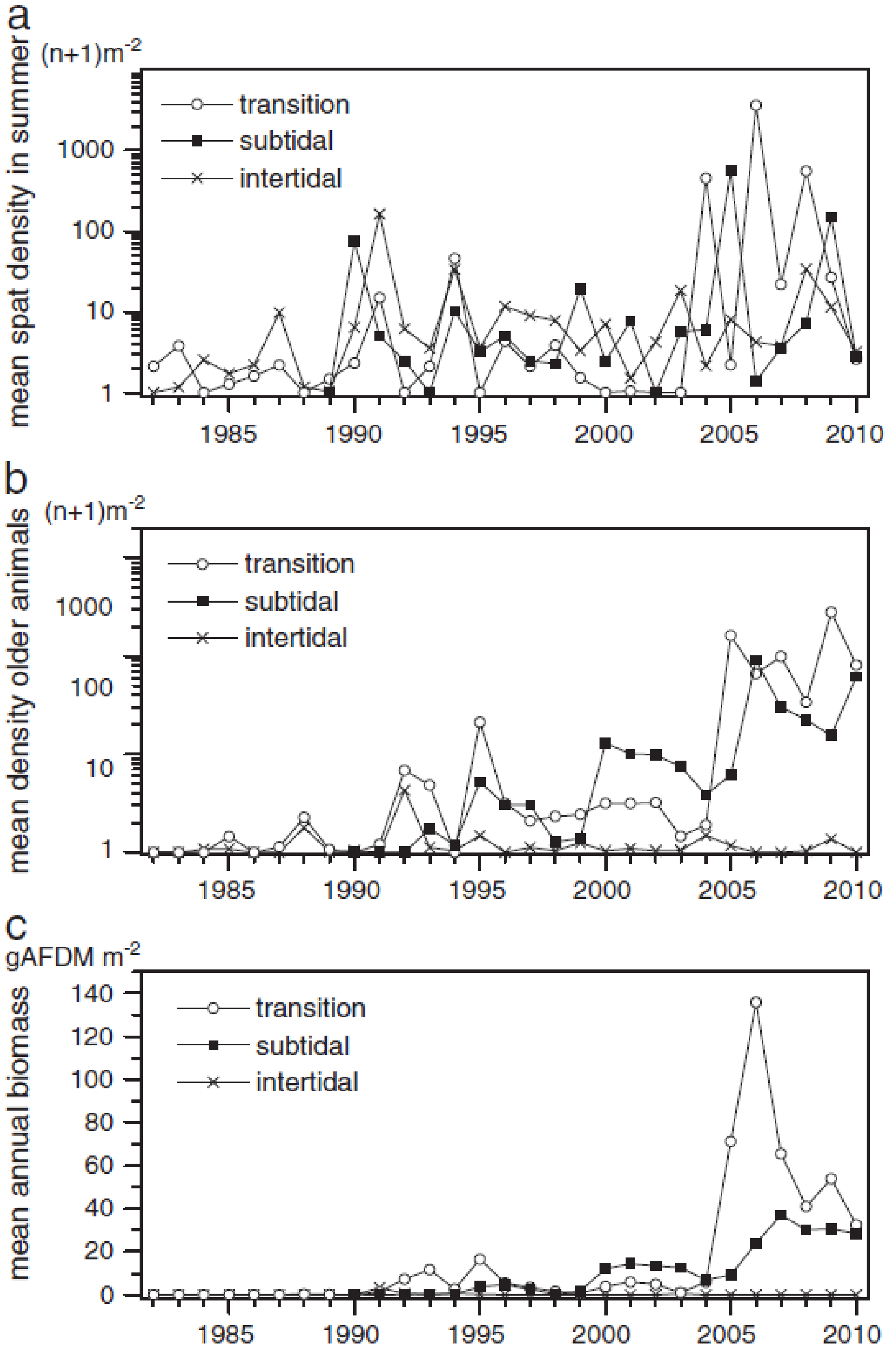


**Figure 7.** ***Ensis directus*** **1982–2010 annual estimates of numbers and biomass of populations in 3 areas of the Dutch Wadden Sea, i.e. crosses = 13 intertidal sites, open circles = 2 transition sites and solid squares = 3 subtidal sites. Top = mean densities of spat-sized individuals (late summer), middle = densities of older individuals (after the first winter), bottom = soft part biomass of the entire populations (Source: Dekker and Beukema 2012).**

After these rapid developments, the populations exhibited substantial declines (Figure 7). Mass mortalities also take place, possibly as a result of washout from the turbulence caused by strong storms (Armonies and Reise 1999, Dannheim and Rumohr 2012). Once the species has been completely washed out of the sediment, reburrowing is difficult (Cadée 2000b). Further, low winter temperatures can cause mortality (Armonies and Reise 1999, Dannheim and Rumohr 2012). Long-term monitoring in the Dutch Wadden Sea has indicated that survival of the first winter is crucial to successful recruitment, which highlights the importance of low winter temperatures on its survival (Dekker and Beukema 2012). These mass mortalities are also known from its native region (Cadée 2000b).

In Dutch coastal waters, *E. directus* was found over a wide coastal area and was recognized since the time that shellfish stock assessments began. Over the past 15 years, the total standing stock of *E. directus* greatly increased. The biomass fluctuates considerably between years and shows sudden increase as in the case of 2002 (Figure 8). However, in the Dutch Eastern Scheldt a peak in density already occurred in the mid 1990s (P. van Avesaath pers. comm.).

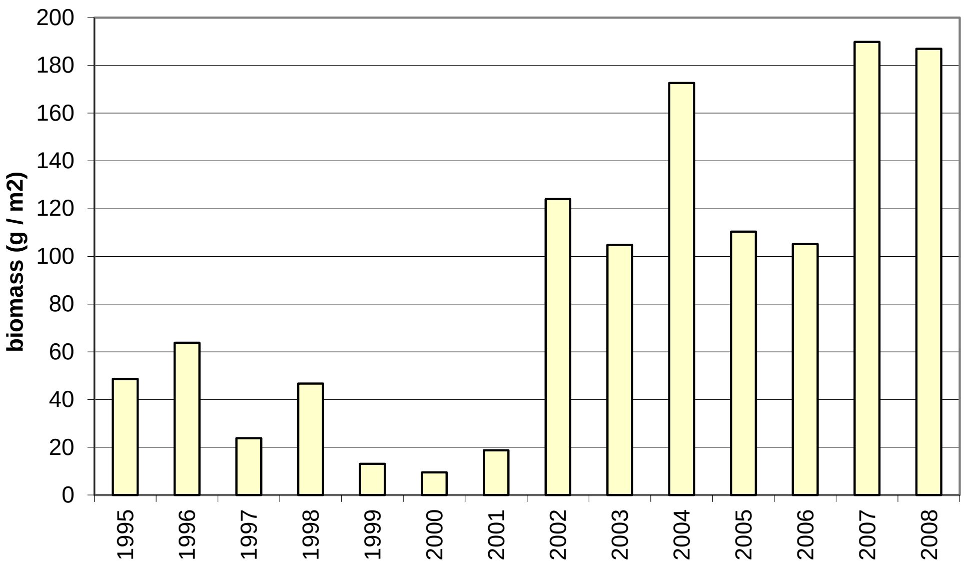


**Figure 8. Standing stock of *Ensis directus* in the Dutch coastal waters in the period 1995-2008 (not published data IMARES) based on yearly stock assessments with modified hydraulic dredge or trawled dredge; sampling efficiency for *E. directus* is estimated at 50%) (Craeymeersch, Perdon, Goudswaard, unpublished, Tulp et al. 2010, Witbaard et al. 2013).**

The *E. directus* distribution in the Wadden Sea is patchy and variable (Figure 9). Mass mortalities and large spat falls are known (Dannheim and Rumohr 2012), with the main distribution and abundance close to the coast.

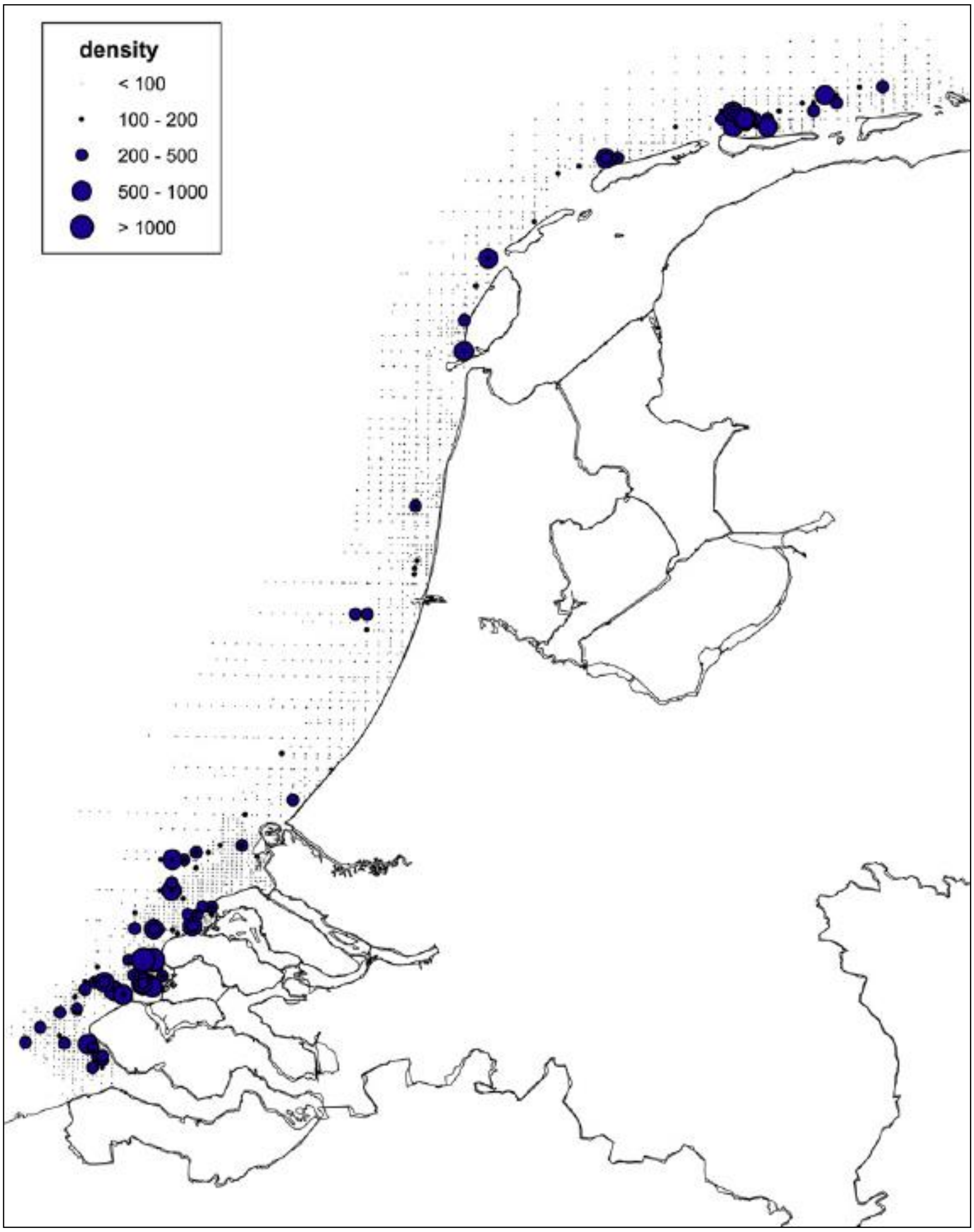


**Figure 9.** ***Ensis*** **spp. spatial distribution and maximum densities (n/m²) along the Dutch coastal zone (1995-2008) excluding inner Scheldt records. Each light dot on the map represents a sampling station (Source: Tulp et al. 2010).**

In Belgian waters, after its first observation in 1987, *E. directus* rapidly colonized all coastal sandy sediments and nowadays, the shells and dying specimens are frequently washed onto the Belgian beaches in millions (Houziaux et al. 2011).

The population genetics of *E. directus*, including specimens from Denmark, have shown high variability within their introduced range (Vierna et al. 2012, ICES 2013), including several haplotypes unique for European populations. Hence, a source population could not be identified and multiple introductions may have taken place. This assumption is also supported by the recent disjunct European distribution of *E. directus*. Further, the cytogenetics of this species have been studied, showing smaller number of telocentric and larger number of subtelocentric chromosomes in *E. directus* than in three native European *Ensis* species (González-Tizón et al. 2013).

### 4.1.2 Habitat and behaviour

The preferred habitat of *E. directus* in its native range includes gently sloping beaches with mobile sand, at a depth of 5–8 m, but it can be found in lower intertidal areas as well as in deeper waters including muddy and gravel habitats (e.g. von Cosel 2009). It prefers wave- and current-swept clean sands (Beukema and Dekker 1995) with small amounts of silt (Kennish et al. 2004), but it can also be found in muddy or coarse sediments (Armonies and Reise, 1999) and can thus be independent of sediment characteristics (Dauvin et al. 2007).

*Ensis directus* move out of the sediment and propel themselves along the seabed in response to their environment becoming stressful, either biochemically or through the threat of physical displacement (Muir 2003). The clams are able to propel themselves over the sand by a series of vigorous lashes with the foot (Figure 4), combined with rapid ejections of water along the vertical side of the foot (Schneider 1982). Post-larval stages may re-enter the water column for secondary dispersal in summer for a period of up to 6–8 weeks. Further, post-larval juveniles of *E. directus* are able to swim and use byssal threads as draglines enabling drifting (Swennen et al. 1985, Armonies 1992, Ovcharenko et al. 2009). Byssus-thread drifting *E. directus* were almost seven times more abundant at night compared to daytime (Armonies 1992), demonstrating a vertical migration between the sediment and the water column. Nocturnal swimming of adult clams may also facilitate dispersal (Ovcharenko et al. 2009).

In the North Sea, *E. directus* have been found down to depths of 26 m (Mühlenhardt-Siegel et al. 1983, Swennen et al. 1985, Dörjes 1992). This is much less than its greatest known depth within its native range (Theroux and Wigley 1983). On account of its rapid burrowing ability it can live in unstable sands (Swennen et al. 1985), which frequent shallow water.

According to habitat suitability mapping of *E. directus* in the Dutch coastal waters, there is a preference for depths of 5–25 m, fine sediments and for those areas where current velocities are not high. The resulting map (Figure 10) shows that *E. directus* might be found to occur extensively along the Dutch coastal zone (De Mesel et al. 2011).

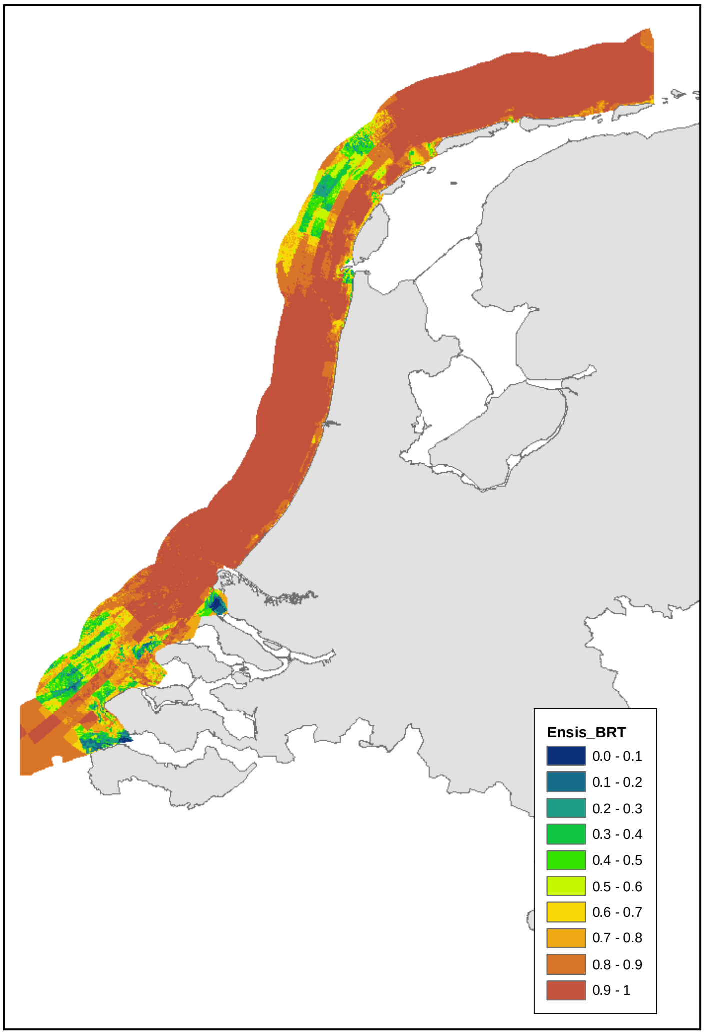


**Figure 10. *Ensis directus* habitat suitability mapping (Boosted Regression Tree model) (De Mesel et al. 2011).**

Long-term monitoring in the Dutch Wadden Sea indicates that the success of *E. directus* is due to its colonization of a previously underutilized habitat formed by highly dynamic, unstable sands (Dekker and Beukema 2012).

In the Belgian coastal area, habitat suitability models show a positive relationship of clam occurrence with bottom shear stress, water depth and sand fraction (Figure 11) and these are considered to be the most important that enable its colonization (Mangelsdorf et al. 1990, Kenchington et al. 1998). The likely areas for further colonization are subtidal and lower intertidal areas (Ovcharenko et al. 2009).

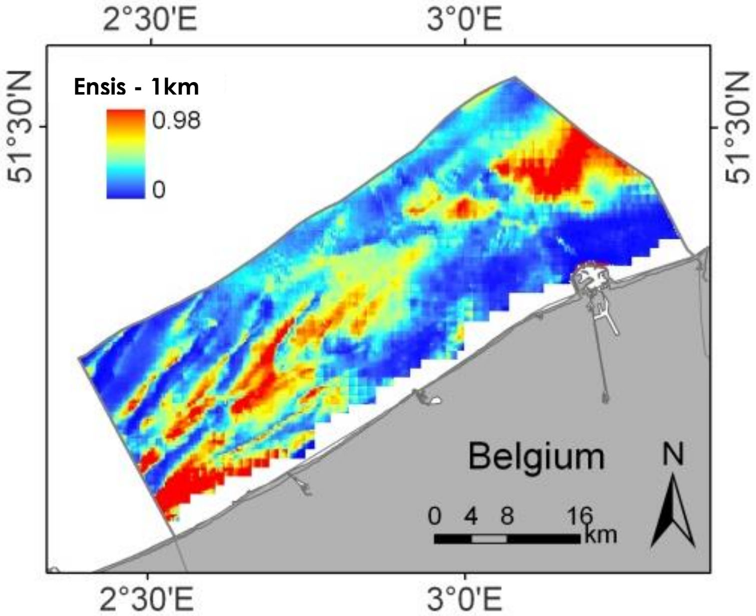


**Figure 11.** ***Ensis directus*** **1 km habitat suitability model for the Belgian coastal area (Houziaux et al. 2011).**

In Danish waters (Horns Rev), *E. directus* were (positively) linked to water depth, areas with relatively flat terrain and carrying capacity index (Skov et al. 2008)

### 4.1.3 Reproduction

*E. directus* reach early sexual maturity after 1 year (Mühlenhardt-Siegel et al. 1983).

In the Wadden Sea, spawning takes place between March and April (Beukema and Dekker 1995). *E. directus* main spawning period was in 2011 and 2012 taking place shortly after the spring plankton bloom in both years (Witbaard et al. 2013). Planktonic larvae were identified in the Isefjord, Denmark in June (Larsen et al. 2007). In the Wadden Sea, it was observed that a second spawning may occur in July/August (Armonies 1996, Wijsman et al. 2006). The free-swimming larvae are distributed by currents in spring. The larval phase is 10 to 27 days depending on water temperatures (von Cosel 2009).

The juveniles settle on clean fine sands with small amounts of silt in the lower zone of the intertidal areas, where they filter-feed on plankton and detritus (Beukema and Dekker 1995, Swennen et al. 1985).

The settlement of larvae is usually reported for May/June and the settling density in this area was observed as approximately 150 individuals·m$^{-2}$ by Beukema and Dekker (1995), although other authors report higher values: 440 ind·m$^{-2}$ (Mühlenhardt-Siegel et al. 1983) and more than 3000 ind·m$^{-2}$ (Dauwe et al. 1998) or even 6500 ind·m$^{-2}$. The largest numbers due to a spat fall (>25,000 ind·m$^{-2}$) were reported by Dannheim and Rumohr (2012). In France, *E. directus* was reported with a density of 5–15 ind·m$^{-2}$ in 1998, they increased up to 100 ind·m$^{-2}$ and the species was found in 81 stations out of the 706 sampled in the Bay of Seine in 2006 (Dauvin et al. 2007). The density has reached up to >1000 ind·m$^{-2}$ in several areas. Densities up to 30,000 individuals/m$^2$ were reported after settlement with adult populations reaching >1,000 ind·m$^{-2}$ in several areas (e.g. Gravelines close to Dunkerque) and mass strandings of juveniles occur all along the Belgian coast (F. Kerckhof and P. Goulletquer pers. comm.).

The spat survival is limited to areas below the level of mean low tides (Beukema and Dekker 1995). Recruitment may be very low or even absent following cold winters (Armonies et al. 2001).

### 4.1.4 Growth rate

Migrating juveniles are mostly 1–3 mm long, occasionally up to 5 mm (Armonies 1992). They reach about 6 cm in length after the first winter. *E. directus* shows a retarded growth in the 1st year (size: 30–50 mm), faster growth the second year. The lifespan is up to five years in the North Sea, although this is rarely observed (Swennen et al. 1985).

A relatively fast (initial) growth rate in *Ensis directus* is known for some European populations, where anterior to posterior shell-growth measurements vary from 5.27 $cm \cdot yr^{-1}$ in the first year to 1.08 $cm \cdot yr^{-1}$ in year five (Cardoso et al. 2013). Normally for bivalves the relative growth is age(size)-dependent (e.g. Ramon and Richardson 1992).

In the Wadden Sea significant shell growth begins late in a year with minimum water temperatures of 12–14°C (Witbaard et al. 2013). During the first two years of their lifespan, growth is rapid with maximum mean rates of 3 mm per month in the first year and in the second year up to 14 mm per month. Growth is variable per season, being highest in summer/early autumn (Dannheim and Rumohr 2012). Stable isotope studies indicate that growth ceases at about 6°C. Growth is greatest at temperatures above 14°C (Cardoso et al. 2013).

In laboratory experiments (Kamermans et al. 2013), the maximum growth rate of *E. directus* was found to be 0.24 mm (shell length) and 2% increase in wet weight per day. A ten-week experimental exposure to silt concentrations of 300 $mg \cdot L^{-1}$ documented a significantly higher growth rate compared to a 150 $mg \cdot L^{-1}$ treatment. Therefore, it seems that a high silt concentration stimulated growth. In a further experiment, *E. directus* was exposed to different concentrations of chlorophyll in water for a ten weeks exposure at a level of 6.5 µg $chlorophyll \cdot L^{-1}$ the shell growth was reduced by ca. 40% when compared with growth at 16.5 µg $chlorophyll \cdot L^{-1}$. Kamermans et al. (2013) concluded that, *E. directus* is more sensitive to a reduction in algal concentration compared with an increase in silt concentration in water.

### 4.1.5 Impacts

Although dense *E. directus* populations may change the community structure of the benthic fauna or compete for space and food, there have been no reports of significant interactions with native species (Dekker and Beukema 2012), perhaps because this aspect has not been specifically studied. However, there is some circumstantial evidence. For example, in the so-called *Abra alba* community (van Hoey et al. 2004) along the Belgian coast, here *E. directus* is now the most common species. There have been declines of other bivalves such as *Mactra stultorum, Cerastoderma edule* and tellinids have been observed since its introduction. Furthermore, the presence of *E. directus* seems to support the settlement of deposit-feeders in general and dense clam clusters may stabilise the sediment and act as sediment-traps (Dannheim and Rumohr 2012). Similarly, in the mid-2000s in both Belgium and The Netherlands, a decline of the bivalve *Spisula subtruncata* has coincided with a strong increase in the biomass of *E. directus*. A link between these events has been suggested with the. invader reducing the abundance and localdistributions of native species through competition for space and food (Houziaux et al. 2011). In dense beds of *E. directus*, fine sediment particles accumulate, which may alter polychaete abundance (Armonies and Reise 1999). For example, there was found to be a shift from *Lanice conchilega* to *Owenia fusiformis* (Houziaux et al. 2011), The full impact on native biota requires further study. Although no extinctions have officially been reported, the indigenous species *Ensis minor* seems to have disappeared along the Belgian coast (F. Kerckhof, unpubl.).

In France and Belgium, the native *Ensis magnus* has been largely replaced by *Ensis directus* and its distribution is now mainly confined to areas offshore (Houziaux et al. 2011). Trophic competition occurs between both species and the distribution of both overlaps (Dewarumez et al. 2011). In contrast, *E. directus* shows the ability to colonize higher intertidal habitats such as sparsely faunated sand and channels exposed to strong currents where native *Ensis* species are absent (Arias and Anadon 2012, Armonies and Reise 1999)

Apparently, *E. directus* has created an ecological niche in areas almost unoccupied by native *Ensis minor*, i.e. the lower intertidal and shallow subtidal parts of the vast flats of fine sand or muddy sand in the Danish, German and Dutch Wadden Sea (von Cosel 2009) and even in semi-enclosed water bodies such as the Spuikom in Oostende (F. Kerckhof and K. Jensen pers. observation). Or: The species also entered semi enclosed systems, like the Eastern Scheldt, Lake Grevelingen and Lake Veere (Hummel & Wijnhoven 2013).

As summarized by Voigt (1999), Ovcharenko et al. (2009) and Jensen (2010), additional various potential impacts include:

- Dense populations may change the benthic community structure due to their burying activities (bioturbation),
- Competition for space and food,
- Dense populations may have an impact on the sediment structure,
- Damage of fishing gear netting from sharp shells,
- Cuts to bathers stepping on *E. directus* in shallow water. Cuts and deep laceration may lead to infections. Other species of razor clam can also cause such conditions
- Provison of a hard substratum for sessile biota such as barnacles (Donovan 2011). Fouling of the anterior exposed end of shells can take place (Figure 12). Fouling also takes place on shell material washed out of sediment (F. Kerckhof and K. Jensen own observervations).

**Figure 12.** ***Ensis directus*** **with epifouling, Fur Island, central Limfjord, Denmark collected 22 May 2005, by Ole S. Tendal and Kathe Jensen. The polychaetes tubes on the left photo are** ***Pomatoceros triqueter*****, the barnacles on the right photo are** ***Balanus crenatus*** **(courtesy of Kathe Jensen).**

The species can provide an abundant food source for birds, in particular eider ducks *Somateria mollissima* (Caldow et al. 2007), gulls (Cadée 2000a), scoters (common scoter *Melanitta nigra* and velvet scoter *M. fusca*) (Dekker and Beukema 2012), waders and corvids (Tulp et al. 2010), but also sea stars (Thompson et al. 2005), thereby interacting with the trophic chain. Following the disappearance of the preferred scoter prey (*Spisula*), scoters adapted to consume the less preferred *E. directus*. The first evidence of common scoters effectively feeding on *E. directus* was observed in 2003 when scoters were seen diving up *E. directus* at the Brouwersdam in the south of The Netherlands (Leopold and Wolf 2003, Wolf and Meininger 2004). This was also observed in Belgium, after 2006, when scoters were seen to take *E. directus* in near coastal waters. For the common scoter predation, the optimum size for foraging was 3–9 cm. While it took some time for scoters to adapt to the new food source (e.g. Houziaux et al. 2011), despite the low density of *E. directus*, oystercatchers *Haematopus ostralegus* also adapted to this food source and became speacilaist predators in selecting *E. directus* thereby reducing the pressure on the declining stocks of cockles *Cardium edule* (Swennen et al. 1985, Freudendahl et al. 2010).

*Ensis directus* forms an important food source for gulls *Larus* spp. Within the native range of *E. directus* gulls are frequently seen feeding on the lower shore of displaced specimens (Schneider 1982). This is also the case within the introduced range (Cadée 2000) where decaying and moribund *E. directus* form an important food source (Knudsen 2001, François 1993, Kerckhof pers. observation). During mass mortalities, *E. directus* partly leaves its burrow and the protruding clams are unable to re-burrow and so become an easy prey for herring gulls *Larus argentatus* at low tide (Cadée 2000).

In addition to predation of *E. directus* by birds on the American coast the snail *Polinices heros* by drilling shells of living individuals. While there are similar snails capable of drilling on European coasts, such as, *Polinices catena,* which ranges from the North to the Mediterranean Sea and is smaller, it is known to avidly feed on bivalves (Clements et al. 2013).

Fish are also known to feed on *E. directus* (Ashelby 2004, Tulp et al. 2010) forming up to 90% of the volume in the gut contents of some flatfish (Tulp et al. 2010) and cod *Gadus morhua*. Cod readily feed on the great numbers that drift near the seabed following storms, when *E. directus* have been washed out of the sediment and their soft tissues became separated from the shells (F. Kerckhof pers. observation).

Tulp et al. (2010) concluded that *the E. directus* introduction will have resulted in a major change in the food relations in the invaded region.

# 5 Prospect for further invasions

*Ensis directus* was included in the list of the 100 most invasive species in Europe (Ovcharenko et al. 2009). Owing to its life history with a free-swimming larvae it is a good candidate for a continued range expansion with water currents or ballast water as being the most likely vectors. Because of its potential to be transported with ballast water it became recorded in the updated "next pest" list of Australia. This list covers those species which have not yet been introduced to Australia and (Hayes et al. 2005).

Hummel and Wijnhoven (2013) took *E. directus* and other non-indigenous species in the Dutch Wadden Sea as examples to conclude that invasions may over time reach a balanced coexistence with the native species, possibly resulting in a localized net diversity gain. However, the impacts of non-indigenous species should not be neglected, especially during their mass developments.

Further likely areas for *E. directus* colonization include temperate subtidal and lower intertidal areas. The areas *E. directus* colonizes are relatively exposed with usually a lower level of macrozoobenthos. The distribution is currently discontinuous along the Atlantic coastline. However, a continuous distribution is likely to occur in the near future due to the available and suitable habitat for this species and having a pelagic life-history phase (Lazure and Jegou 1998, Puillat et al. 2004). Considering its depth distribution in its native range *E. directus* has the potential to colonize the entire German Bight (Armonies 2001) and large areas of the Iberian Peninsula and Bay of Biscay (P. Goulletquer, pers. comm.). The authors believe an immigration to the Mediterraniean Sea is also possible .

The spread of *E. directus* may arise from the discard of live specimens intended for human consumption. Large numbers of *E. directus* captured in Dutch waters are marketed in southern Europe and the possibility of a new range extension from this source may take place. Vacant shells of *E. directus* have been found on a beach near Lisbon in 2012, with the remains of other non-native Mollusca (F. Kerckhof unpublished).

It is interesting that *E. directus* has not (yet) colonized suitable habitats on other continents, which highlights its potential to become introduced to habitats outside Europe. Considering the *E. directus* habitat preferences and temperature as well as salinity tolerances, new potential areas of colonization may be found in South America, along the north American west coast, Asia, Australia and New Zealand.

# 6 Prospects for control or management where introductions occur

As with most introduced species, after establishment in a new region, the control or mitigation options are minimal. This is especially true for species that have developed massive population densities or have become widely distributed. Both of these scenarios occurred with *Ensis directus* in the Wadden Sea and elsewhere along the European coastline. Indeed, the abundance and the ease of inducing spawning of *E. directus* has made it a potential candidate for aquaculture in the maritime region of North America (Kenchington et al. 1998), where there is a small commercial fishery (Leavitt et al. 2005).

A control option to avoid reintroductions from its native range might be achieved by mid-ocean exchange of ballast water or effective ballast water treatment. Furthermore, the potential of local predators (e.g. *Polinices* spp.) in controlling, in part, populations could be considered unless this interferes with production from fishing.

In Europe, a commercial fishery on *E. directus* exists in The Netherlands (Houziaux et al. 2011), and it is frequently found on restaurant menus in Wadden Sea countries. The results of Houziaux et al. (2011) suggest that a yield of ≈ 2 $kg{\cdot}m^{-2}$ of marketable *E. directus* specimens can be expected annually, and Hervás et al. (2012) determined that the *E. directus* fishery of the Dutch Fishers's Association was certified according to the Marine Stewardship Council Principles and Criteria for Sustainable Fisheries. However, the fishing activities will unlikely depress the *E. directus* population, as no intensive fishing efforts have yet been authorized. And in Belgium targeted fishing of this shellfish is prohibited (F. Kerckhof pers. observation).

Attempts to develop aquaculture using *E. directus* were abandoned due to a low market value and insufficient demand in France (P. Goulletquer, pers. comm.). Targeted *Ensis* spp. fishing (on native species) is reported for e.g. the Bay of Biscay populations with larger specimens being collected for direct human consumption and small individuals being used as bait (Arias and Anadon 2012). On the Dutch coast densities of up to 91 $ind{\cdot}m^{-2}$ have been obtained, demonstrating that this species may continue to support a viable and sustained fishery (Witbaard et al. 2013). However, it should be evaluated whether or not the disturbance due to fishing efforts make the harvest viable. Trials of different fishing methods, e.g. hydraulic dredging and electrical fishing, have been carried out in Scotland (Addison et al. 2006, Breen et al. 2011), and the potential for aquaculture has also been investigated in the Limfjord, Denmark (Freudendahl and Nielsen 2005), so far without success which is likely due to the difficulties to capture them and that are only accessibly during very low tides.

It is also seen as controversial to establish a commercial fishery on this species as this may trigger an incentive to support the spread of *E. directus* by moving live clams actively to places where they were previously absent to create new fisheries. In this sense, the *E. directus* case study is similar to other invasive species with regard to a marketable approach to manage such populations as in the case of the fishery developed for the predatory snail *Rapana venosa* in the Black Sea (ICES 2004), a debatable question emphasized by Nunez et al. (2012).

In laboratory experiments, Thompson et al. (2005) demonstrated that the sea star *Leptasterias polaris*, native to the Northwest Atlantic Ocean (Gaymer et al. 2001), prefers *E. directus* over *Mya truncata* and *Spisula polynyma* as prey. However, attempts to control the *E. directus* population with imports of a non-indigenous sea star should be strongly discouraged as this intentional introduction may result in unexpected negative impacts and its diet may not be selective and might include native European species. In contrast, a better understanding of potential native European predators should be evaluated should biocontrol efforts regarding *E. directus* be considered.

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## Annex 6 Meetings history of WGITMO

| Year | Date | Meeting Location | Chair | Meeting Number |
|---|---|---|---|---|
| 1970 | July 16-17 | London, England | **Henry A. Cole [England]** | 1 |
| *Between 1970 and 1980 the WG was called the, "Working Group on the Introduction of Non-Indigenous Marine Organisms"* [*] | | | | |
| 1971 | Sept 2-3 | London, England | " | 2 |
| 1972 | June 26-28 | London, England | " | 3 |
| 1973 | Jan 31-Feb 1 | London, England | " | 4 |
| ***No meetings were held 1974-1978*** | | | **-----** | **--** |
| 1979 | April 2-4 | Conwy, Wales | **Carl J. Sindermann [USA]** | 5 |
| | *The first re-convened meeting* | | | |
| 1980 | April 22-25 | Nantes, France | " | 6 |
| 1981 | May 5-8 | Sete, France | " | 7 |
| 1982 | May 4-7 | La Coruna, Spain | " | 8 |
| 1983 | May 10-13 | Bergen, Norway | " | 9 |
| 1984 | May 17-19 | Halifax, Canada | " | 10 |
| 1985 | May 18-Jn 1 | Goteborg, Sweden | " | 11 |
| 1986 | June 3-5G | Gdynia, Poland (*) | " | 12 |
| 1987 | June 9-12 | Brest, France | " | 13 |
| 1988 | May 31-Jn 3 | Edinburgh, Scotland | " | 14 |
| 1989 | May 23-26 | Dublin, Ireland | " | 15 |
| 1990 | June 6-8 | Halifax, Canada | " | 16 |
| 1991 | June 4-7 | Helsinki, Finland | **James T. Carlton [USA]** | 17 |
| 1992 | April 14-17 | Lisbon, Portugal | " | 18 |
| 1993 | April 26-28 | Aberdeen, Scotland | " | 19 |
| 1994 | April 20-22 | Mystic, USA | " | 20 |
| 1995 | April 10-13 | Kiel, Germany | " | 21 |
| 1996 | April 22-26 | Gdynia, Poland | " | 22 |
| 1997 | April 21-25 | La Tremblade, France | " | 23 |
| 1998 | Mar 25-27 | The Hague, Netherlands | " | 24 |
| 1999 | April 14-16 | Conwy, Wales | " | 25 |

*Held in Conwy [cf. 1979] on the occasion of the 25th Anniversary of WGITMO*

| | | | | | |
|---|---|---|---|---|---|
| 2000 | March 27-29 | Pärnu, Estonia | " | | 26 |
| 2001 | March 21-23 | Barcelona, Spain | **Stephan Gollasch** | | 27 |
| 2002 | March 20-22 | Goteborg, Sweden | **[Germany]** | | 28 |
| 2003 | March 26-28 | Vancouver, Canada | " | | 29 |
| 2004 | March 25-26 | Cesenatico, Italy | " | | 30 |
| 2005 | Meeting by correspondence | | " | | 31 |
| 2006 | March 16-17 | Oostende, Belgium | " | | 32 |
| 2007 | March 21-23 | Dubrovnik, Croatia | **Judith Pederson** | **[USA]** | 33 |
| 2008 | March 12-14 | Copenhagen, Denmark(**) | " | | 34 |
| 2009 | March 11-23 | Washington, D.C., USA | " | | 35 |
| 2010 | March 10-12 | Hamburg, Germany | " | | 36 |
| 2011 | March 16-18 | Nantes, France | **Henn Ojaveer [Estonia]** | | 37 |
| 2012 | March 14-16 | Lisbon, Portugal | " | | 38 |
| 2013 | March 20-22 | Montreal, Canada | " | | 39 |
| 2014 | March 19-21 | Palanga, Lithuania | " | | 40 |

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(*) **Bernt I. Dybern [Sweden]** was acting chair for the meeting when Dr. Sindermann could not attend

(**) **Stephan Gollasch [Germany]** was acting chair for the meeting when Dr. Pederson could not attend

[*] Historical note: The ICES *Procès-verbal de la Reunion* in 1969 referred to the nascent Working Group by the name "Working Group on Transplantation and Acclimatization of Alien Species into New Areas." A Council Resolution of 1970 referred to the Group under the name, "Working Group to Consider the Benefits and Dangers in the Introduction of Fish and Shellfish in the ICES Area from other Parts of the World." However, from the first meeting and on, the names of the WG are as shown above.

Prepared by J. T. Carlton

# Annex 7 Report of the non-native species consultation meeting beweeen ICES and CIESM

**Consultation meeting on non-native species cooperation between ICES and CIESM (Copenhagen, Denmark, 19. December 2013)**

CIESM: Drs Jamila Ben Souissi, Tamara Shiganova (co-Chairs, Committee on Living Resources), and Frederic Briand (Dir. General)
ICES: Drs Anne Christine Brusendorff (General Sec.), Adi Kellermann (Head, Science Program), Henn Ojaveer (Chair, WGITMO)

The basis of the consultation meeting was the Memorandum of Understanding (MoU) between the Mediterranean Science Commission, CIESM, and the International Council for the Exploration of the Sea, ICES, signed on 30 August 2012. Amongst others, the MoU states that *'within available time and budgetary resources, CIESM and ICES intend to cooperate in the development of methodologies and approaches on the following science priorities: Introduced species, including the economic implications of introductions'*.

Participants agreed that:

- Invasions of alien species are a continuous process which can hardly be controlled, but perhaps only minimized in terms of ecological and economical damage. The common issues between both organizations in the field of alien (incl. invasive) species were discussed and target species with potential for cooperation identified. A currently spreading pelagic invasive alien species in both CIESM and ICES waters is the comb jelly *Mnemiopsis leidyi*.

- It was agreed to jointly organize an ICES–CIESM workshop on *latest advances regarding the ecology and impact of Mnemiopsis leidyi', including* its associated alien predatory ctenophore *Beroe* spp. and economic aspects. The workshop, envisaged for 2014, would be attended by around 20 specialists jointly selected by ICES and CIESM from a variety of marine science disciplines (incl. hydrology, molecular biology, ecology, and marine economics).

- It was further discussed that in addition to the *Mnemiopsis* workshop, a series of similar events on diverse issues of mutual interest re: alien species could be profitably organized, such as:
    1. a vulnerability analysis by mapping potential marine hotspots of biological invasions (ports and aquaculture sites and their vicinity), including hydrological matching of donor and source areas;
    2. predictive risk assessment exercises on potential new invasions.

- Progress and quality of research activities is dependent on data and information availability and reliability of the underlying sources. It was recognized that our knowledge on alien species is relatively limited and reliable information is restricted to a few organism/taxonomic groups only (e.g., macroalgae, fish, molluscs, crustaceans, very limited numbers of phytoplankton and zooplankton species), which hampers comprehensive assessments. It was agreed to jointly address the database issue and involve relevant structures from both organizations such as ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) and the CIESM Exotic Species Program. It was noted that several experts from the Mediterranean Sea already actively participate in WGITMO activities.

## Annex 8 Proposed Terms of Reference for 2015

2014/x/SCICOMxx The **ICES Working Group on Introduction and Transfers of Marine Organisms** (WGITMO), chaired by Henn Ojaveer, Estonia, will meet in Bergen, Norway, from 18-20 March 2015, with a back to back meeting 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*.

WGITMO will report by xx April 2015 for the attention of SCICOM.

### Supporting Information

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| **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).<br>b) The group will continue contributing to the MSFD Descriptor 2 issues, incl. further developing alien species indicators, especially those related to ecological impacts.<br>c) We continue identification and evaluation of climate change impacts on the establishment and spread of non-indigenous species by starting investigating the |

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| | salinity change impacts.<br>e) We continue addressing one of the high-priority topics of ICES – Arctic – by investigationg developments in non-native species issues in the area as a result of climate change and resource developments.<br>f) We'll continue investigations on increasingly important issue of various artificial structures for alien species spread and invasions.<br>g) We'll start producing the next alien species alert report – on the sea squirt *Didemnum vexillum*. |
| **Resource requirements:** | None required other than those provided by ICES Secretariat and national members |
| **Participants:** | WGITMO nominated members and invited experts from, e.g. Auatralia, and 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. |