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

13–15 March 2017

Woods Hole, USA

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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

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Executive summary

The 43rd meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was held at the National Oceanic and Atmospheric Administration (NOAA) Northeast Fisheries Sciences Center in Woods Hole, USA, on 13–15 March 2017. This meeting included a joint day with the Working Group on Ballast Water and Other Ship Vectors (WGBOSV). The meeting was hosted by Judy Pederson (USA) and chaired by Cynthia McKenzie (Canada). The meeting was attended by 23 scientists in person, two by web-conference and five by correspondence, representing 16 countries; four additional scientists attended on the joint meeting day. The objective of the meeting was to communicate new information and discuss several aspects of the introductions and transfers of marine organisms relevant to the six terms of reference for the working group. There was a particular focus on introductions into the Arctic environment, biofouling of vessels and structures, and developing indicators to evaluate impact of non-indigenous species in marine environments.

This year's interim report provides: a summary of the 16 National Reports (reports attached in Annex 4); the 20 presentations provided by members and chair invited members in support of term of reference objectives (abstracts provided in Annex 5); discussions, achievements, limitations and a recommendation. All Terms of Reference were discussed with this report structured so that each Term of Reference is dealt with in sequential order. The National Reports provide an overview of the priorities, findings, meetings and publications for each country. In addition, it provides discussion points for methodologies, collaborations and knowledge gaps that need to be addressed by the group (ToR a). The AquaNIS database continues to be updated and the data is now georeferenced. There were three additional presentations under this term of reference addressing monitoring methodology and an invasion risk assessment tool.

WGITMO considered two ToRs jointly with WGBOSV: examining the effect of climate change on the establishment of aquatic species in the Arctic (ToR b); and examining biofouling as vector for the introduction and transfer of aquatic organisms on vessels and structures (ToR c). An update was provided on an ongoing initiative to address Descriptor 2 of the EU-MSFD, in particular Indicator 2.2.1 regarding impact of Invasive Alien Species (IAS) on marine environments (ToR d). The final goal is to develop a new indicator of impact that can be proposed for the implementation within the Marine Strategy Framework Directive. Two ICES Cooperative Research Reports developed by WGITMO were recently released. One was an alien species alert report on the invasive tunicate *Didemnum vexillum* and the other summarized the status of non-indigenous marine species in the North Atlantic and adjacent waters 2003–2007 (ToR a). An update was provided on communications regarding the Suez Canal enlargement and bioinvasion problems in the Mediterranean Sea.

A theme session for the 2017 ICES ASC on bioinvasion trajectories and impacts in contrasting marine environments was proposed by WGITMO as collaboration between ICES-PICES-CIESM. The proposal was accepted and will be jointly chaired by representatives of the three groups.

1 Administrative details

Working Group name

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

Year of Appointment within the current cycle

2017

Reporting year within the current cycle (1, 2 or 3)

1

Chair

Cynthia McKenzie, Canada

Meeting venue

Woods Hole, MA, USA

Meeting dates

13–15 March 2017

2 Terms of Reference a) – f)

a) Advance reseach, develop collaborations and address surveillance and knowledge gaps in issue related to the introduction and transfer of marine organsims, through annual reviews of national/ international activities and responding to advice requests;

b) Evaluate the impact climate change may have on the introduction and spread of non-indigenous marine organisms, including in Arctic environments;

c) Investigate biofouling as a vector for the introduction and transfer of aquatic organisms on vessels and artificial hard structures, their pressure and impact on the ecosystem with a comparison of prevention or selective mitigation methodologies;

d) Advance knowledge base to further develop indicators to evaluate the status and impacts of non-indigenous species in marine environments;

e) Alien Species Alert report for ICES CRR on *Pseudo-nitzschia* sp. complex in Arctic Regions;

f) Contribute regional text (150 words and 1–2 graphs in each case) to new ecosystem overviews for (i) Iceland, (ii) Norwegian Seas, (iii) Azorean ecoregions and (iv) the Oceanic north-east Atlantic ecoregion in relation to the rate of discovery of invasive species where information is available.

3 Summary of the Work Plan

Year 1	Working on all ToRs, but with special focus on ToRs b, c, and d.
Year 2	Working on all ToRs, but with special focus on ToRs a, c, and e.
Year 3	Report on all ToRs

4 List of Outcomes and Achievements of the WG in this delivery period

- A review of national activities (16 countries) was conducted to advance research, develop collaborations and address surveillance and knowledge gaps in issue related to the introduction and transfer of marine organisms.
- It was noted that in both the United States and Canada there were no new species reported in 2016. However, in Europe several countries reported new sightings including the invasive tunicate *Didemnum vexillum* in Germany and a new location on an oyster farm in the United Kingdom (Scotland).
- The AquaNIS database continues to be the main repository of new non-indigenous species data with each country updating the database annually. Georeferenced data can soon now be stored which will address the needs of OSPAR and other potential users.
- Numerous papers and reports have been published collaboratively among working group researchers that have addressed ToR objectives including publications in Nature and other journals.
- Two ICES Cooperative Research Reports developed by WGITMO were recently released; an Alien Species Alert on *Didemnum vexillum* Kott, 2002: Invasion, impact and control CRR#335 and a report on the status of introductions of non-indigenous marine species in the North Atlantic and adjacent waters 2003–2007 CRR#334.
- Working group members participated in testing the AS-ISK risk assessment tool and results of this study were discussed, including implications for use.
- A theme session for the 2017 ICES ASC on bioinvasion trajectories and impacts in contrasting marine environments will be chaired jointly by ICES-PICES-CIESM.
- A scientific paper reviewing the status and risks of introduced species in the Arctic was initiated (jointly with WGBOSV).
- Information about approaches for vessel biofouling assessment and management were reviewed and considered (jointly with WGBOSV).
- Ecosystem overviews were developed for Iceland, and the Azorean
- Ecoregion as requested intersessional by ICES Secretariat. Following a group discussion it was determined that members of the working group did not have data to contribute to an overview of the Oceanic north-east Atlantic ecoregion as our knowledge and data collection is coastal.
- A scientific paper reviewing temporal trends in the introduction of nonindigenous species globally was initiated with WGBOSV.

5 Progress report on ToRs and workplan

ToR a) The 16 National Reports provide an overview of the priorities, findings, meetings and publications for each country. In addition it provides discussion points for methodologies, collaborations and knowledge gaps that need to be addressed by the group (ToR a). The group discussed expanding the country reports to include research and gaps to highlight areas of concern or collaboration. The AquaNIS database continues to be updated and the data is now georeferenced. There were three additional presentations under this term of reference addressing monitoring methodology and an invasion risk assessment tool.

It was noted that in both the United States and Canada there were no new species reported in 2016. However, in Europe several countries reported new sightings including the invasive tunicate *Didemnum vexillum* in Germany and a new location on an oyster farm in the United Kingdom (Scotland). An ICES Cooperative Research Report on the status of introductions of non-indigenous marine species in the North Atlantic and adjacent waters 2003–2007 led by several members of the working group was recently released(CRR#334).

In addition to the National Reports, three presentations were made relating to ToR a). Two researchers reported on methodology in monitoring alien species and one detailing the results of the AS-ISK screening tool study that many members of the working group assisted in testing as requested at the 2016 meeting. The Wadden Sea monitoring program is focused on developing a harmonized monitoring program. During a trilateral workshop in November 2016, a group of experts discussed the main components of a monitoring program for alien species and a proposal for a harmonised monitoring program of alien species in the Trilateral Wadden Sea area was developed. Guiding principles for the AS monitoring included: cost effective and appropriate instruments, marine and terrestrial habitats are to be considered, for early detection and rapid response the temporal resolution should be at least once a year, for high probability of detection, the spatial resolution should concentrate on „hot spots“ and to harmonize the programme, standardized protocols such as OSPAR/HELCOM Joint Harmonized Procedure (JHP) and extended Rapid Assessment should be used. The OSPAR/HELCOM JHP was adopted in 2015 for port sampling when planning vessel exemptions from ballast water management requirements. The protocol is also used for monitoring activities targeting non-indigenous species. The AquaNIS database continues to be the main repository of new non-indigenous species (NIS) data with each country updating the database annually. Georeferenced data can now be stored which will address the needs of OSPAR and other potential users.

Information and results from the AS-ISK assessment tool project were presented. Numerous members of the working group had participated in testing the tool, during the intersession period using several species and multiple regions. Following the presentation, the members participated in a demonstration of how to access and enter data in the program.

ToR b) In 2016, jointly with WGBOSV, WGITMO developed questions that could direct the development of demonstration advice on “risk management of nonindigenous species associated with shipping in the Arctic”, in response to a direct request received from

ICES Bureau. After that time, however, ICES Bureau decided not to proceed with the development of such advice. As a result, this year (1), a subset of WGBOSV/WGITMO members began to develop a review paper for publication in a scientific journal, building on the efforts of the previous year, and bringing in results of a separate project undertaken to assess changes in Arctic shipping traffic (which were presented during the meeting). The goal of the review paper is to compile a comprehensive list of introduced species in the Arctic, to evaluate the risk associated with current and future vectors of introduction, and to identify knowledge/data gaps, to serve as guidance for future research and management efforts related to NIS in the Arctic. The project Leader made a presentation on the joint meeting day to share progress to date, having compiled a list of introduction records based on literature review in consultation with regional experts. In addition the project Leader reviewed existing definitions of the marine Arctic and discussed the implications of adopting the different definitions in terms of invasion risk. The Groups discussed the need to be careful with the use of invasion terminology and recommended including definitions of important terms in the paper. A presentation on the use of eDNA metabarcoding as a new surveillance tool for coastal Arctic biodiversity provided information on activities in the Canadian Arctic to test this new method. They successfully used eDNA metabarcoding of water samples to monitor coastal metazoan species in the Arctic. They showed that eDNA is spatially and temporally heterogeneous within ports and that the efficiency of the eDNA monitoring surveillance is improved when sampling under-ice cover. The researchers believed that allowing rapid sample collection by inexperienced or novice individuals, reducing the cost associated with data collection/shipping and reducing manipulation of organisms, the analysis of eDNA from water samples could be a revolutionary tool to increase the power of detection, spatial coverage and frequency of sampling, thus improving detection of biodiversity shifts in large coastal Arctic ecosystems.

ToR c) Five presentations were contributed under this ToR on the joint day, examining risks associated with rafting of species across the Pacific Ocean on tsunami debris and biofouling on commercial vessels. One presentation provided information about biofouling meetings recently held in the United States with international experts to identify and discuss approaches used to quantity and manage biofouling on vessels. The Groups discussed the importance of replicate sampling and analysis of data using rarefaction curves to distinguish if new reports of introduced species are confounded by sampling effort. The Groups discussed the need to learn from years of experience in setting regulations and inspections procedures for ballast water when embarking on similar activities related to biofouling, with a view towards setting more practical procedures in place.

An additional three presentations were contributed to this ToR addressing biofouling on infrastructures including marinas, oyster aquaculture and windmills. A decision was made at Orkney Harbour Authority to look into the non-native species preventative measures in the marinas and to prepare a contingency plan for a worst case scenario. Once the report for the project is finalised, feasibility of implementing the recommended measures will be considered in collaboration with the decision makers and stakeholders including the Marina Managers. At an oyster aquaculture site in Loch Creran, Scotland molecular analysis of collected samples confirmed the identity of *D. vexillum*. A 24-hour freshwater soak treatment has been written into a Species Control Agreement which the farm owner has voluntarily entered into. The agreement also includes notification of all

future movement plans by the owner. A study of wind farms found that in the subtidal zone, the offshore wind farms will only marginally contribute to the further spread of introduced species given the vast amount of both natural and artificial hard substrata already available in the North Sea, which already contain established populations of the same introduced species. However, for the intertidal zone, the wind farms may have the potential to substantially increase the risk of the further spreading of introduced species, given that offshore intertidal habitat still is relatively rare. Wind farms will indeed drastically increase the available habitat to intertidal introduced species.

The combined ICES Working Groups recalled the open request for information related to biofouling management by IMO, suggesting that outputs of the biofouling meetings held in the United States and research conducted by member states on biofouling on marinas and recreational vessels could serve as a basis for a future contribution.

ToR d) A presentation was contributed on the ongoing initiative to address Descriptor 2 of the EU-MSFD, in particular Indicator 2.2.1 regarding impact of Invasive Alien Species (IAS). The aim is to evaluate available literature information on impacts of selected invasive taxa, encompassing plankton, benthos and nekton. Literature has been searched for relevant articles referred to IAS impacts in EU marine waters; articles are classified for geographical coordinates, type of environment (physical, chemical, abiotic), type of study (qualitative information only, presence-absence comparison, correlative study, controlled field experiments, etc.), habitat/substrate type, response variable measured and process responsible for the impact (bioturbation, filtration, oxygen consumption, etc.). The confounding factors that could affect the results of the surveyed studies are also being considered. Final goal is to develop a new indicator of impact that can be proposed for the implementation within the Marine Strategy Framework Directive.

ToR e) An ICES Cooperative Research Report developed by WGITMO was recently released as an Alien Species Alert on *Didemnum vexillum* Kott, 2002: Invasion, impact and control CRR#335. *Didemnum vexillum* Kott (2002) is a high-impact, globally-invasive, colonial tunicate species that is native to Japan. It is generally a temperate cold-water organism, and its introduced range currently includes New Zealand, The Netherlands, France, Germany (record in 2016 came known too late to be included in CRR#335), Ireland, United Kingdom, Spain, Italy, and both the west and east coasts of the United States and Canada. Like other invasive tunicates, *D. vexillum* has the capacity to reproduce rapidly, outcompete native species, deteriorate environmental integrity, and cause significant economic harm. For these reasons, the report aimed to increase awareness of *D. vexillum*, with a focus on identification, natural history, current global distribution, potential impacts, and prospects for management and control where introductions occur. A new alien species alert report on harmful algae and blooms (HAB) and the risk to the Arctic ecosystem was discussed. The ICES Working Group on Harmful Algae Bloom Dynamics (WGHABD) were approached regarding a joint report. Both groups agreed that the first step in this report was to investigate what information is currently known regarding presence and toxicity of HABs in the Arctic before developing the alien species alert report.

ToR f) Intersessionally, the ICES Secretariate requested WGITMO provide new ecosystem overviews for (i) Iceland, (ii) Norwegian Seas, (iii) Azorean ecoregion and (iv) the Oceanic north-east Atlantic ecoregion in relation to the rate of discovery of invasive species where information is available. The ecosystem overview (Appendix 5) for Iceland

was presented to the group. The recently completed Azorean ecoregion overview (Appendix 5) was presented to the group and discussed. It was noted that in these overviews the information contained in the AquaNIS data system was particularly important in developing these summaries. The request to provide an overview for the Oceanic northeast Atlantic ecoregion was discussed and it was determined that the working group does not have the data or knowledge for this ecosystem. Research conducted by our group is coastal based and does not have information on this oceanic region. The use of invasive species in this request was problematic as was the terminology on rate of discovery. The group decided that determing the rate of introduction or discovery is not a viable way to report on new introductions. However, this approach may be suitable to determine the European target of Good Environmental Status in coastal waters in the reporting period. There appears to be no easy way to standardize the rate which is uneven and episodic. Limits include non-reporting of new species, prevention of new species and consideration of the stability of vector pressure. The group suggested that rather than using number of species, the focus should be on vectors and how to prevent their use in species spread.

Other Business

A theme session for the 2017 ICES ASC on bioinvasion trajectories and impacts in contrasting marine environments (Appendix 6) was proposed by WGITMO in collaboration with PICES and CIESM, and was accepted. The intentional or accidental introduction of non-indigenous marine species can have series ecological and economic impacts, contributing to the global loss of biodiversity and negatively affecting coastal communities. These impacts are not, however, equal among organisms or invaded ecosystems due to differences in native biodiversity, vectors, and ecosystem characteristics. Recognizing and understanding the contextual nature of marine invasions will thus enable better management decisions, especially for data-limited systems such as the Arctic, and can inform policy development that could slow the rate and/or impacts of invasions. The three organizations supporting this session have long histories of working on marine non-indigenous species issues in the Atlantic, Pacific and Mediterranean. The session will draw on this unique expertise to contrast marine invasions in these different systems. The session will be jointly chaired by ICES-PICES-CIESM.

After a presentation on PICES activities concerning introductions of aquatic species, the Group discussed benefits of working more closely with relevant PICES experts. It was noted that an upcoming meeting on marine and freshwater invasive species, to be held 20–23 May 2018 in Beijing China, could serve as a platform for interaction and collaboration between ICES and PICES aquatic invasion experts.

A report on the media coverage of the Suez Canal and marine invasives was presented and found that after analysis of 282 sources, three main types of articles were found: (1) local findings of alien species or articles focused on single "high risk" species, such as the lionfish; 2) general articles about alien species, briefly mentioning the Suez canal as one of the possible pathways; (3) articles specifically dealing with the canal enlargement, and discussing its geopolitical aspects. The species most often mentioned in the news are those harmful to humans: *Lagocephalus sceleratus*, *Rhopilema nomadica*, *Pterois miles*. Surprisingly, the fact that the Suez Canal has been enlarged is mentioned only by 60% of the sources; it is unclear if this omission is due to lack of information, or it is intentional.

6 Revisions to the work plan and justification

No revision of work plan required.

7 Next meetings

The WGITMO proposes to meet in Canical (Madeira Island), Portugal, 7–9 March 2018, hosted by Joao Canning-Clode (Marine and Environmental Sciences Centre). A joint full day meeting with WGBOSV is proposed for 7 March 2018.

Annex 1: Participants

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Annex 2: Recommendations

RECOMMENDATION	ADRESSED TO
1. Initiate discussion/coordination with other Arctic organisations (e.g. PAME, CAFF) with a view to jointly address non-native species issues in the Arctic.	SCICOM

Annex 3: Agenda

ICES Working Group on Introductions and Transfers or Marine Organisms (WGITMO)
MEETING AGENDA
13–15 March 2017

Venue: NOAA Northeast Fisheries Science Center (NEFSC)
Stephen H. Clark Conference Room
166 Water Street, Woods Hole, MA, USA

	MONDAY 13TH MARCH	
08.30	Set up Computers	.30
09.00	**Opening of the meeting**	.20
	Welcoming remarks**:** **Cynthia McKenzie** (Chair), **Judy Pederson** (Host)	
	Introduction of Participants	
	Review of WGITMO Terms of Reference and Agenda	
09.20	**ToR a):** Advance research, develop collaborations and address surveillance and knowledge gaps in issues related to the introduction and transfer of marine organisms, through annual reviews of national/international activities and responding to advice requests.	
	ToR lead: Cynthia McKenzie	
	National reports	
	• Belgium **Francis Kerckhof**	.10
	• Canada **Nathalie Simard**	.10
	• France **Ameila Curd**	.10
	• Germany **Stephan Gollasch**	.10
	• Italy **Agnese Marchini**	.10
10.30	**Morning break**	.30
11.00	Review of National Activities continued	
	• Lithuania **Sergej Olenin** (Remote participation)	.10
	• Norway **Anders Jelmert**	.10

	• Portugal **Joao Canning-Clode** • Sweden **Rahmat Naddafi** • UK **Lyndsay Brown, Jenni Kakkonen** • USA **Judy Pederson** • Summary of Reports by Correspondence (Denmark, Estonia, Israel, Poland)	.10 .10 .10 .10
12.30	**Lunch break**	.60
13.30	**ToR a) continues**	
	Presentation: Development of a Wadden Sea monitoring programme for alien species – **Katja Broeg/Stephan Gollasch**	.20
	Presentation: NIS monitoring system/framework for HELCOM – **Sergej Olenin** (by Remote)	.20
	Presentation: AS-ISK trial applications for aquatic plants and animals for various risk assessment areas – **Gordon Copp**	.20
	Question and Discussion ToR a	
14.30	**ToR d):** Advance knowledge base to further develop indicators to evaluate the status and impacts of non-indigenous species in marine environments. ***ToR Leads: Sergej Olenin and Henn Ojaveer***	
	Presentation: NIS Environmental Impact Assessment Scheme – **Agnese Marchini**	.20
	Presentation: AquaNIS status update – **Sergej Olenin** (by WebEx)	.20
	Question and Discussion on ToR d	.10
15.00	**Afternoon break**	.30
15.30	**WGITMO ToR b) Evaluate the impact climate change may have on the introduction and spread of non-indigenous marine organisms, including the Arctic environments.** ***ToR Lead: Nathalie Simard/Anders Jelmert***	

	Presentation: eDNA and early detection in the Arctic and ARIAS (the Arctic Invasive Alien Species Strategy) **Anaïs Lacoursière-Roussel/ Kim Howland**	.20
	Discussion	
	Presentation: Global review on salinity change effects on non-indigenous species – **Joao Canning-Clode**	
	General Discussion WGITMO ToR b Priorities	.20
17.00	**WGITMO ToR e):** Alien Species Alert report for ICES CRR on *Pseudo-nitzschia* sp. complex in Arctic Regions ***ToR Lead: Cynthia McKenzie***	
	Discussion Status of *D. vexillum* ASA-CRR	.10
	Update on ASA for *Pseudo-nitzschia* sp. and next steps	.20
17.30	**Close of Day 1**	

TUESDAY 14TH MARCH		
08.30	Reconvene for day 2 – set up computers	.30
09.00	Review of previous day discussions, additional comments, action items	.30
9.30	**Inspirational Presentation by Host Country and Global Activities**	
	Presentation: Title TBD **Judy Pederson**	
	Questions and Discussion	.30
	Presentation: Suez Canal Enlargement Update – **Agnese Marchini**	
	Questions and Discussion	.30
10.30	**Morning break**	.30
11.00	**WGITMO ToR f)** Contribute regional text to new ecosystem overviews for (i) Iceland, (ii) Norwegian Seas, (iii) Azorean ecoregions and (iv) the Oceanic north-east Atlantic ecoregion in relation to the rate of discovery of invasive species where information is available.	

	ToR Leads: Henn Ojaveer/Anders Jelmert	
	Presentation: Overviews for Iceland and Norwegian Seas – **Anders Jelmert**	.20
	Presentation: Overview for Azorian Ecoregions – **Joao Canning-Clode**	.20
	Discussion: Overview for Oceanic north-east Atlantic ecoregion,	.20
	General discussion ToR f	
12.30	**Lunch break**	.60
13.30	**ToR c) Investigate biofouling as a vector for the introduction and transfer of aquatic organisms on vessels and artificial hard structures, their pressures and impact on the ecosystem with a comparison of prevention and selective mitigation methodologies.** **ToR Lead: Cynthia McKenzie**	
	Presentation: Marine NNS Preventive Measures: Marina's in the Orkney Islands – **Jenni Kakkonen**	.20
	Presentation: *Didemnum vexillum* outbreak at a west coast oyster farm – **Lyndsay Brown**	.20
	Presentation: Introduced species on wind farms and ecological consequences – **Francis Kerchof**	.20
	General discussion and WGITMO priorities ToR c **Stephan Gollasch**	
15.00	**Afternoon break**	.30
15.30	**Future planning**	
	• ICES Annual Science Meeting Special ICES/PICES/ CIESM Joint Session on *Bioinvasion trajectories and impacts in contrasting marine environments* – **Cynthia McKenzie / Tom Therriault**	
	• Other business or issues	
17.00	**Close of Day 2**	

	WEDNESDAY 15TH MARCH **JOINT MEETING WITH WGBOSV**	
08.30	Reconvene for day 3 - Set up computers	.30
08.45	Welcoming remarks: **Sarah Bailey, Cynthia McKenzie** (Co-Chairs), **Judy Pederson** (Host)	.5
	Introduction of Participants	.10
09.00	A few words about NEFSC – Deputy Director, **Dr. Susan Gardner**	.15
	Review WGBOSV/WGITMO Joint Day Agenda	.5
	Update on relevant PICES activities – **Tom Therriault**	.10
09.30	**WGITMO ToR c)** Investigate biofouling as a vector for the introduction and transfer of aquatic organisms on vessels and artificial hard structures, their pressure and impact on the ecosystem with a comparison of prevention or selective mitigation measures. **WGBOSV ToR e):** Investigate and evaluate methods/technologies to assess risks of, to minimize extent of, and to respond to vessel biofouling to inform national and/or international policies or guidelines ***ToR Lead: Stephan Gollasch***	
	Review ToR c objectives and deliverables	.10
	Presentation: Transoceanic rafting of marine biofouling communities – implications for marine debris as a vector for non-indigenous species – **Jim Carlton**	.20
	Questions	.10
	Presentation: US Biofouling Workshop – **Lisa Drake**	.20
	Questions	.10
10.45	Morning break	.15
	Presentation: Title to be determined - **Greg Ruiz**	.20
	Questions	.10
	Presentation: Biofouling Risk in the Canadian Arctic – **Farrah Chan**	.20
	Questions	.10
	Discussion, Gap Analysis and Strategic Planning under ToR c [WGBOSV ToR e]	.30

12.30	Lunch break	.60
13.30	**WGITMO ToR b):** Evaluate the impact climate change may have on the introduction and spread of non-indigenous marine organisms, incl. in Arctic environments.**WGBOSV ToR d):** Investigate and evaluate climate change impacts on the establishment and spread of ship-mediated nonindigenous species, particularly with respect to the Arctic ***ToR Lead: Anders Jelmert***	
	Review of ToR objectives and deliverables	.10
	Presentation: Results of Canadian Arctic Domestic Shipping Project- **Kim Howland**	.20
	Questions	.10
	Progress Update: Review Paper on AIS risks to the Arctic	
	Part 1 - **Farrah Chan**	.20
	Part 2 – **Stephan Gollasch**	.20
15.00	**Afternoon break**	.15
	Group Discussion to Further Progress the Review Paper	.45
	Discussion, Gap Analysis and Strategic Planning under ToR b) [WGBOSV ToRd]	.30
	Location of next meeting	.15
	Discuss any Joint Issues Outstanding/ End of Joint Meeting Day	.15
17.30	Close of WGITMO	

Annex 4: National Reports (ToR a)

Belgium

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Report unavailable, presentation on the SharePoint site.

Canada

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Overview:

Fisheries and Oceans Canada has finalized the new Aquatic Invasive Species Regulations for the *Fisheries Act* and it is now in force in Canada effective June 17, 2015. (http://gazette.gc.ca/rp-pr/p2/2015/2015–06–17/html/sor-dors121-eng.php).

Didemnum vexillum, observed for the first time in 2013 in Atlantic Canada in Minas Basin, in the upper Bay of Fundy, was reconfirmed in 2016 through genetic analysis from a specimen collected at Greville (Bay of Fundy). The European sea squirt (*Ascidiella aspersa*) was first detected in Atlantic Canada in 2012 (Lunenberg harbor, Atlantic Coast of Nova Scotia) and was found at a new location in Shelburne (Nova Scotia) in 2016.

Other species that have already invaded Canadian waters continue to spread, including European green crab (*Carcinus maenas*), vase tunicate (*Ciona intestinalis*), golden star tunicate (*Botryllus schlosseri*), violet tunicate (*Botrylloides violaceus*), clubbed tunicate (*Styela clava*), Japanese skeleton shrimp (*Caprella mutica*), coffin box (*Membranipora membranacea*), and oyster thief (*Codium fragile* subsup. *fragile*).

1. Regulations
Fisheries and Oceans Canada has developed regulations to manage the threat of aquatic invasive species (AIS). The Aquatic Invasive Species Regulations for the *Fisheries Act* is now in force in Canada effective 17 June 2015.

2. Intentional Introductions

Prior to December 31, 2015, Fisheries and Oceans Canada, along with the provinces and territories, managed 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, disease risk is now managed by the Canadian Food Inspection Agency (CFIA) through the National Aquatic Animal Health Program under the Health of Animals Regulations.

For details on the intentional introductions by province for 2016, see

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

3. Unintentional Introductions

New Sightings-

There were no sightings of new marine AIS reported in 2016.

Spread of established AIS species-

Didemnum vexillum, confirmed for the first time in 2013 in Atlantic Canada in Minas Basin, in the upper Bay of Fundy, was reported at additional sites in 2014 and 2015. In 2016, *D. vexillum* was confirmed within Bay of Fundy (Greville near Parrsboro, Nova Scotia) attached to mussels and lemon weed bryozoan (*Flustra foliacea*).

Ascidiella aspersa was first detected in Atlantic Canada in 2012 (Lunenberg harbor, Atlantic Coastal Nova Scotia). In 2016, *A. aspersa* was found at a new location in Shelburne (Atlantic Coast of Nova Scotia).

Carcinus maenas continues to spread into north-eastern New Brunswick, Prince Edward Island and the Gulf coast of Nova Scotia. Abundances of green crab in 2016 are increasing in several recently invaded bays of these areas despite a sharp abundance decrease reflected in 2014/2015. Green crab continues to spread in Newfoundland in Placentia Bay, the west coast of NL, and Fortune Bay on the south coast, which is an area of high lobster productivity. Abundances of green crab in Magdalen Islands, Quebec have decreased since 2013 with no capture in 2015 and only seven crabs in 2016. Cold winters or control efforts are potential factors that could explained this important drop.

Ciona intestinalis is now well 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 and is found in isolated areas of the Burin Peninsula in Newfoundland and Labrador. This species is also well established along the eastern shore of Prince Edward Island (confirmed in Wood Islands in 2016) and is sporadically distributed along the Gulf shore of Nova Scotia. *C. intestinalis* is only observed in one harbor in the Magdalen Islands, where control efforts have been put in place to minimize dispersal risks into aquacultures sites.

Botryllus schlosseri is now present in most bays and harbors along the south, and south west coast of mainland Nova Scotia, as well as in coastal Cape Breton and the Bras D'Or lakes, Gulf shore of Nova Scotia, Prince Edward Island and Magdalen Islands. It is well established in SW New Brunswick and continues to spread into the NE of the province. Golden Star Tunicate was detected for the first time in Gaspésie, Quebec on collector plates in 2012 but was never observed in that area since that time. In Newfoundland, *B. schlosseri* has been found in many coves throughout Placentia Bay. It has also been

found in isolated areas along the south coast of Newfoundland, including Fortune Bay, Hermitage Bay, and since 2013 has been found on the southwest coast of the Island. It is present in only one harbour (Long Pond) in Conception Bay.

Botrylloides violaceus is well established and continued to spread to new locations in SW New Brunswick. *B. violaceus* has established in most bays on the northern shore of Prince Edward Island, in the Magdalen Islands and on the Atlantic coast of Nova Scotia. In Belleoram, Newfoundland, where *B. violaceus* was originally detected in that province, abundances have decreased in the last 2–3 years, possibly due to colder winters or changes in boat traffic. Isolated populations have been discovered throughout Newfoundland, including the west coast (Codroy), Placentia Bay (Arnold's Cove), and Conception Bay (Long Pond).

Styela clava was reported in Prince Edward Island in 1998 and is mostly restricted to the eastern shore and a few bays on the northern shore of this province (confirmed from South Rustico in 2016). *S. clava* was reported for the first time in Nova Scotia in 2012 at a few locations within Chedabucto Bay and has been present since that time.

Diplosoma listerianum was first reported in the Magdalen Islands in 2008 but no colonies have been found in that area since that time. This species was found for the first time in Nova Scotia in Lunenberg Harbor in 2012 and has not been observed since that time. In 2016, *D. listerianum* was reported for the first time in SW New Brunswick at nine locations. Genetic analyses will be used to confirm the identifications.

Caprella mutica is well established on the Atlantic coast of Canada since the 1990s. In 2016, *C. mutica* was observed for the first time in the Bay of Sept-Îles located on the West Coast of the Gulf of St. Lawrence.

Membranipora membranacea is well established on the Atlantic coast of Canada since the 1990s. In Quebec, this invasive bryozoan is found in the Magdalen Islands, Gaspe Peninsula and on the West coast of the Gulf of the St. Lawrence. It has also been detected in a few locations in eastern PEI, the Gulf shore of Nova Scotia but not in high densities. *M. membranacea* is well established in Newfoundland and has been found in most coastal areas throughout the province, including southern Labrador.

Codium fragile subsp. *fragile* is established along the shores of the Northumberland Strait and in Malpeque Bay (northern shore of Prince Edward Island) as well as in the Magdalen Islands. In Newfoundland, *C. fragile* was first discovered attached to the substrate in 2013 in Placentia Bay (near Arnold's Cove). It has since been observed attached in Notre Dame Bay (near Pilley's Island) and within Fortune Bay (near Little Harbour East). In Nova Scotia, *C. fragile* was reported for the first time in 1991 and spread along coasts since that time. It was found in Northern Cape Breton (Dingwall) in 2015–2016.

4. Pathogens

None reported.

5. Meetings

Canadian Conference for Fisheries Research (St John's, Newfoundland, Canada; 8–10 January 2016) (www1.uwindsor.ca/glier/ccffr/past-programsabstracts).

Atlantic Zonal AIS Monitoring meeting, St. John's, NL, February 2016.

Canadian Aquatic Invasive Species Network II Annual General Meeting, Windsor, Ontario, Canada, May 2016.

19th International Conference on Aquatic Invasive Species (ICAIS), Winnipeg, Canada, 10–14 April, 2016

Future meetings

20th International Conference on Aquatic Invasive Species (ICAIS), Fort Lauderdale, FL, September 2017.

International Conference on Marine Bioinvasions X, October 16–18, 2018 in Argentina.

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Denmark

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1. Highlights

Methodology for monitoring invasive species is being developed. Authorities are working on implementation of MSFD descriptor 2 (non-indigenous species), the Ballast Water Convention, and the EU directive on invasive species. Several non-indigenous species have been reported from the northern harbor of Copenhagen.

2. Regulations

As of 1 July 2016 the Nature Agency was (again) sub-divided, and the authority responsible for non-indigenous species as well as the WFD, MSFD and Ballast Water Convention is now called the Agency for Water and Nature Management (Danish abbreviation SVANA).

In connection with implementation of the MSFD, an action program has been developed (Ministry of Environment and Food 2016). It suggests developing a strategy for reduction of escape of non-indigenous species from aquaculture in inner open Danish waters. Also, a report has been published on non-indigenous species as hull fouling in Danish waters (Bohn *et al.*, 2016).

The Danish Agrifish Agency has posted a report specifying minimum demands for monitoring of non-indigenous species in selected Danish ports, a project to be carried out during 2017/2018. The project will include "traditional" sampling and identification

procedures as well as eDNA (environmental DNA) molecular methods. A report on these methods has been published by NIVA-DK (Andersen *et al.*, 2016).

A number of Executive Orders passed in 2016 are relevant for management of NIS. BEK nr. 439 af 19/05/2016 on determination of environmental goals for water courses, lakes, transitional waters, coastal waters and ground water. BEK nr. 952 af 27/06/2016 on handling of ballast water and sediments from ships' ballast water tanks. BEK nr. 1088 af 18/07/2016 on prevention and handling of introduction and dispersal of invasive non-indigenous species. BEK nr. 1517 af 07/12/2016 on approval of listed enterprises. The latter included aquaculture and mariculture facilities. All Executive Orders (BEK, Bekendtgørelser) are available at https://www.retsinformation.dk .

Import and Export (source: Statistikbanken at http://www.statistikbanken.dk/)

In 2016 Denmark imported 22 tons of saltwater aquarium fish, mostly from the Netherlands but also Belgium and Indonesia. 55 tons of oysters and 24 tons of mussels were imported mainly from France and the Netherlands. 135 tons of live lobsters (*Homarus* spp.) were imported, of which 59 tons were from Canada and 31 tons from the USA. The rest were mainly from European countries.

Denmark exported 16,415 tons of live blue mussels, almost exclusively to other EU countries. Also 134 tons of live flat oysters were exported, mainly to other EU countries. 5,735 tons of live salmonid fishes (trout, salmon etc.) were exported, mostly to other EU countries and Switzerland.

Fisheries statics for 2015 are available at http://webfd.fd.dk/info/sjle3/fsa_bog2015/Fiskeristatisk.pdf

3. Unintentional introductions

A report summarizing trends in records and contribution of NIS to Danish marine bottom communities has been published by the Danish Center for Environmental Research (Staehr *et al.*, 2016).

Macrophytes

One study has been published on herbivore consumption of *Sargassum muticum* compared to various native algae (Pedersen *et al.*, 2016).

Invertebrates

Several papers on the biology of the Pacific oyster, *Crassostrea gigas*, have been published (Holm *et al.*, 2016; Vismann *et al.*, 2016; Nielsen *et al.*, 2017). These are focused on coexistence with native species, mainly blue mussels. Partly unconfirmed reports on finding *Crassostrea gigas* in the harbor of Copenhagen have been reported by divers to the local press (see https://www.oesterbro-avis.dk/uoensket-oestersart-har-fundet-vej-til-nordhavn/). As this species is difficult to mistake for other locally occurring species, the find is included in this report. Presumably the long warm summer allowed spawning in populations along the Swedish coast, and for larvae to settle further south. It will be interesting to see if they are able to establish at the low salinity of the harbor.

Rhithropanopeus harrissii has also been found in the northern part of Copenhagen harbor (confirmed from photos).

One paper on bioturbation by *Marenzelleria viridis* has been published (Vasquez-Cardenas *et al.*, 2016). A student thesis from Roskilde University on occurrence of *Marenzelleria* in the Isefjord has been overlooked, but is now recorded (Jensen, 2014).

Ficopomatus enigmaticus has also been found in the northern part of Copenhagen harbor. This is a new locality compared to previous occurrences, which were restricted to the area around the cooling water outlet from a power plant in the southern part of the harbor. Occurrence has been confirmed from photos.

The barnacle *Austrominius modestus* has again been found in the Limfjord (confirmed by specimens). Again this is probably due to a long and warm summer 2016.

Fish

A status report on distribution of non-indigenous fish has been published (Carl *et al.*, 2016). This report also includes information on the Chinese mitten crab.

Findings from 2016 includes one *Huso huso* from Lohals beach in June, one *Acipenser gueldenstaedtii* captured at Solrød beach also in June.

In October 2016 there was a mass escape (about 80,000 fish) of rainbow trout from a mariculture facility in Lillebælt that was hit by a ship.

4. Meetings

A meeting of the advisory group on invasive species was held in April (participation by invitation/ membership of group). The meeting focused on the EU list and risk assessments, so very little on marine species.

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Estonia

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1. Overview

Two important findings were obtained in 2016: i) record of the first alive individuals of the gulf wedge clam (*Rangia cuneata*) in Pärnu Bay (NE Gulf of Riga), and ii) the second observation of the signal crayfish (*Pacifastacus leniusculus*) in Päru Bay. National non-indigenous species monitoring was continued in the scope and aims as in previous years, with the major objective to monitor non-indigenous species in the high-risk areas of new invasions. Also, port biological sampling was continued in Muuga harbor according to HELCOM guidelines. Based on surveys in vicinity of the largest port in the country – Muuga harbor – no new non-indigenous species were identified in 2016. Long-term time-series of all more abundant alien and cryptogenic species in Estonian coastal sea was

updated and their ecological impacts summarised. In difference from other sea areas and species, very high biomasses were recorded in the Gulf of Riga for the following four benthic invertebrates: the cirriped *Amphibalanus improvisus*, the polychaete *Marenzelleria neglecta*, the zebra mussel *Dreissena polymorpha* and the clam *Mya arenaria*. Spatio-temporally the most widespread and abundant populations were those of *A. improvisus*, *M. neglecta*, the predatory cladoceran *Cercopagis pengoi* and the round goby (*Neogobius melanostomus*), the latter being, together with the mud crab (*Rhithropanopeus harrisii*), the most expansive non-indigenous species. New evidences on the invasion ecology of *N. melanostomus* and *Gammarus tigrinus* are provided, together with synthesizing the history and patterns of the Baltic Sea introductions. Two pan-Baltic activities were directed at synthesizing introductions trajectories based on the info on introduction events stored in AquaNIS and proposing non-native species monitoring framework to HELCOM (jointly with Lithuania and Finland).

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

The IMO BWMC ratification process is not yet finalized.

3. Unintentional introductions

Two important findings were obtained in 2016: i) record of the first alive individuals of the gulf wedge clam (*Rangia cuneata*) in Pärnu Bay (NE Gulf of Riga), and ii) the second observation of the signal crayfish (*Pacifastacus leniusculus*) in Päru Bay.

In 2016, non-indigenous species monitoring was continued in the scope and aims as in previous years, with addition of port biological sampling according to HELCOM methodology. One of the aims is to monitor non-indigenous species in the high-risk areas of new invasions. Based on surveys both at and in vicinity of the largest port in the country – Muuga harbor (Port of Tallinn) – no new non-indigenous species were identified in 2016. The samples taken both from the harbour area as well as adjacent localities confirm that spatio-temporally, the most stable and abundant populations were those of the cirriped *Amphibalanus improvisus* and the polychaete *Marenzelleria neglecta* (Anon. 2017).

The other major aim of the non-indigenous species monitoring program is to track the long-term performance of the already existing non-indigenous species in Estonian coastal sea (please also see figures 1–5 at the end of the report). In difference from other sea areas and species, very high biomasses were recorded in the Gulf of Riga for the following four benthic invertebrates: the cirriped *A. improvisus*, the polychaete *M. neglecta*, the zebra mussel *Dreissena polymorpha* and the clam *Mya arenaria*. Spatio-temporally the most widespread and abundant populations were those of *A. improvisus*, *M. neglecta*, the predatory cladoceran *Cercopagis pengoi* and the round goby (*Neogobius melanostomus*), the latter being, together with the mud crab (*Rhithropanopeus harrisii*), the most expansive non-indigenous species.

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 dominate in the benthic invertebrate communities at shallow depths. In 2016 the species was not found elsewhere in the Estonian coastal sea.

The bloody-red shrimp *Hemimysis anomala* has been increasingly found in the Estonian coastal sea. Although its densities are very low, a number of new localities have been

observed in recent years: Pärnu Bay (Gulf of Riga) in 2009, 2012 and 2013; Muuga Bay (Gulf of Finland) in 2012 and Tallinn Bay (Gulf of Finland) in 2013. In 2015 and 2016 no *H. anomala* were recorded in benthic samples. However, it is important to note that this species occurs only sporadically in the traditional monitoring samples due to its very specific habitat range.

In 2016 the grass prawn *Palaemon elegans* dominates among palaemonids in most near-coastal habitats of the whole Estonian coastal sea. Recent unpublished field and experimental studies showed that the non-native *P. elegans* had wider geographical range compared to native species but nevertheless the novel species had narrower niche space. *P. elegans* inhabited lower salinity areas and more eutrophicated habitats compared to the native species. Experiments demonstrated that the non-native shrimp had higher affinity to vegetated substrates compared to native species.

The North-American amphipod *Gammarus tigrinus* Sexton, 1939 is a successful invader in European waters due to its high reproductive potential and tolerance to severe environmental conditions and various pollutants. We followed the invasion and establishment of this exotic species in a species-poor ecosystem of the northern Baltic Sea. Two years after the establishment of *G. tigrinus*, over half of the sampling sites were occupied exclusively by *G. tigrinus*, whereas *G. tigrinus* coexisted with native gammarids in only one tenth of all sites. There was a clear separation of habitat occupancy between native species and *G. tigrinus* in terms of abiotic environment and macrophytic habitat. *G. tigrinus* preferred shallow sheltered areas dominated by vascular plants, while native species mainly occurred in more exposed, deeper habitats with phaeophytes and rhodophytes. In its suboptimal habitats, *G. tigrinus* exhibited moderate abundances, which allowed for the coexistence of native gammarids and the invasive gammarid. Since its establishment, the abundance of *G. tigrinus* has showed no signs of decline, with abundances exceeding almost fifteen times those of native gammarids at some locations. The results suggest that, irrespective to the competitive superiority of *G. tigrinus* over the native gammarids, the invasive *G. tigrinus* does not monopolize the entire coastal area of the northern Baltic Sea but mostly outcompetes native species in its favoured habitats (Reisalu *et al.* 2016). In addition, we have applied the species marginality index and species distribution modeling in the northern Baltic Proper to determine (1) if environmental niche spaces at habitat scale differ between taxonomically and functionally closely related invasive and native gammarid species, and (2) whether the observed pattern relates to the species distribution overlap. Both methods agreed in notably narrower and more segregated realized niche of invasive *G. tigrinus* compared to the studied native gammarids. Among native species, the distribution of *G. zaddachi* overlapped the most with *G. tigrinus*. Our results confirm that widespread colonization does not require a wide niche of the colonizer, but may rather be a function of other biological traits and/or the saturation of the recipient ecosystem. The niche divergence and wider environmental niche space of native species are likely to safeguard their existence in habitats less suitable for *G. tigrinus* (Herkül *et al.* 2016)

Catch index of the Chinese mitten crab *Eriocheir sinensis* has been monitored in gillnet fishing nets in Muuga Bay (Gulf of Finland) since 1991. While until 2002, the species was relatively rarely found, significantly elevated catch index level was recorded since then. However, no or only a very few crabs were found in the bay during the past years (Figure 4; Anon 2017).

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 (Figure 4, Anon 2017). Pan-Baltic modelling results show that the distribution of the round goby is primarily related to local abiotic hydrological conditions (wave exposure). Furthermore, the probability of round goby occurrence was very high in areas in close proximity to large cargo ports. This links patterns of the round goby distribution in the Baltic Sea to shipping traffic and suggests that human factors together with natural environmental conditions are responsible for the spread of NIS at a regional sea scale (Kotta *et al.* 2016). Our laboratory experiment showed that the round goby is able to effectively consume a diverse variety of prey when given the choice between dominant benthic invertebrates: bivalves (*Macoma balthica, Mytilus trossulus, Cerastoderma glaucum*) and amphipods (*Gammarus* spp.). In contrast consumption of the gastropod (*Theodoxus fluviatilis*) was very low in all provided combinations. Nevertheless, the round goby had no statistically significant preference towards any of the prey taxa. The round goby exhibited size-specific consumption of *M. trossulus*, with smaller individuals being consumed at least 25% more than larger size classes. In addition elevated prey density resulted in higher consumption of prey by the fish. The broad diet suggests that shifting densities of benthic invertebrate prey has little influence on the further dispersal of the round goby in the Baltic Sea as the species is potentially able to switch between several native invertebrate taxa. This opportunistic feeding behaviour has likely favoured this invasion and ensured success of the species in the invaded ecosystem (Nurkse *et al.* 2016)

We investigated the feeding of the dominant small pelagic fish – herring *Clupea harengus membras* and three-spined stickleback *Gasterosteus aculeatus* – in the Gulf of Riga (Baltic Sea) in the summers of 1999–2014. From the total of 9652 stomachs, 26 different prey items were identified. Most frequent of these were the cladoceran *Bosmina* spp. (present in[50% of all nonempty stomachs), followed by the copepod *E. affinis* (36.7%), the non-native large predatory cladoceran *C. pengoi* (21.0%), the copepod *Acartia* spp. (16.7%) and the small cladoceran *Podon/Pleopis* spp. (8.7%). Judging from the relative proportion and frequency of occurrence, *Bosmina* spp. and *E. affinis* were the most consumed prey items; in the diets of three-spined stickleback and large herring, *C. pengoi* also contributed substantially (17% and 27%, respectively; Ojaveer *et al.* 2016a).

The gibel carp *Carassius gibelio* was introduced to fish ponds in Estonia during the mid-1950s and was first found in the sea in 1985. Out of the routinely investigated coastal fish monitoring stations, this non-indigenous fish is most abundant at the southern coast of Saaremaa (Kõiguste) in the northern Gulf of Riga with relatively stable values during the several past years (Figure 5, upper panel). During five past years, relatively high CPUE values with a general declining trend was observed in the Gulf of Finland (Figure 5, lower panel). The fish occurs in several coastal fish monitoring sites at low abundances and is therefore considered as a common (an in several places dominating) species in coastal fish communities.

Two pan-Baltic activities

By exploiting the species introduction event data stored in the online information system on aquatic non-indigenous and cryptogenic species, summary and synthesis of non-native species introductions was performed. The authors of the paper are national experts form all Baltic Sea countries, who have critically evaluated the available infor-

mation from the previous sources and updated their country records. Out of the total of 132 NIS and cryptogenic species recorded, 59% are currently established in at least one country surrounding the Baltic Sea. On average, each country currently hosts 27 such species with 15% of the established species being found in at least 50% of the countries. Benthic macroinvertebrates dominate, both among those recorded (48%) and established (59%) species. Shipping, deliberate stocking and natural spread of NIS previously introduced to the North Sea are the main introduction pathways, with considerable dynamics over time. Amongst the pathways responsible for the currently established species, shipping and natural spread strongly dominate. Substantial uncertainty in the information on introduction pathways (except for deliberate releases) hampers detailed analyses and poses major challenges for management. Spatio-temporal variability in the invasion dynamics reflects both the spatial differences in the main hydrographic conditions of the Baltic Sea as well as the availability of introduction pathways. We conclude that the Baltic Sea cannot be considered as a uniform waterbody in terms of the established introduced species and at least two major regions withdiffering hydrographic conditions and introduction pathways can be clearly distinguished. Due to the importance of natural spread of NIS from the North Sea, regional cooperation in bioinvasion management should be enhanced in the future (Ojaveer *et al.* 2016b).

Framework proposal for an integrated NIS HELCOM monitoring programme, which combines all types of surveys and approaches, which may provide information on NIS findings, establishment and spread, including routine HELCOM biological monitoring (HELCOM COMBINE), Port Biological Baseline Surveys (HELCOM/OSPAR), HELCOM coastal fish monitoring and other already ongoing and developing monitoring approaches was jointly prepared by Sergej Olenin, Maiju Lehtiniemi and Henn Ojaveer (Olenin *et al.* 2016). Amongst others, the proposal recommends using AquaNIS, the Information system on Aquatic Non-Indigenous and Cryptogenic Species, as a central database for data storage, analysis and reporting.

4. Website

Multiple entries throughout the year to 'Information system of aquatic alien and cryptogenic species in Europe' (AquaNIS; http://www.corpi.ku.lt/databases/index.php/aquanis) to update the Baltic non-native species invasion events (first record by country, source region, pathway/vector responsible, species status, population status). Information of the invasion events module of the Baltic Sea is freely accessible. All Estonian data was updated in AquaNIS as per 24 February 2017.

5. Pathogens

Nothing to report.

6. Meetings (list of presentations)

Kotta, J. 2016 Introduced crab pushes coastal ecosystem from bottom-up to top-down control and glides benthic and pelagic baselines [Oral presentation]. 51.EMBS, Rhodos, Greece 26–30 September 2016.

Kuprijanov, I. 2016 Ecological niche differentiation between native and alien caridean shrimps in the northern Baltic Sea [Oral presentation]. 51.EMBS, Rhodos, Greece 26–30 September 2016.

Nurkse, K. 2016 Ecology of the most important non-native species and on how the round goby fits into the scheme. National BONUS BAMBI/BIO-C3/INSPIRE seminar on 'The new challenges in management of the Baltic Sea'. Tallinn, Estonia, 27 April 2016

Nurkse, K., Kotta, J., Pärnoja, M., Kotta, I. 2016. Separate and interactive effects of non-indigenous species on native communities: the two aggressive novel benthic predators in the Baltic Sea [Oral presentation]. 51.EMBS, Rhodos, Greece 26–30 September 2016.

Nurkse, K., Kotta, J., Pärnoja, M., Orav-Kotta, H. and Ojaveer, H. 2016. Round goby (*Neogobius melanostomus*) in the brackish Baltic Sea – feeding ecology and impacts on benthic communities [Poster presentation]. IX ICMB. Sydney, Australia 19–21. January 2016.

Nurkse, K., Kotta, J., Pärnoja, M. and Orav-Kotta, H. 2016. Invasive mud crab *Rhithropanopeus harrisii* Gould (Crustacea, Decapoda) in the brackish Baltic Sea - Experimental evidence suggests an impact on benthic invertebrates and sediment [Poster presentation]. IX ICMB. Sydney, Australia 19–21. January 2016.

Ojaveer, H.; Olenin, S.; Narscius, A.; Florin, A.-B.; Ezhova, E.; Gollasch, S.; Jensen, K.R.; Lehtiniemi, M.; Minchin, D.; Normant-Saremba, M; Strake, S. 2016. Dynamics of biological invasions and pathways over time: the Baltic Sea case study [Oral presentation]. IX ICMB. Sydney, Australia 19–21 January 2016

Ojaveer, H.; Olenin, S.; Minchin, D.; Boelens, R. 2016. Assessing exemptions under the Ballast Water Management Convention [Oral presentation]. IX ICMB. Sydney, Australia 19–21 January 2016

Ojaveer, H. 2016 Introduction to the session Exotic species: fluxes and vectors across seas. 41th CIESM Congress, Kiel, Germany, 12–16. September 2016

Ojaveer, H. and Klais, R. 2016. Dynamics of pelagic fish, their feeding and prey. National BONUS BAMBI/BIO-C3/INSPIRE seminar on 'The new challenges in management of the Baltic Sea'. Tallinn, Estonia, 27 April 2016

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Oganjan, K.; Lauringson, V.; Kotta, J.; Rostin, L.; Martin, G. 2017. Factors affecting the recruitment of Amphibalanus improvisus and Dreissena polymorpha in a highly eutrophic brackish bay. Estuarine, Coastal and Shelf Science, 184, 37–45.

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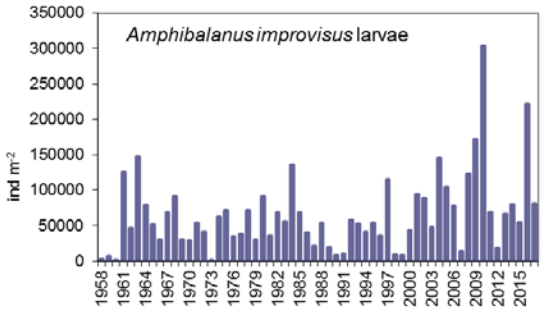
Amphibalanus improvisus larvae
ind m-2
350000
300000
250000
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150000
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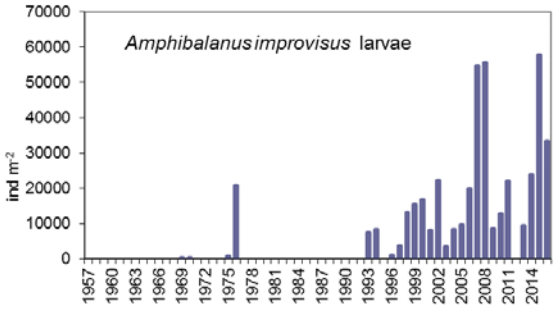
Amphibalanus improvisus larvae
ind m-2
70000
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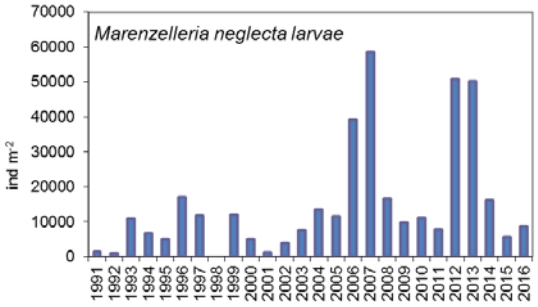
Marenzelleria neglecta larvae
ind m-2
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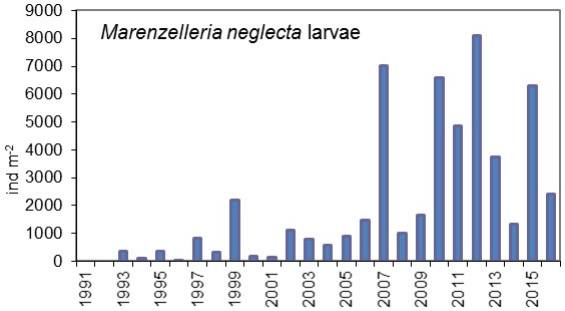
Marenzelleria neglecta larvae
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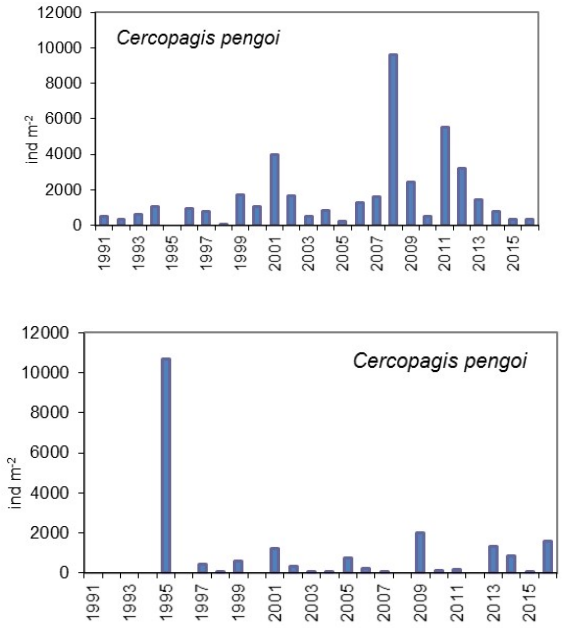
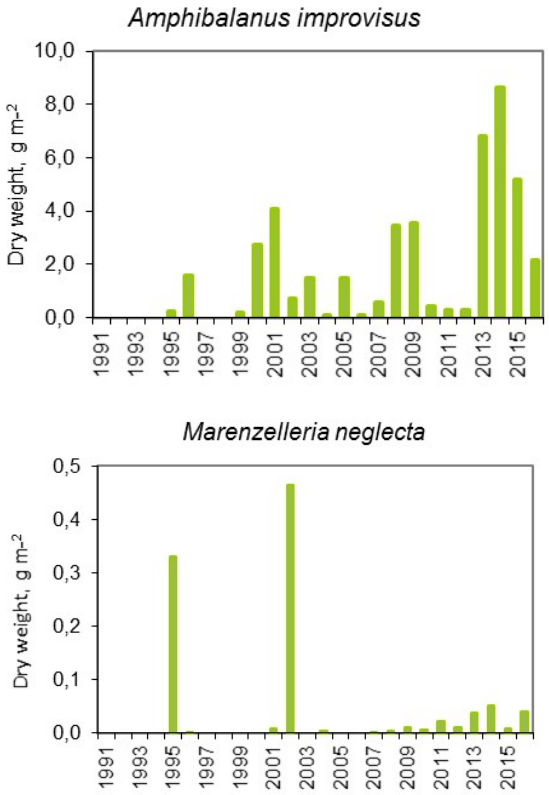


Figure 1. Long-term abundance dynamics of *Amphibalanus improvisus* larvae, *Marenzelleria neglecta* larvae and *Cercopagis pengoi* in the NE Gulf of Riga (left) and Tallinn and Muuga Bays, Gulf of Finland (right). Anon 2017.


Amphibalanus improvisus
Dry weight, g m-2
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8,0
6,0
4,0
2,0
0,0
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
Marenzelleria neglecta
Dry weight, g m-2
0,5
0,4
0,3
0,2
0,1
0,0
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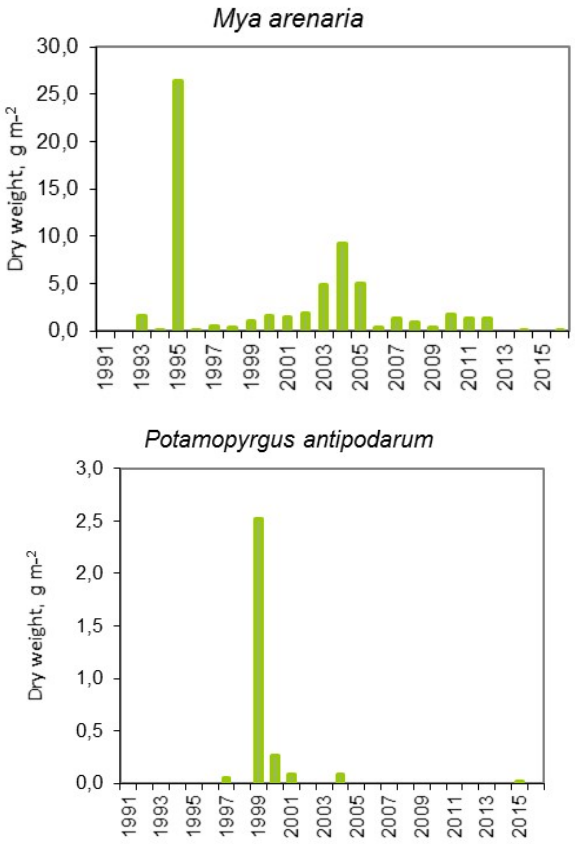
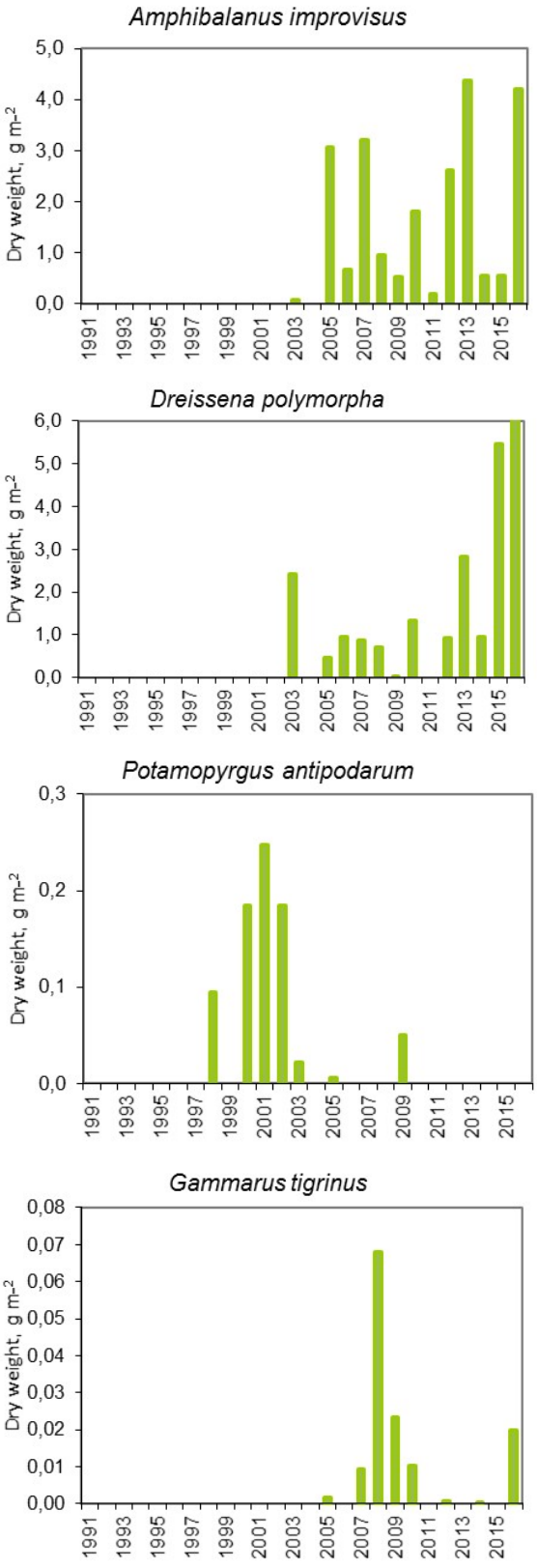


Figure 2. Long-term biomass dynamics of selected benthic non-indigenous and cryptogenic species in Tallinn and Muuga Bays (Gulf of Finland, Baltic Sea). Anon 2017.


Amphibalanus improvisus
Dry weight, g m-2
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4,0
3,0
2,0
1,0
0,0
1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015
Dreissena polymorpha
Dry weight, g m-2
6,0
5,0
4,0
3,0
2,0
1,0
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1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015
Potamopyrgus antipodarum
Dry weight, g m-2
0,3
0,2
0,1
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1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015
Gammarus tigrinus
Dry weight, g m-2
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1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015

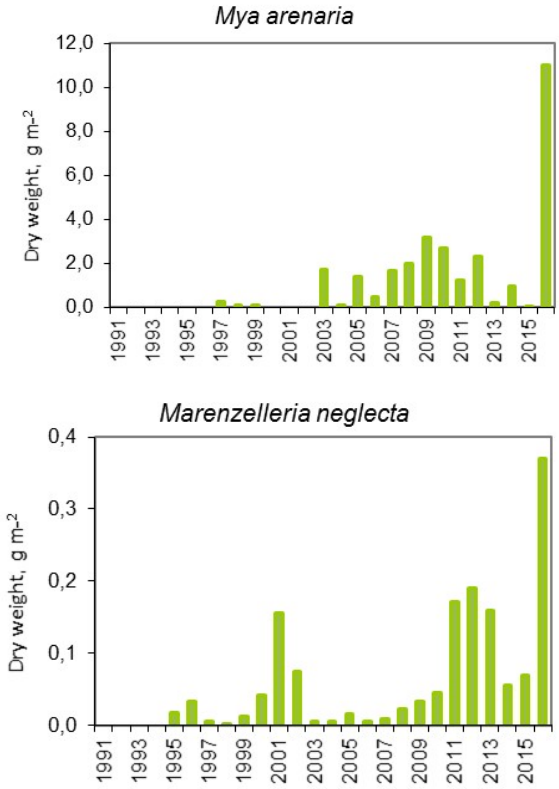

Figure 3. Long-term biomass dynamics of the selected benthic non-indigenous and cryptogenic species in the Gulf of Riga (Baltic Sea). Anon 2017.

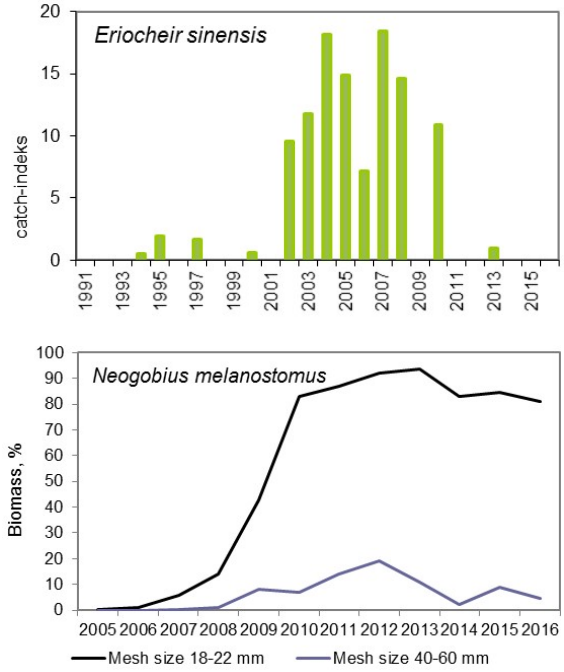

Figure 4. Catch index of the Chinese mitten crab *Eriocheir sinensis* (left panel) and percent contribution of the round goby *Neogobius melanostomus* (right panel) in experimental gillnet catches in Muuga Bay (Gulf of Finland, Baltic Sea). Anon 2017.

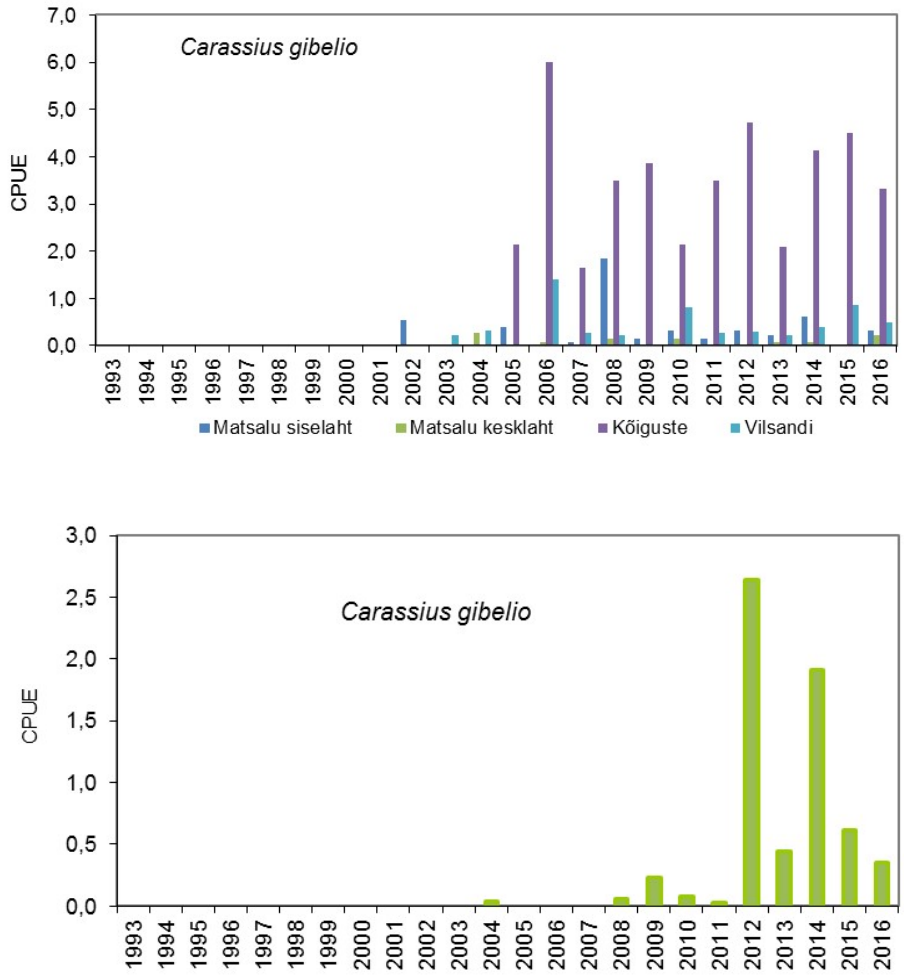

Figure 5. Catch per unit effort (CPUE) of gibel carp *Carassius gibelio* in various locations in Estonian coatsal sea: upper panel: Matsalu Bay (West-Estonian Archipelago Sea), Kõiguste (southern coast of Saaremaa in the Gulf of Riga), Vilsandi (west coast of Saaremaa Island) and lower panel: Käsmu (southern coast of the middle Gulf of Finland). Anon 2017.

Finland

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Lauri Urho, Natural Resources Institute

Overview:

A *Laonome* species (Sabellidae) found in 2014 is yet unidentified but it has been observed in several samples along the whole coastline of the Gulf of Finland. Finland ratified the IMO BWMC 8 September 2016 and with this ratification the Convention will enter into force 8 September 2017. Three pan-Baltic activities were completed on NIS in the Baltic

Sea. A synthesis paper on introductions based on the information stored in AquaNIS, proposal on non-native species monitoring framework to HELCOM (jointly with Lithuania and Estonia) and NIS indicator data set completion for the second HELCOM assessment (jointly with HELCOM secretariat, Lithuania, and co-leads Germany and Sweden).

1. Regulations

Finland has been in the ratification process already years and finally ratified the International Maritime Organization's International Convention for the Control and Management of Ships' Ballast Water and Sediments (the BWM Convention) 8 September 2016. With this ratification the Convention will enter into force 8 September 2017.

2. Intentional

Synthesis of introductions

Deliberate releases into the Baltic Sea were (including rivers draining into the Baltic) for fisheries and fish stock enhancement purposes in 2016 as follows: 0.001 million newly hatched and 1.3 million older salmon (*Salmo salar*), and 0.4 million newly hatched and 0.8 million older sea trout (*Salmo trutta* m. *trutta*), ca 35.6 million newly hatched and 7.1 million older whitefish (*Coregonus lavaretus*).

3. Unintentional:

No new species were observed in 2016.

Previous Sightings

Not yet identified *Laonome* species (Sabellidae) was observed in southwest coastal area in three different locations Inkoo, Turku and Uusikaupunki in 2014–2015. And in 2016 samples it was observed from Naantali (Archipelago Sea) to Loviisa (eastern Gulf of Finland). The species is different from the one observed and identified from the Estonian coastal waters (*Laonome kroyeri*).

More information: VELMU-portal.

Not Seen Species Yet

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

4. Pathogens

No investigations on pathogens during 2016.

5. Meetings

-National meetings (board on invasive species issues, group on development of national NIS legislation, ad hoc group on BWMC implementation)

-HELCOM/OSPAR TG Ballast meeting in Brussels November 2016

France

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Highlights:

A national invasive alien species strategy was finalized and will enter into force in 2017. The revised Marine Strategy Framework Directive commission Decision on Good Environmental Status was adopted by Member States in November 2016. Three quantifiable criteria now specify Descriptor 2 "non-indigenous species". New records for 2016 include the tanaid crustacean *Sinelobus stanfordi* which was sampled in the English Channel in the Raz Blanchard, the amphipod *Melita nitida*, identified on the Atlantic coast in Arcachon Bay and in the Gironde Estuary. 24 scientific articles relevant to the WGITMO terms of reference were written by French authors or co-authors. Non-native species present in biofouling assemblages in marinas are currently being studied in two ongoing programmes, with environmental DNA and metabarcoding approaches continuing to be developed as monitoring tools.

1. Regulations

On the 8th of August 2016, a law (loi n°2016–1087) on the "recovery of biodiversity, nature and landscapes" was adopted, which led to a revision of the French Environmental Code. A decree is currently being finalised to deal both with the entering into force of the EU Regulation 1143/2014 on Invasive Alien Species, and the revised articles of the Environmental Code concerning invasive alien species.

An Invasive Alien Species Strategy for France was developed in the summer/autumn of 2016 and submitted to public consultation until the 10th of January 2017. This French IAS Strategy, which will be approved in 2017, aims to prevent the introduction of new invasive species and the management of those that are already established. Its emphasis is on France's overseas largely insular territories, which host over 80% of national biodiversity.

The Marine Strategy Framework Directive (MSFD-2008/56/EC) requires EU Member States to take measures to reduce the impact of activities on the marine environment in order to achieve or maintain a Good Environmental Status (GES) by 2020. Eleven qualitative descriptors were defined to assess GES, including "Non-Indigenous species (D2)".

The determination of GES was the subject of a Commission Decision in 2010 (Decision 2010/477/EU). The Decision was revised after the first six year assessment period in order to take into account new scientific knowledge, evolution of anthropogenic activities and associated measures, and also to integrate the results of monitoring programs. During 2016, the French MSFD scientific pilots studied the different versions of the proposed

new GES decision including a revised version of Annex III of the Directive and proposed some improvements to the European Commission. The final versions of these texts were adopted by the Member States at the Regulatory Committee meeting on 10 November 2016. The decision will be officially published in spring 2017.

This new decision builds on existing obligations and developments within the EU legislation. Member states are invited to cooperate with EU neighbouring countries to identify lists of species and habitats to be assessed, as well as to establish threshold values for GES. The decision is based on 11 descriptors as previously, but declined in 42 criteria, compared to 29 criteria in the 2010 version. Of these 42 criteria, 24 are identified as primary. Whilst primary criteria are minimum requirements to ensure consistency across the Union, secondary criteria have a degree of flexibility which shall be used to complement a primary criterion or when the marine environmental status is at risk of not achieving or not maintaining GES for a particular criterion.

Three criteria have been defined for the D2 Non-Indigenous Species (NIS):

- D2C1 (primary): Newly introduced NIS
- D2C2 (secondary): Quantification of established NIS (abundance and spatial distribution)
- D2C3 (secondary): Adverse effect of NIS on species groups and broad habitat types

D2C1 is used to monitor introductions of non-indigenous species. D2C2 (quantification of abundance and spatial distribution of non-indigenous species) should contribute to the assessment of D2C3. D2C3 (impacts of non-indigenous species) should provide the extent of impact for each relevant species group and broad habitat type, contributing to their assessments under Descriptors 1 and 6.

In 2017, France will revise the initial assessment of GES for its waters, based on the new definition of the GES. The results of this new assessment will be published in 2018 and reported to the European Commission in 2019.

2. Intentional

Algae

Undaria pinnatifida: status and trends at the European level (data and modelling)

An expert assessment regarding status and trends of kelp forest in Europe included the Asian kelp *Undaria pinnatifida*, introduced in Europe, was carried out (Araujo *et al.* 2016). Distribution maps were built based on data gathered along the French and Brittany coasts notably gathered in the course of programs supported by the Brittany Region, the European projects INVASIVES and Interreg IVA Marinexus as well as from observational data from the Station Biologique of Roscoff and the Museum National d'Histoire Naturelle (Concarneau). Based on these data, a qualitative "expanding" trend was reported for *U. pinnatifida* in Northern Europe, notably in artificial habitats. However, this expansion could not be ascertained with accuracy in the absence of quantitative data. The mapping exercise revealed a lack of temporal data with high spatial coverage for most of the regions in Europe for every kelp species, including *U. pinnatifida*. New data based on long term monitoring programs designed to allow quantitative comparisons are required to confirm these trends.

Such temporal data would be valuable regarding the prediction of a modelling approach carried out to examine the role of temperature limitations in determining the present-day and putative future range of *Undaria pinnatifida* at the European level (Murphy *et al.* in press). The model was validated against field data from a real-life population in Brittany (Murphy *et al.* 2016), and predicted theoretical temperature limits for growth (9.1 - 22.5°C) values which match closely the actual current global range limits for the species (9.5 - 22.4°C) reported in the literature. In addition, the model showed a wider ecological niche in conditions of high seasonality.

3. Unintentional

3.1 New Sightings

Crustacea

Sinelobus stanfordi (Richardson, 1901) is a new crustacean tanaid invader in Europe (Van Haaren and Soors, 2009). It is described as living in tubes attached to hard (usually artificial) substrates which occur in the brackish water of estuaries and harbours. It was first discovered in the Scheldt near the Antwerp harbour, shortly after its European introduction into the Dutch Rhine Delta (Van Haaren and Soors, 2009). This is the first localisation of the species (only one specimen) in the "Raz Blanchard" area of the English Channel from an offshore sampling station (PT1, 35 m depth) on pebbles.

The non-native amphipod *Melita nitida* Smith, 1873 was collected between 2013 and 2016 in Arcachon Bay, Hossegor Lake and the Gironde Estuary (SW France) in intertidal oyster reefs and under stones (Gouillieux *et al.*, 2016). This species, native to the Atlantic coast of North America, is considered as a non-indigenous species on the Pacific coast of North America. Recently, the presence of *M. nitida* was reported in Europe, both in The Netherlands and in Germany. The most likely vectors of introduction to Arcachon bay are fouling on recreational boats and oyster transfers.

3.2 Previous Sightings

Algae

Polysiphonia morrowii – Introduction and status

Alexandre Geoffroy and his co-authors (Geoffroy *et al.* 2016) recently re-evaluated the introduction history and status of the red algae *P. morrowii*. They analyzed the genetic diversity at chloroplastic and mitochondrial marker genes of >400 samples collected in the North Pacific, the South Atlantic, and the North Atlantic (including France). From this study, the authors proposed that both recent introduction events and ancient introductions are responsible for the current distribution and diversity observed in the North Atlantic. They conclude that *P. morrowii* should be better defined in the study areas as a cryptogenic species *sensu* Carlton 1996.

Porifera

The distribution and abundance of the marine invasive sponge *Celtodoryx ciocalyptoides* is described for the first time along the Etel River, a Natura 2000 site of the French Atlantic coast (Gentric & Sauleau 2016). This invasive species, which was originally considered as cryptogenic, is now well established along both sides of the Etel River and has colonized about 29.3% of the surface of the rocky reef at a depth of 10–18 m. In the Etel marina, *C.*

ciocalyptoides covers all the pilings with a covering rate estimated at 17.4% between 5 and 9 m deep.

Tunicata

Ciona robusta: settlement dynamics and competitive process with its native congener *C. intestinalis* in Brittany

*Ciona robusta (*previously known as *C. intestinalis* type A) is a tunicate, native to the Pacific, which has been recently introduced in the native European range of a congener, *Ciona intestinalis* (previously known as *C. intestinalis* type B; ref. in Bouchemousse *et al.* 2016). Using *in situ* settlement panels, the settlement dynamics of the invasive *Ciona robusta* were monitored and compared to its native congener *C. intestinalis* in marinas where the two species co-exist. Two similar settlement periods were identified for each species (end of spring–early summer and late summer–early fall). Competitive exclusion at early stages between the introduced *C. robusta* and its native congener is thus unlikely to play a major role in determining their patterns of coexistence. The settlement rate of juveniles was however variable between seasons for the non-indigenous species *C. robusta*, with increased density in autumn compared with spring. This increase is most likely due to warmer conditions that are more favorable to *C. robusta* recruitment. Environmental changes (particularly temperature increase) may thus eventually modify the strength of competitive interactions between the two species as well as species dominance.

Non-indigenous ascidians of the fouling community (floating pontoons) During her PhD at the Station Biologique of Roscoff, Sarah Bouchemousse examined fouling communities under floating pontoons in marinas in Brittany, with a special focus on non-native and native tunicates. One of the studies involved scraping of the surface under the pontoons using quadrants (to get quantitative data) by scuba divers during two seasons (spring and autumn). The analysis showed that the proportion of specimens of non-indigenous ascidians varies between ca. 20% and 60% according to marina and season (Bouchemousse 2015; Bouchemousse *et al.* in prep.). This study adds to the growing number of studies providing clear evidences of the commonness of non-indigenous ascidians in the biofouling communities found in marinas.

Fish

Several new sightings of the Lessepsian migrant *Fistularia commersonii* were observed along the coast of Monaco and the French riviera in 2016 (P. Francour, pers. comm.). The Atlantic fish *Pomadasys incisus* is now regularly observed in the Gulf of Lions (Pastor, Roulleau and Louisy., 2016). A paper recently submitted to *Mediterranean Marine Science* discusses the origin of the blunthead puffer *Spheroides pachygaster* (Kara *et al.*, submitted). Despite multiple records in the eastern Mediterranean, there is now a general consensus that this is a Herculean species.

3.3 *General Information*

Programmes :

The ANR project HySea (ANR-12-BSV7–0011; resp. F. Viard) started in November 2012 was ended in November 2016. This project used field studies, lab experiments and genomic tools to examine hybridization processes notably due to biological introductions. Results from this project largely contributed to provide evidences that supported the taxonomic revision of the *Ciona* genus (see report 2016). Besides *Ciona robusta (*previ-

ously known as *C. intestinalis* type A, introduced in the N. Atlantic) and *C. intestinalis* (previously known as *C. intestinalis* type B and native to the N. Atlantic), this project also examined *Crassostrea gigas* and *C. angulata*, in Europe. More information (in French only) can be found on the project website http://www.hysea-anr.fr/.

The project AQUANIS 2.0 (2016–2021; coord. F. Viard), supported by the Fondation TOTAL, aims to develop new tools based on environmental DNA and metabarcoding approaches, two promising tools for non-indigenous species detection and monitoring in marine coastal habitats (see review in Viard *et al.* 2016). This project is focusing on non-indigenous species and their native relatives present in the biofouling communities in artificial habitats (e.g. marinas). Besides tools, this project will continue to support surveys of NIS in marinas from Brittany (surveys started in 2010 as part of the Marinexus Program).

The project 'Marine communities structuring: harbor ecology and invasion biology as comprehension tools" (coord. Christophe Lejeusne), supported by the Brittany Region and the Conseil Departemental Finistere, is focusing on biofouling assemblages in marinas. It specifically aims at examining the response of native vs. non-native species to environmental factors such as temperature and pollutants. Using environmental survey and experimental approaches, it aims to understand how abiotic factors are drivers of harbor community assemblages and potentially favor non-native species.

The project REGENI (REalisation d'un Guide des Espèces Non Indigènes en Normandie; coord. UMR M2C Caen University) supported by the Agence de l'Eau Seine-Normandie, aims to publish a guide to marine non-native species in the Normandy region. Maps of past and present distribution will be elaborated, and for those non-native species which are invasive there will be a focus on monitoring and management measures, thus contributing to biosurveillance objectives of the Marine Strategy Framework Directive.

In the Mediterranean, the citizen science project Fish Watch Forum (FWF: http://www.fish-watch.org/; coord. Peau Bleue NGO and ECOMERS University of Nice Sophia-Antipolis) was launched in 2016, inviting SCUBA divers to report fish observations, including non-native species. Observations are cross-checked by a network of researchers affiliated to FWF. End of 2016, a complimentary program, ECOCIMED (https://www.facebook.com/Ecocimed-215292395603569) was launched, with the participation of the AMPN (Association Monégasque pour la Protection de la Nature). The aim of ECOCIMED is to mine data on Mediterranean fish populations from social media, which will then be graphically summarised on a website.

In Corsica, the "Réseau Alien Corse" (coord. Université de Corse, Office de l'Environnement de la Corse (OEC) and the Comité Régional Corse de la Fédération françaises d'études et de sports sous-marins (FFESSM)) launched in summer 2016 another citizen science initiative where SCUBA divers are asked to report sightings of 36 marine invasive species (http://doris.ffessm.fr/Forum/Reseau-Alien-Corse-17965). Data from this network is shared with the IUCN MedMIS information system.

The monitoring network of non-native species in the Saint-Pierre and Miquelon archipelago is ongoing in collaboration with the DFO Canada. It is now managed by the "DTAM Service Agriculture, Alimentation, Eau et Biodiversité ».

4. Pathogens

A paper by Gervais *et al.* (2016) on *Bonamia ostreae* shows that *Ostrea edulis* specifically responds to this pathogen by inducing apoptosis of hemocytes.

5. Meetings

Past year (2016)

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

- AIS (Aquatic Invasive Species) Monitoring Atlantic Zone meeting. (Northwest Atlantic Fisheries Centre, St Johns, Newfoundland, 10–11 February, 2016)
- OSPAR Biodiversity Committee (BDC) (Gothenburg, Sweden, 29th February – 4th March)
- 19th International Conference on Aquatic Invasive Species (ICAIS), Winnipeg, Canada, 10–14 April 2016
- Marine and Freshwater Invasive Species, Buenos Aires, Argentina, 2–4 May 2016
- OSPAR ICG-COBAM (3) (Hamburg, Germany,31st May-2nd June 2016)
- Island Biology 2016 (Terceira Island, Azores, 18–22 July 2016)
- NEOBIOTA 2016 – 9th International Conference on Biological Invasions (Vianden, Luxembourg, 14–16 September 2016)

Meetings in 2017

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

- OSPAR ICG-COBAM (Madrid, Spain, 29th November – 1st December 2016)
- AIS (Aquatic Invasive Species) Monitoring Atlantic Zone meeting. (Ottawa, 22–23 February, 2017)
- OSPAR Biodiversity Committee (BDC) (Berlin, Germany, 6–10th March 2017)

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Germany

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Overview:

New species records for Germany in 2016 added to AquaNIS in February 2017 include:

- Sea squirt *Didemnum vexillum*, Sylt Island (Lackschewitz *et al.* 2017)
- Brown algae *Undaria pinnatifida*, Sylt Island (Lackschewitz *et al.* 2017)
- Polychaet *Boccardia proboscidea*, Helgoland Island (Lackschewitz *et al.* 2017)
- Sea squirt *Corella eumyota*, in Jade-Weser-Port, first record for German Bight (Nestler 2017)
- Amphipod *Monocorophium uenoi*, first record for German Bight in Port of Bensersiel (Nestler 2017).

Intentional species introductions remain at a similar level as last year.

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

The BWMC has already been transposed into national law in 2014 (Abschnitt 4, See Umweltverhaltensverordnung – SeeUmwVerhV)[1]

No new German legislation has been implemented in 2015/2016. An implementation of the EU Regulation 1143/2014 on Invasive Alien Species in national law is currently in development.

As reported in previous years, 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 Monitoring Programme" the national body that takes care of the duties arising from national and international obligations. This work includes the development of a monitoring programme for NIS and the implementation of a national focal point neobiota (https://www.awi.de/forschung/besondere-gruppen/nordseebuero/neobiota-meldestelle.html). The trend indicators (rate of new invasions) and an impact indicator (invasiveness) for Descriptor D2 of the Good Environmental Status (MSFD: 2008/56/EC) are discussed and German members of HELCOM, OSPAR, and CWSS WGs on NIS issues supported.

Based on the above mentioned activities, a regular targeted non-indigenous species monitoring programme (extended rapid assessment (e-RAS) of hot spots based on a NIS-baseline study of intensive surveys) was established along both, the German North and Baltic Sea coasts. Data are used for the consistent calculation of the trend indicator.

In a recent documentation (HELCOM 2015) it was shown that the trend in new NIS introductions increased since the beginning of the 1900s, which indicates a sub-GES status in the entire Baltic Sea in the period up to 2012. However, there has been a slight decrease in the number of new NIS introduced species in recent years, but an overall assessment is still missing. The boundary between GES and sub-GES is "no new introductions of NIS per assessment unit through human activities during a six year assessment period". The German NEOBIOTA group considers to use less than one new human-mediated NIS during six years to indicate GES. Considering that at least 5 new species were found in 2016 (see above) a GES cannot be expected for German coastal waters. However, for the first agreed six year period (2011–2016) GES was documented for parts of the German Baltic coast (Mecklenburg Bay and Arkona Basin) with no new NIS recorded.

A comprehensive summary of German coastal monitoring activities is available online at:

http://www.meeresschutz.info

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

EU Regulation 1143/2014 on Invasive Alien Species

This regulation comprises the compilation of lists of "critical species" as species of Union-wide concern, species of regional concern, and species of national concern. The Union list has recently been adopted[2]. Only one out of 37 species listed is a marine (catadromous) species, i.e. the Chinese mitten crab. All other species are freshwater or terrestrial. A re-

[1] https://www.gesetze-im-internet.de/seeumwverhv/BJNR137110014.html
[2] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1468477158043&uri=CELEX:32016R1141

cent German study developed species selection criteria (Nehring *et al.* 2015[3]). We see a possible research gap to in detail identify species selection criteria for these lists. Further, it may be considered to add marine species to the list of species of Union concern as not all such species are covered by the IMO Ballast Water Management Convention, IMO biofouling guidelines and the EU Aquaculture Directive. One species example to be considered is the highly invasive lion fish (Pterois sp.). Records are known from the Mediterranean Sea and also one unconfirmed record from the Azores. At this relatively early stage of colonization an eradication effort might be successful.

Based on the IAS Regulation each Member State needs to report the presence and distribution of the species on this list also providing options for management and/or eradication. However, some species on the lists are so widely distributed that eradication efforts are meaningless. After consultation with WTO, the commercial trade with living organisms of these species will be prohibited. However, some issues remain, including the question on what will happen when organisms of these species are imported from non-EU Member States. Nehring (2016) published a report documenting the current distribution in Germany of the 37 species of EU-wide concern.

Ballast Water Management Convention (IMO-BWMC)

The entry-into-force requirements for this Convention were met, so that ballast water management requirements will be in force from 8th of September 2017 onwards. Within the coming 5 years, more and more ships will have to comply with the D-2 standard of the BWMC (new ships from the moment of entry into force onwards, ships already built need to comply from their next IOPP survey onwards, which is in maximum 5 years after entry into force of the convention). Within a trial period which will also comprise a so-called "experience building phase", non-compliance with the D-2 will not be pursued.

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.

One individual of *Homarus americanus* was found in the Lübeck Bight by a commercial fishermen in Summer 2014. This individual was probably intentionally released (Rabitsch *et al.* 2017).

3. Unintentional

New Sightings

New species records for Germany in 2016 which were added to AquaNIS in February 2017 include:

- Sea squirt *Didemnum vexillum*, Sylt Island (Lackschewitz *et al.* 2017). In Europe it is known from Le Havre, France (first record 2001), Ireland (2005), the Celtic Sea

[3] Nehring, S., Essl, F. & Rabitsch, W. (2015): Methodik der naturschutzfachlichen Invasivitätsbewertung für gebietsfremde Arten, Version 1.3. – BfN-Skripten 401, pp. 48.

and English Channel, UK (2005) and The Netherlands (2009). It seems that this species spreads north and eastwards in Europe (AquaNIS),

- Brown algae *Undaria pinnatifida*, Sylt Island (Lackschewitz *et al.* 2017). The alga seems to follow a similar route of spread as *D. vexillum*. The first northern European record was in 1983 in France and in 1999 it was found in The Netherlands (AquaNIS),
- The polychaet *Boccardia proboscidea* was found on Helgoland Island (Kind & Kuhlenkamp, pers. comm., Lackschewitz *et al.* 2017) and also seems to spread north and eastwards in Europe (findings: southern Bay of Biscay, Spain in 2002 and Belgium in 2012),
- Sea squirt *Corella eumyota*, found in Jade-Weser-Port, first record for German Bight (Nestler 2017). In 2002 in the Bay of Biscay, France thereafter in many north-western European countries, these new German records are the eastern-most findings in Europe (AquaNIS), and
- Amphipod *Monocorophium uenoi*, first record for the German Bight in Port of Bensersiel (Nestler 2017). It was in 2013 found in the Netherlands, but nowhere else in north-western Europe (AquaNIS).

As all new findings seem to spread north and eastwards they may (soon) be found in Denmark, Norway or Sweden.

The most up-to-date lists of alien species in German coastal and marine waters may be found at:

- At the German Neobiota Platform on marine non-indigenous species www.awi.de/forschung/besondere-gruppen/nordseebuero/neobiota-meldestelle.html.
- www.aquatic-aliens.de/species-directory.htm (site managed by Stefan Nehring)
- in AquaNIS: http://www.corpi.ku.lt/databases/index.php/aquanis/ and

Previous Sightings

The non-indigenous diatom *Mediopyxis helysia* was first already recorded in spring 2009 in the backbarrier tidal flats of Spiekeroog, Island (North Sea). This finding only became known by a recent publication (Meier *et al.* 2015).

The bivalve *Mytilopsis leucophaeata* was for the first time recorded in German Baltic coastal waters (Odra Bank) in 2013 (Wasmund *et al.* 2014), but was not found again in 2014 (Wasmund *et al.* 2015).

It is interesting to note that two species were found on the drifting algae *Himanthalia* sp. near Helgoland. The red alga *Antithamnionella ternifolia,* first recorded in the North Sea in 2007, was observed on floating *Himanthalia* sp. on boulders (protective barrier) in front of the Helgoland Island harbour pier in August 2014. In August 2012 the bryozoan *Watersipora subtorquata* was also found on this algae (Kuhlenkamp & Kind pers. comm., PHYCOMARIN, Hamburg, Germany). *Antithamnionella ternifolia*, was in 2014 also found in the Flensburg Fjord (Baltic Sea) (P. Schubert, pers. comm., Lackschewitz *et al.* 2017).

Another bryozoan, *Schizobrachiella verrilli*, was found at four sites in the coastal waters of Belgium, the Netherlands and Germany. It is an encrusting cheilostomatous bryozoan

unknown from Europe and was identified by microscopical and scanning electron microscope studies as *Schizobrachiella verrilli* (Cheilostomata, Schizoporellidae). Until now, it was only known from North America (Atlantic coast). A re-examination of historic samples confirmed the existence of *S. verrilli* in the North Sea since 1905. The first confirmed records in Germany are from 2011–2012. The few recent findings suggest that *S. verrilli* is a rare species living at sublittoral shell banks of the North Sea (Kind *et al.* 2015, Kuhlenkamp & Kind pers. comm., PHYCOMARIN, Hamburg, Germany).

During a rapid assessment project of non-indigenous species in 2014 the research team of the Institute for Baltic Sea Research, Warnemünde (IOW) found the amphipod *Echinogammarus trichiatus* in the Stettin Lagoon (Germany, Mecklenburg-Western Pomerania) (Zettler 2015). The species was first recorded in Germany in the Danube River the 1990s and was spreading since. In September 2014 *E. trichiatus* was fort the first time recorded in the Stettin Lagoon near Kamminke and Zecherin (Germany, Mecklenburg-Western Pomerania). This finding represents the first record from German coastal waters adjacent to the Baltic Sea. Zettler (2015) lists other non-indigenous and longer established malacostracan species in the lagoon (the mysids *Limnomysis benedeni* and *Hemimysis anomala*, the amphipods *Chelicorophium curvispinum*, *Cryptorchestia cavimana*, *Dikerogammarus haemobaphes*, *D. villosus*, *Gammarus tigrinus*, *Obesogammarus crassus*, *Pontogammarus robustoides*, the isopod *Proasellus coxalis* and the decapods *Eriocheir sinensis* and *Orconectes limosus*). The Stettin Lagoon record is the only record of *E. trichiatus* from the German coastal waters.

In 2015 during a Rapid Assessment monitoring effort the red algae *Heterosiphonia japonica* was found at the German North Sea coast (Dagmar Lackschewitz & Ralph Kuhlenkamp, AWI, pers. comm.).

Hemigrapsus takanoi, a widespread non-indigenous decapod of the European Atlantic and North Sea coasts (northern Spain to southern Denmark), was in July 2014 recorded in the Baltic Sea for the first time (inner Kiel Fjord, Schleswig-Holstein); (Geburzi *et al.* 2015).

The isopod *Synidotea laticauda* was found in the Port of Brunsbüttel (Schleswig-Holstein, North Sea) in the "Ölhafen" and "Ostermoor". In Ostermoor a single specimen was already found in 2014, but at this time it was wrongly identified as *S. laevidorsalis*. In 2015 *S. laticuada* was found in both port areas in higher abundances on settling plates (Gesche Bock, Geomar, pers. comm.). This may not be the first records of this species in Germany as it was probably found earlier along the Lower Saxony coast.

The tube and reef building polychate *Ficopomatus enigmaticus* was in 2014 found in the Port of Schlutup (Schleswig-Holstein, Baltic Sea between Lübeck and Travemünde) (Gesche Bock, Geomar, pers. comm.). This represents the first record from the German Baltic coastal waters.

In 2014 a single specimen of the cladoceran *Evadne anonyx* was found in the Kiel Bight. This is the first finding from German Baltic waters (Jörg Dutz, Leibniz Institute for Baltic Sea Research Warnemünde, pers. comm., Wasmund *et al.* 2015).

The bivalve *Dreissena rostriformis bugensis* was found in the Stettin Lagoon in 2015, which is possibly the first sighting of this species in German Baltic coastal waters (Michael Zettler, Leibniz Institute for Baltic Sea Research Warnemünde, pers. comm., see also next issue of the Lauterbornia journal).

The red alga *Ceramium circinatum* was already found 2015 on an oyster reef near Juist Island and was located again in 2016 (Nesteler 2017).

The hydrozoan *Garveia franciscana* is known from Germany since the 1950s with established populations in the Kiel Canal. Several decades later it was also found in estuaries along the North Sea coasts. In 2014/2015 it was also found in Kiel and Travemünde (C. Lieberum pers.Mitt., Lackschewitz D *et al.* 2017) as first German Baltic record.

Diadumene lineata is another interesting case. This sea anemone was first recorded in German coastal waters (North Sea) in 1920. Later it became extinct, but it was found frequently on vessel hulls in North Sea ports. In 2011 it was first recorded in the German Baltic coast and it re-appeared in the North Sea with records in 2014 in the Port of Büsum, a smaller more regional and recreational port (Lackschewitz *et al.* 2017). It is unlikely that this species was overlooked as it looks very characteristic with its orange stripes.

The decapod *Palaemon macrodactylus* was first recorded in the Kiel Canal in 2009 near Kiel. It seems to spread westwards in the canal as it was in 2015 found in the Port of Rendsburg (Lackschewitz D *et al.* 2017).

The bryozoan *Arachnidium lacourti* was first recorded in 2014 in the Jade-Weser-Port. In 2015 it was found further north in Husum (Lackschewitz D *et al.* 2017).

The red alga *Ceramium circinatum* was already found 2015 on an oyster reef near Juist Island and was located again in 2016 (Nestler 2017).

The bivalve *Rangia cuneata*, in Poland recorded in 2011, occurs in scattered populations between Belgium (<2000) and Estonia (2015), was also found in the Kiel Canal near the North Sea locks in 2013. In 2015 it was the first time recorded in a lagoon of the Trave river, German Baltic Sea (Wiese *et al.* 2016).

Not Yet Seen Species

We searched AquaNIS for introduction events since 2005 in our neighboring countries The Netherlands, Denmark and Poland and present the data here separately for the Baltic and North Seas coasts of Germany.

Baltic Sea

Six introduction events are included in AquaNIS along the Danish Baltic coast since 2005 of which one is unknown in Germany.

- The ctenophore *Beroe ovata* was found in the Danish Belt Sea in 2011, but this species was not documented anywhere else in northern Europe. It has a high potential to spread.

In total 13 introduction events are included in AquaNIS for Poland since 2005. The species not known from German coastal waters are:

- The oligochaete *Limnodrilus cervix*, found in 2010, not documented anywhere else in northern Europe,

- The oligochaete *Potamothrix vejdovskyi*, known from Poland (2008), the Russian Federation (St. Petersburg area in 1960s and Kaliningrad in 1997) and Sweden (end of 1960s), it was also found in the German North Sea estuaries, but not along the German Baltic coast (Rabitsch *et al.* 2017),
- The oligochaete *Tubificoides heterochaetus*, in northern Europe only known from Belgium (1953) and Poland (2013)[4].

North Sea

For Denmark we found that all five new recorded species since 2005 were also recognized in German North Sea waters.

When comparing the 17 recent new NIS/CS records of The Netherlands we note that the following were not (yet) found in Germany:

- The sea spider *Ammothea hilgendorfi*, recorded in The Netherlands 2013 and formerly in 1978 in the UK / English Channel,
- The polychaete *Bispira polyomma* was recorded in The Netherlands in 2010, but nowhere else in north-western Europe,
- The red alga *Gelidium vagum* was recorded in The Netherlands in 2010, but nowhere else in north-western Europe,
- The ostracod *Eusarsiella zostericola*, recorded in The Netherlands 2012 and formerly after 1870 (!) in UK / English Channel and North Sea coasts,
- The polychaete *Marphysa sanguinea*, found in The Netherlands in 2008, but nowhere else in northern Europe,
- The Asian oyster drill (gastropod) *Pteropurpura (Ocinebrellus) inornata.* Occurs in France (1995), Portugal (1999) and The Netherlands (2007), but unknown from Germany,
- The predatory gastropod *Rapana venosa.* Found in scattered populations in Spain (2007), France, Celtic Seas (1998), Belgium (2006) and The Netherlands (2005), also along the North Sea coast of UK (2005). No record from Germany known,
- The Manila clam *Ruditapes philippinarum*, since the 1970s in France (Bay of Biscay), nowadays widely spread in Europe with populations occurring between Portugal (1984) and Norway (1987), but not in Germany nor in Denmark,
- The Korean rockfish *Sebastes schlegelii*, in north-western Europe only know from Belgium and The Netherlands (both in 2008),
- The Atlantic oyster drill (gastropod) *Urosalpinx cinerea*, found in France (Celtic Seas and Bay of Biscay in the 1960s), UK (North Sea coast in 1928) and The Netherlands (2007),
- The freshwater snail *Viviparus acerosus*, found in northern Europe only in The Netherlands (2007).

Aquatic gardening species

The German Federal Agency for Nature protection (BfN) is very active to warn the public about introduced species and issues flyers how to identify them and what to do when they are found, e.g., in your garden pond.

[4] Lackschewitz *et al.* 2017 categorise it as cryptogenic species, and assume this is an endemic brackish water species for Germany.

4. Pathogens

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

5. Meetings

The "Platform for Information Exchange on Neobiota (NEOBIOTA)" has two to three meetings annually and works towards a harmonized alien species monitoring programme to assess the EU MSFD Good Environmental Status (GES) concerning descriptor 2 on non-indigenous species.

The Wadden Sea Alien Species Working Group (WG-AS) met twice in 2015 and once in 2016. In addition, a workshop has been initiated in 2016 in order to develop a recommendation for a trilateral monitoring programme for alien species in the Wadden Sea. A list of Wadden Sea marine alien species has been compiled. As a living document, this list will be subject to continuous updating and is therefore one important element of the trilateral alien species management and action plan. The website of Common Wadden Sea Secretariat (CWSS), Wilhelmshaven, Germany, was suggested as focal point to host the list which should also be linked with the NOBANIS website and/or AquaNIS. The draft recommendation for the trilateral monitoring programme on marine and terrestrial alien species was presented at the meeting.

In addition, Germany is actively contributing to non-indigenous species-related meetings at IMO, HELCOM, and OSPAR and regional and international meetings related to the implementation of the EU-MSFD.

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Israel

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Note: This report does not reflect an official position or knowledge of the relevant Israeli Government bodies

17 February 2017

***Pterois miles* in Israel's largest national park/marine nature reserve (Akhziv – Rosh HaNikra). Photograph O. Klein.**

Overview

The southern Levantine coast, located down-current of the Suez Canal opening into the Mediterranean, is under intense propagule pressure and consequently, hosts the highest number of established Erythraean alien species (Galil *et al.* 2017). Of the 11 species recorded between the ICES Working Group on Introduction and Transfers of Marine Organ-

isms (WGITMO) in March 2015 and the present meeting, three are considered to have been introduced through the Suez Canal, six with fouled vessels, and one each through aquaculture and aquarium release. The majority of the new records are bryozoans, 2 each are crustaceans and fish, and one each mollusc and tunicate. Four are the earliest records for the Mediterranean Sea, highlighting the role of the southern Levant as a "hotspot", a beachhead and dispersal hub for their secondary spread.

Recognizing that high NIS load nullifies **marine conservation strategies in MPAs**, we recommend the following actions

A. New MPAs to be located away from the regional hubs of vectors and pathways of NIS introduction, i.e. the entire Levant littoral as well as ports and marinas;

B. Established MPAs with high NIS load to conduct risk assessment of secondary spread and analyse cost of effective options for long term control of NIS populations. Should NIS populations **be at levels that adversely affect the MPA's** natural biodiversity and natural habitats, or risk secondary spread, mitigation actions or changes to the protection status should be implemented;

C. Stakeholders should be informed of the extent of bioinvasions in MPAs, consulted as to management actions and commitment of resources for their control, and possible changes to protection status.

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

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2. Intentional introductions

-

3. Unintentional introductions

New alien species for the Israeli Mediterranean coast

Crustacea

***Grandidierella bonnieroides* Stephensen, 1948**

227 specimens of the invasive aorid amphipod crustacean *Grandidierella bonnieroides* were collected next to the Na'aman estuary, Haifa Bay (32° 55′ 07′′ N, 35° 04′ 33′′ E), Israel, on August 7, 2014, at a depth of 8 m. A widespread circumtropical species, recorded off the Saudi coast of the Arabian Gulf, the Red Sea and the Suez Canal, it was likely introduced into the Mediterranean through the Suez Canal. *Grandidierella bonnieroides* is known as an opportunistic pollution indicator species, colonizing areas which undergo periodic defaunation, establishing on occasion dense populations. It is therefore not surprising that the species occurs in the eutrophic and heavily polluted Haifa Bay. The collection site is sampled annually, therefore it is assumed that this is a recent introduction. The large number of specimens collected in August 2014, including ovigerous females and numerous juveniles, indicates a locally established population (Lo Brutto *et al.*, 2016).

Penaeus aztecus Ives, 1891

On 30 April 2015, a single male specimen of the penaeid shrimp *Penaeus aztecus*, a West Atlantic species, was collected at depth of 36 m, near Palmahim, (lat. 31°54.973N, long. 34°38.091E), Israel. This alien species has been previously recorded off Turkey, Greece, Montenegro and the Tyrrhenian coast of Italy. The species identity was confirmed based

on morphological characters and by sequencing 406 nucleotides of the 16S RNA gene and 607 nucleotides of the COI. The 16S rRNA sequences of the specimens collected in Israel, France and Italy were identical, and exhibited three different COI haplotypes. The near concurrent records from distant locations in the Mediterranean put paid to the premise that *P. aztecus* was introduced into the Mediterranean Sea in ballast waters. A more prudent proposition is that many of these populations issue from illegal introductions. Potential risks to native biodiversity and economic value are the likely competition with commercially important native prawns, co-introduction of pathogens and parasites, and risk of infecting penaeid populations elsewhere in the Mediterranean Sea with Erythraean alien disease agents previously limited to the Levant (Galil *et al.*, 2016).

Mollusca

***Isognomon legumen* (Gmelin, 1791)**

A single live juvenile specimen of the Indo-Pacific tree oyster, *Isognomon legume,* was collected in the shiqmona marine nature reserve, Haifa Bay, at depth of 3.2 m, on November 12, 2015. It has likely been introduced from the Red Sea through the Suez Canal. First record for the Mediterranean (Mienis *et al.* 2016).

Bryozoa

Drepanophora birbira (Powell, 1967)

Specimens were collected off Rosh-Hanikra (33° 5.256'N, 35° 6.059' E) at depth of 25 m, and Tel Aviv (32° 5.112'N, 34° 45.837'E) (Sokolover *et al.* 2016). The species was originally described from material collected in the southern Red Sea. Recently it was collected from Lebanon, including off Tyre. It may have been introduced with fouled vessels to Lebanon and drifted with fouled debris to Rosh Hanikra, a distance of 22 km, or the records may result from separate introductions as there is no shipping traffic between Israel and Lebanon.

***Electra tenella* (Hincks, 1880)**

Specimens were collected off Achziv (33° 2.927'N, 35°5.960' E), fouling a wreck at depth 20 m (Sokolover *et al.* 2016). Widely spread in tropical and temperate sea, known from the western and central Mediterranean, this is the first report from the Eastern Mediterranean and Levant Basin. Possibly introduced with fouled vessels and debris.

***Microporella harmeri* (Hayward, 1988)**

Specimens were collected off Achziv (33° 2.927'N, 35°5.960' E) and Ashkelon (31° 40.510'N, 34° 32.986'E) (Sokolover *et al.* 2016). The species was originally described from material collected in the western Indian Ocean, and subsequently from the Red Sea. Recently it was collected from Lebanon. It may have been introduced with fouled vessels to Lebanon and drifted with fouled debris to Achziv, just south of the border with Lebanon, or the records may result from separate introductions as there is no shipping traffic between Israel and Lebanon.

***Parasmittina egyptiaca* (Waters, 1909)**

Specimens collected in the Tel-Aviv marina (32° 5.181'N, 34° 46.037'E) intertidal (Sokolover *et al.* 2016). The species was originally described from material collected in the

southern Red Sea and subsequently from the Suez Canal. Recently it was found to be well established along the coast of Lebanon. It seems established in the Levant.

Parasmittina proteca (Thornely, 1905)

Specimens collected in Achziv (33° 2.927′N, 35°5.960′ E) (Sokolover *et al.* 2016). The species was first described from the Indian Ocean, the Red Sea and the entrance to the Suez Canal, before being recently reported from two harbors in Lebanon. It may have been introduced with fouled vessels to Lebanon and drifted with fouled debris to Achziv, just south of the border with Lebanon, or the records may result from separate introductions as there is no shipping traffic between Israel and Lebanon.

Tunicata

***Botrylloides nigrum* Herdman, 1886**

The species was first recorded, but not described or illustrated, by Pérès (1958a, b) from material collected in Caesarea, as *Metrocarpa nigrum* (Herdman, 1886). It was subsequently collected from Acre and Mikhmoret, redescribed and identified as *Botrylloides leachii* (Savigny, 1816). Recent molecular analysis of specimens collected in Haifa reassigned it to *Botrylloides nigrum* Herdman, 1886, a species widespread in tropical and warm water regions across the globe, possibly originating in the Caribbean Sea (Sheets *et al.*, 2016). It has likely been introduced with fouled vessels, as all locales are next to harbors.

Fish

Encrasicholina gloria Hata & Matomura, 2016

A small sized anchovy, *Encrasicholina gloria,* recently described from material collected in Suez Bay, and known only from the Persian Gulf and the Red Sea. The species was collected off Jaffa and between Tel Aviv and Ashdod. It has likely been introduced from the Red Sea through the Suez Canal. First record for the Mediterranean (Hata & Matomura, 2016).

***Paracanthurus hepatus* (Linnaeus, 1766)**

A single specimen of the Indo-Pacific palette surgeonfish, *Paracanthurus hepatus,* was observed on September 2, 2015, off Bat Yam (32°1.23N 34°44.18E), at depth of 2 m. Though widely distributed in the Indo-Pacific, from East Africa to Samoa, it has not been recorded in the Red Sea. Since it is one of the most common marine aquarium fish, it is considered to have been an aquarium release. First record for the Mediterranean (Marcelli *et al.*, 2016).

4. Previous Sightings

Cumacea

Cumacean (Crustacea, Peracarida) assemblages from 443 samples collected between 2005 and 2012, at 148 sites along the Israeli Mediterranean coast were analyzed. In all, the 31,508 cumaceans were identified to 18 species. Three of the species, *Eocuma rosae* Corbera & Galil, 2007, *E. sarsii* (Kossmann, 1880) and *Scherocumella gurneyi* (Calman, 1927), are considered to have been introduced into the Mediterranean through the Suez

Canal. These species occurred only in Haifa Bay, a highly polluted and eutrophic region, where *S. gurneyi* reached high densities, 345.8 ind. m^{-2} in May 2010. (Corbera & Galil, 2016).

Diet of *Charybdis longicollis* (Leene, 1938)

The swimming crab *Charybdis longicollis* (Leene, 1938), native to the western Indian Ocean, was first recorded in the Mediterranean in 1954. It is now established from Egypt to Greece, and dominates the sandy-mud bottoms at 25–80 m in the southeastern Mediterranean. Sex has had no bearing on food items. No significant impacts were observed of seasons, depth, class size, sex and infection on stomach fullness. *Charybdis longicollis* revealed preference for infaunal and slow moving prey, as attested by the notable amount of sediment in their stomachs; the most frequent food items were molluscs, crustaceans and fish. Microplastics were detected in a quarter of the specimens examined. Since the species is extremely abundant in the Levantine littoral and sublittoral, it is likely to impact the local biota (Stasolla *et al.*, 2016).

Deepest record of an Erythraean NIS

Since the early 1990s its populations in Israel and Turkey have been heavily parasitized by the alien rhizocephalan *Heterosaccus dollfusi* Boschma, 1960, which impacts on its host's behaviour, growth and fecundity, and causes mortality. Yet, sixty years after its first record in the Mediterranean, the population of *C. longicollis* seems durable, and has recently spread to the lower shelf and upper slope off Israel, where it is common at 80 m and is found down to 250 m, greatly increasing its spatial spread. The maximal percentage of parasitization was 87.2, 88.8, 75.5 and 81.8% at depths of 40, 60, 80, 100 m respectively, and 50% at 120 and 250 m. It is suggested that the depletion of its putative fish predators, mainly rays, contributed to the prevalence of *C. longicollis* on the shelf (Innocenti *et al.*, 2017).

Changes to the food web

The invasion of Indo-Pacific fish through the Suez Canal has dramatically altered the fish assemblages on the upper shelf of the southeastern Mediterranean. The impacts of Erythraean alien fish on the structure of the food web along the Israeli upper shelf soft bottoms, was studied as expressed by their biomass relative abundance, and by comparing the mean and distribution patterns of the trophic levels among the aliens and the native species. Based on examination of more than 200 000 fishes (111 species) the study revealed that at 20-m Erythraean species comprised 54% of all sampled individuals while comprising 70% of the biomass and at 40 m 67% of all sampled individuals and 45% of the biomass. Overall, the mean weighted trophic level of Erythraean species was 3.74, while that of the natives was 3.39. These findings indicate that the local food webs have gone through significant modification, with a trend of increasing dominance of Erythraean alien fish (Goren *et al.*, 2016)

Conservation challenge: no reserve is an island

Marine protected areas (MPAs), created to conserve indigenous diversity, are meant to offer an ecosystem-based approach to conservation, and to provide protection to species,

habitats, ecosystems, and insurance against environmental or management uncertainty. It is, however, questionable whether MPAs, or even networks of MPAs, are able to conserve the indigenous biota under a high NIS load. Along the Mediterranean coast of Israel there are 9 designated, and 8 proposed marine nature reserves. A biodiversity study of the Rosh Haniqra-Akhziv nature reserves was conducted in 2004 (Ramos Esplá and Pérez 2004) documented the overwhelming presence of erythraean NIS from the littoral to the depth of 40 m. Recent studies and observations confirm the results of that survey and record the massive presence of the invasive apogonid *Cheilodipterus novemstriatus*, and the lionfish *Pterois miles*. It is suggested that MPAs in highly invaded regions have been overwhelmed by NIS, and that unless bioinvasion prevention and management are incorporated in the regional *spatial planning*, the conservation of the indigenous biota is endangered (Galil *et al.* 2017).

5. Meetings

IMCB Sydney, Australia

Galil B.S., Marchini A., Occhipinti-Ambrogi A., Ojaveer H. 'The enlargement of Suez Canal: Bioinvasions and Conservation in the Mediterranean Sea'

EuroMarine workshop, Ischia, Italy

A EuroMarine workshop, entitled 'Management of Bioinvasions in the Mediterranean Sea: the way forward', discussed a framework for a comprehensive action plan to manage NIS under the unique conditions of the Mediterranean Sea. The workshop, co-convened by Maria Cristina Gambi, a Senior Researcher at Stazione Zoologica Anton Dohrn, Napoli, and Bella Galil, was held in Ischia, Italy from 4–5 May 2016. The workshop participants formulated the 'Ischia Declaration', a document calling for specific strategic actions focused on effective science-based transboundary management of bioinvasions to reduce the risk of new introductions and the further spread of NIS already present in the Mediterranean Sea.

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Italy

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Society (SIBM) on a voluntary basis. It does not reflect an official position or knowledge of the relevant Italian Government bodies.

Overview:

The records of new introduced species for Italy include: two jellyfish species, one opisthobranch, one isopod, two bryozoans and one ascidian. Some of these records refer to species already occurring in the country, but never recognised before as introduced. The biology and ecology of established non-indigenous species of algae have been studied. Several invertebrates have spread along the coasts of Italy. A few review papers highlight the pivotal role of Italy at the centre of the Mediterranean Sea, dividing the Eastern and Western basins. In May 2016, Italy has hosted an international workshop gathering scientists to discuss bioinvasions in the Mediterranean Sea.

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

In adopting (EC) Regulations nos. 708/2007, 506/2008, 535/2008 and the Regulation (EU) 304/2011 the European Union Council established a regulatory framework governing the use in aquaculture of alien and locally absent species. In Italy, the competent authority to comply with Article 5 of (EC) Regulation708/2007 is the Ministry of Agricultural, Food and Forestry Policies, Department of European and International Policies, which has designated an Advisory Committee of experts (D.M. 339/2008 of 12.12.2008) and has entrusted to ISPRA (Italian National Institute for Environmental Protection and Research), the Technical Secretariat supporting the activity of the Advisory Committee and the task of compiling a register of alien and locally absent species (http://www.registro-asa.it/en).

2. Intentional introduction

No new intentional introductions have been reported.

3. Unintentional introduction

New Sightings

Invertebrates

An integrative morphological and molecular approach has allowed for the identification of two new non-indigenous jellyfish species, which had been previously misidentified as native *Aurelia* species: *A. coerulea* and *A. solida* (Scorrano *et al*., 2016). The Pacific *A. coerulea* was identified from material from the Tyrrhenian coast of Italy (Sabaudia lake), as well as the Adriatic coast (Varano Lake). Further records are from Spain (Balears) and France (Perpignan). Aquaculture is the likely vector of introduction in Italy and France. The Indo-Pacific *A. solida* instead may have entered the Mediterranean Sea through the Suez Canal, either alone or by vessels. Confirmed Italian records are from the Ionian Sea (Porto Cesareo) and Adriatic Sea (Trieste). Further records include Tunisia (Bizerte) and France (Cannes).

The janirid isopod *Ianiropsis serricaudis*, native to the North-West Pacific region, has recently been identified as a non-indigenous species in several localities in the Northern Hemisphere. The first occurrence in the Mediterranean Sea, namely in the Lagoon of Venice (Italy) confirms the hypothesis that this species is more widespread in Europe than expected, but has long been underreported on account of the small size of isopods

and the taxonomic complexity of the genus (Marchini *et al.*, 2016a). *Ianiropsis serricaudis* was a dominant species among the crustacean assemblages of the Lagoon of Venice in summer 2012. It was present in all the samples stations, often being the most abundant species and reaching hundreds of individuals in several samples, up to about one thousand specimens in the industrial Marghera harbor. In summer 2014, *I. serricaudis* was also observed in the harbour of Olbia, Sardinia. Transfer of shellfish stocks are the putative vector of introduction (Marchini *et al.*, 2016b).

The observation of a relatively large number of living adult specimens (15) of the opisthobranch mollusk *Chelidonura fulvipunctata* between March and June 2015 at Lago di Faro, NE Sicily, represents the first record for Italy, although this species had been recorded previously in Malta, France, Spain and the eastern Mediterranean. The introduction of *C. fulvipunctata* from the Indo-West Pacific where it is widely distributed contrasts with a single report for the Red Sea, despite the large number of studies on opisthobranchs in that Sea. So the authors make the hypothesis of a ship mediated introduction from distant locations (Malaquias *et al.*, 2016).

Three species of Bryozoans that may be non-indigenous to the Mediterranean Sea and result from ship-mediated introductions have been collected during a survey of marine caves near the coast of Sicily (Rosso *et al.* 2016). One colony of *Catenicella paradoxa* was collected in 2014 in Plemmirio MPA (near Syracuse – Sicily). It was also found in the Isola dei Ciclopi (near Catania – Sicily) in 2015 (Mytilineou, 2016). This species was already known from Sicily since 2009, but its non-indigenous status was considered uncertain (Rosso, 2009), therefore the species had not been included in previous check lists of Italian alien species; its valid alien status still awaits confirmation. A second putative introduced species is *Smittina nitidissima*, already known from Israel and Lebanon (Harmelin *et al.*, 2009). The previous findings in the Eastern Mediterranean have been justified with a range of hypotheses, including the migration through Suez Canal, the ship-mediated transport from the eastern Atlantic, or the result of relictual Pleistocene populations. The hypothesis of a complex of sibling species, each with a restricted distribution has been also pointed out (Harmelin *et al.*, 2009). The current finding extends the range of the *S. nitidissima* to the central Mediterranean; however, the finding in a submarine cave within an MPA does not strongly support the hypothesis of human-mediated introduction. The third species is *Cradoscrupocellaria hirsuta*, probably from the Atlantic, where it was first described from the Azores. Colonies of *C. hirsuta* were recently found in different environments and sectors of the Mediterranean Sea: Lastovo island (Croatia – 2002), Egadi Islands (W Sicily Strait – 2007), Lampedusa island (Central Sicily Strait – 2009), Capo Caccia (W Sardinia – 2009), and at Plemmirio (Sicily, W Ionian Sea – 2009). The species was often collected from artificial substrates within MPAs: further research is needed to establish if the Mediterranean Sea is part of the natural distribution of the species, or its occurrence there is explained by human introduction.

Taxonomic and molecular analyses revealed the occurrence of the species *Clavelina oblonga* in the Mediterranean Sea. Previous records of *Clavelina phlaegrea* are now assigned to this species, which is native to the Caribbean region and has been introduced to Brazil, Cape Verde, Senegal and Azores. In Italy, the species is known since 1929 (first record of *C. phlaegrea* in Lake Fusaro), and now occurs in the Mar Piccolo of Taranto, as well as in Spain (Cadiz and Ebro river Delta). The most likely vector of introduction is transfer of mussel stocks (Ordonez *et al.*, 2016).

Previous Sightings

Algae & higher plants

The correlation between saxitoxins (STX) production and genetic content of dinoflagellates in the Mediterranean Sea was studied by Penna *et al.* (2015). Their study established the relationship between the sxtA1 and sxtG genes and STX content in 43 cultured strains of *A. minutum* from the Adriatic, Ionian, Tyrrhenian and Catalan seas. Moreover, the assay developed in this study is proposed as a specific quantification method for the effective assessment of STX-producing *Alexandrium* species in environmental samples collected from bloom events. It was successfully used to estimate toxic cell concentrations in seawater samples in 2014 during a bloom of *A. minutum* co-occurring with *A. pacificum* in Syracuse Bay (Ionian Sea) together with the estimation of STX compounds.

Cecere *et al.* (2016a) examined intervalvar water and shells of edible bivalves imported from elsewhere in Taranto fish market, thus concluding that *Asparagopsis taxiformis* can be introduced by live seafood imports.

The main factors influencing the spread of *Caulerpa cylindracea* were reviewed by Piazzi *et al.* (2016) through an overview of the results from 47 published papers on this topic; *C. cylindracea* has been one of the most studied marine invaders, and the overall knowledge acquired has allowed the development of a model that describes the interactions among different factors affecting the algal spread.

Bulleri and Piazzi (2015) reanalyzed the results of a previous study showing the significant interaction *C. cylindracea* ⊙ nutrients on the effects of *C. cylindracea* on native species richness and total cover: they show that elevating nutrient levels caused significant changes in both the importance and intensity of competition from *C. cylindracea* on resident assemblages, generating context dependency in the ecological impacts of this seaweed.

A three-year experimental study was performed by Balata (2015) to evaluate the interactive effects of topographic complexity and sedimentation in determining the structure of rocky macroalgal assemblages in Tuscany: high sediment deposition increased the abundance of *Caulerpa cylindracea* on low complexity substrata, but decreased it on high complexity substrata.

Manipulative experiments on quadrats in 8 sites across the Mediterranean (6 in Tuscany, 1 in Sicily and one in Istria) were performed in order to assess the influence of human land based influence on the effects of *Caulerpa cylindracea* (Bulleri *et al.*, 2016 a). The removal of this seaweed from extant assemblages had positive effects on canopy-forming species at sites little exposed to human activities. At pristine sites, preventing re-invasion of cleared plots by *C. cylindracea* favoured the recovery of canopy-forming and encrusting macroalgae, whilst it depressed that of algal turfs, ultimately increasing species richness. In contrast, at more impacted sites, algal turfs responded positively to the removal of *C. cylindracea*. They suggest that features of native assemblages (e.g. species composition and relative abundance) were more important than the abundance of *C. cylindracea* in determining the extent of its effects on the native biota. They conclude that the study experimentally supports the predictions from the meta-analysis of Tamburello *et al.* (2012) and suggests that the effects of invasive seaweeds are likely to be more negative at relatively well preserved sites.

Bulleri *et al.* (2016 b) tested the competition outcome after experimental disturbance between *Caulerpa cylindracea* and three native species of *Cystoseira* co-occurring in a rocky shore near Rovinj (Croatia). The resistance to invasion by native species vs the NIS was found to depend on specific biological traits.

Three studies on food webs originating by NIS have been performed in Lampedusa Island (Sicily straits). To assess effects of *C. cylindracea* in rocky ecosystems, benthic food webs have been studied (Alomar *et al.*, 2016) through stable isotopes analyses in rocky shores: the trophic niche width is at least 1.4 times wider in invaded conditions than in non-invaded conditions. In addition, their study gives evidence of feeding analogies between the invasive herbivore fish, *Siganus luridus* and the native *Sparisoma cretense*. Marić *et al.* (2016a) also used stable isotope analysis to investigate trophic interactions between indigenous benthic taxa, two introduced algae, *Caulerpa cylindracea* and *Asparagopsis taxiformis*, and two invertebrates, the crab *Percnon gibbesi* and the sea hare *Aplysia dactylomela* . Isotopic niche of NIS showed no overlap with the ones of indigenous macroinvertebrates and fish. *Caulerpa cylindracea* provided the largest contribution to the diet of *P. gibbesi.* Felline *et al.* (2017) analysed stomach contents and caulerpin levels in the native sparid species along with the Lessepsian siganid *Siganus luridus*. *Caulerpa cylindracea* was found in the stomachs of all fishes; chemical analysis of fish tissues revealed that only *Spondyliosoma cantharus* and *Sarpa salpa* accumulated caulerpin.

The dynamics of the cold-temperate brown seaweed *Undaria pinnatifida* showed a boom-and-bust path, ending in apparent local extinction. In contrast, the tropical red seaweed *Hypnea cornuta* has shown a steadily invasive path since its introduction in the brackish water basins of Mar Piccolo di Taranto (Cecere *et al.*, 2016b).

Pusceddu *et al.* (2016) investigated meiofauna and sedimentary C cycling in seagrass (*Posidonia oceanica*) and unvegetated sediments invaded and not invaded by the non-indigenous tropical algae *Caulerpa cylindracea*, within the Marine Protected Area of Torre Guaceto MPA (Southern Adriatic Sea). Their results show that the increased availability of organic substrates in sediments invaded by *C. cylindracea* does not stimulate microbial abundance and activity. The abundance and biomass of meiofauna in sediments of both habitats invaded by *C. cylindracea* did not change significantly from those without the macroalgae, although variations occur in the species composition of the community.

Rizzo *et al.* (2016) assessed the abundance and diversity of culturable vibrio bacteria associated with the surfaces *C. cylindracea* in Torre Guaceto (Southern Adriatic Sea) throughout a year, using culture-based and molecular methods. Thirteen *Vibrio* species were identified from *C. cylindracea* surfaces and assigned to known type strains not including human pathogenic species, while some are pathogens of aquatic organisms.

The potential of exploitation in biotechnology and recycling options in eradication programs of the lipidic extract of the Mediterranean invasive seaweed *Caulerpa cylindracea* has been investigated by Stabili *et al.* (2016).

Invertebrates

A jellyfish previously described from the Northern Adriatic as a new species of non-Mediterranean origin, *Pelagia benovici* (Piraino *et al.*, 2014, reported in the Italian National Report of 2014) was investigated with a phylogenetic approach. Results indicate that the

species belongs to a new distinct genus, until then undescribed; the name has therefore been changed to *Mawia benovici* (Avian *et al.*, 2016).

The taxonomic composition and distribution of the shallow-water sponge fauna from the coastal basin Faro Lake (Southern Italy), now hosting 23 species of Demosponges and 1 of Calcarea has been observed since 50 years. *Paraleucilla magna* has been recorded for the first time in the Lake (cryptogenic according to Marra *et al.*, 2016).

A large specimen of the venomous tropical scyphozoan *Rhopilema nomadica* was recorded in October 2015, at the surface at the Poetto seaside resort near Cagliari (Sardinia). A second specimen was spotted in September 2016 at the island of Levanzo within the Aegadian archipelago off the western coast of Sicily (Balistreri *et al.*, 2017).

The comb jelly *Mnemiopsis leidyi* was found in the Lesina and Varano lagoons (Apulia, Southern Adriatic) (Mytilineou *et al.*, 2016). A mass development of *M. leidyi* has been followed by Mizzan (in press), during the summer of 2016, in the Lagoon and in the Gulf of Venice, reaching the Croatian shores. Moreover, large shoals of *M. leidyi* were present already in summer 2015 and bloomed in 2016 in the Po river coastal lagoons south of Venice. They survived during the winter (temperatures as low as 7 °C) and are suspected to have caused the observed decrease of fisheries yield, including cephalopods in the area (Cristina Mazziotti pers. comm.).

A total of 42 individuals of the polychaete *Pseudonereis anomala* were reported for the first time along the Ionian coast of Italy in the Sicilian harbours of Augusta and Siracusa (D'Alessandro *et al.*, 2016). *Branchiomma bairdi* population dynamics was studied in the Gulf of Taranto by Lezzi *et al.* (2016). The Sabellid Polychaete *Branchiomma bairdi*, already known from Sicily, was found in the Egadi Archipelago (Mytilineou *et al.*, 2016).

The aorid amphipod *Grandidierella japonica*, that was found in Viareggio (Tuscany) in 2013 (Marchini *et al.*, 2016c) was also found in the Sacca di Goro Po river delta in 2015 (Munari *et al.*, 2016). Three alien crustaceans, *Caprella scaura, Paracerceis sculpta* and *Paranthura japonica*, were found in Ortona harbour (central Adriatic Sea), associated with the bryozoan *Amathia verticillata*. Notably, the same association had been previously found in the port of La Grande Motte, France (Dailianis *et al.*, 2016).

Since August 2015, an increasing number of blue crabs, *Callinectes sapidus* has been reported in the Marano and Grado lagoon, in the northern Adriatic Sea (Manfrin *et al.*, 2016). The first record of *C. sapidus* in Italy and in the entire Adriatic Sea dates back to 1949 in the Lagoon of Grado, but no other record had been reported yet since the first one.

The Northern brown shrimp *Penaeus aztecus*, recorded in 2015 from the Tyrrhenian Sea was found in 3 localities in the Strait of Sicily (Scannella *et al.*, 2016). It is commonly caught by fishing fleet in the Corigliano Gulf (Calabria – Ionian Sea; Mytilineou, 2016). After a careful reevaluation, the record of *Penaeus semisulcatus* from the Gulf of Taranto, which was reported in the Italian National Report of 2015, has to be assigned to *P. aztecus* (Froglia pers. comm.).

The opistobranch molluscs *Aplysia dactylomela* and *Bursatella leachii* were found in large numbers in the Faro Lagoon near Messina (NE Sicily - 38°15'57"N, 15°37'50" E). The first species (*A. dactylomela*) is suspected to be a range expanding species, not an alien species, since the work of Valdés *et al.* (2013). Other opistobranch NIS were recorded: *Melibe virid-*

is, Polycera hedgpethi , Haminoea cyanomarginata, Chelidonura fulvipunctata (D. Vitale *et al.*, 2016).

Bartoli *et al.* (2016) review the role of farmed *Ruditapes philippinarum* as regulators of some of the multiple processes involved in the ecosystem metabolism and biogeochemistry in the Sacca di Goro (Po river Delta, NW Adriatic Sea).

Casoli *et al.* (2016) reported the introduction of *Mytilus edulis* from the hull fouling of a barge form the NE Atlantic participating in the rescue of the wrecked Costa Concordia cruise ship near the Island of Giglio (Tuscany). The species identification was made by molecular methods: a large population of mussels developed and lasted for about one year.

Nine alien species of invertebrates and five cryptogenic species, all already known from the western Italian coast, were found in the marina of Rome. Boaters reported that in summer, colonies of *Amathia verticillata* were able to settle and grow on boat hulls in just one week, requiring intensive efforts for cleaning boats and marina structures (Ferrario *et al.*, 2016a).

Fish

The abundance of the dusky spinefoot (*Siganus luridus*) was monitored around the island of Linosa (Strait of Sicily), where the species was first recorded in 2003. Both underwater visual census and surface snorkeling were performed in 2005–06 and 2012–15. Both approaches highlighted significant proliferation of this tropical invader, with an average abundance of 0.36 individuals/250 m^2 across the 0–30m depth range.

An adult specimen of the silver-cheeked toadfish *Lagocephalus sceleratus* was captured by purse seine off the Tyrrhenian coast, a second specimen was recorded from a Ionian locality, both in the Region Calabria (Azzurro *et al.*, 2017).

The age and growth parameters of *Fistularia commersonii* specimens caught in Southern Sicily has been analysed by S. Vitale *et al.* (2016).

Species not yet seen

Algae & higher plants

Dictyota cyanoloma, a distinctive brown algal species characterized by a blue-iridescent margin, was recently reported from the Mediterranean coast of Spain, mainly in harbour and marina environments (Aragay *et al.*, 2016). Genetic analysis revealed that Mediterranean samples are conspecific with material from Australia, which is the likely native region (Steen *et al.*, 2017). Analyses of herbarium samples also demonstrated that *D. cyanoloma* also occurs in France and Croatia (first record: Split, 1935). The only unconfirmed report from Italy is a photograph taken in Sicily in 2011 (Steen *et al.*, 2017); the species is provisionally excluded from the Italian check-list, and its occurrence awaits confirmation.

Invertebrates

The first Adriatic record of the Bryozoans *Celleporaria brunnea* (NIS) and *Watersipora subtorquata* was reported by Marić *et al.* (2016b) from a marina near Zadar (Biograd na Moru – Croatia). The two bryozoans, which are non-indigenous and cryptogenic in the Medi-

terranean Sea, respectively, are already known from Italy but not yet from the Adriatic coast.

The non-indigenous ascidian *Herdmania momus* was first recorded from the southeast coast of Malta in 2013. Surveys at eight sites along the east coast of Malta revealed that it has since spread to another two sites, mainly on artificial substrata (Afoncheva *et al.*, 2016).

The Indo-Pacific flatworm *Maritigrella fuscopunctata* was found for the first time in the Mediterranean Sea in summer 2015 in Malta. The species was observed in five sites along the coast, especially in sheltered rocky habitats with boulders and surfaces covered with fouling organisms (Vella *et al.*, 2016).

Fish

Two individuals of the Erythrean NIS *Sargocentron rubrum* widely diffused in the Eastern basin were caught in Malta. They are probably the first spotting of *S. rubrum* in the central Mediterranean, however the record is affected by taxonomic uncertainty (Deidun *et al.*, 2016).

New distribution records for the Indo-Pacific lionfish *Pterois miles* were published from Tunisia in Zembra Island and Cape Bon (Dailianis *et al.*, 2016).

Natural range expanding species

A specimen of the circumtropical fish *Taractes rubescens* was spotted in southern Sicily in 2014 (Karachle *et al.*, 2016). This finding may represent a vagrant individuals that has entered the Mediterranean by Gibraltar, or could result from eggs or larvae transported by currents.

Mannino *et al.* (2016a) reviewed the distribution of the crab *Percnon gibbesi*, which was formerly included in alien species. Their conclusion suggests that the species has likely entered the Mediterranean Sea by currents, unaided by human intervention, and labelled the species as cryptogenic. Since the origin of *P. gibbesi* is known (Atlantic Ocean), we rather consider this crab as a likely natural range expanding species. Stasolla *et al.* (2016) reported the presence of numerous specimens of *P. gibbesi* from 4 stations in the Marine Protected Area of the Elba Island (Tuscany).

4. Pathogens

No new information

5. Meetings and research projects

The Zoological Station of Naples and EuroMarine (European Marine Research Network) organised in 4–5 May 2016 a workshop entitled Management of Bioinvasions in the Mediterranean Sea -the Way Forward. Invited scientists from all over Europe joined in the island of Ischia (Gulf of Naples) to discuss a general framework of a comprehensive action plan for managing NIS under the unique conditions of the Mediterranean Sea. In the plenary session the participants formulated and discussed the 'Ischia Declaration', available at:

http://www.uzionlus.it/documenti/EuroMarine_FWS_Ischia_Declaration_Statement_31_05_2016.pdf

Outputs of the European FP7 Projects VECTORS and DEVOTES have revealed that the westward spreading of Erythrean species from the Eastern Mediterranean basin is interesting Italian coasts (Galil *et al.* 2016, and Olenin *et al.* 2016).

Within the EU-FP7 project VECTORS, nine biological traits of the 68 most widespread NIS in European Seas have been analysed, with the aim of determining the characteristics of successful invaders, by assessing which traits directly confer invasiveness and those which are just correlated (Cardeccia *et al.*, 2016).

Other projects regarding marine alien species in Italy have been accomplished in 2016:

An updated overview of the marine alien and cryptogenic species recorded in the Egadi Islands Marine

Protected Area (Tyrrhenian Sea, Italy) was published by Mannino *et al.* (2016a). Altogether, 17 species (14 aliens and 3 cryptogenic) belonging to five taxonomic groups were reported in the area.

In their review of Mediterranean Bryozoans, Rosso and Di Martino (2016) list ten percent of species (59 out of 556 spp.) living today as NIS, although some of them only tentatively and other cryptogenic.

Sicuro *et al.* (2016) reviewed the diffusion of alien species in Italian aquaculture activities.

Ferrario *et al.* (2016b) presented a model to assess the risk of fouling and spreading of NIS and its application to data derived from a questionnaire given to Italian boat owners. The model uses a two-levels fuzzy logic approach, combining two separate risks: hull fouling and spreading.

The following projects are underway:

- An analysis of anthropogenic activities and possible vectors in Taranto Seas was recently carried out within the framework of the RITMARE Project, involving local stakeholders (Cecere *et al.*, 2016c).
- A wide Citizen Science project developed by a non-profit organization, Reef Check Italia Onlus (RCI-www.reefcheckitalia.it) involved volunteer divers in the monitoring of the spread of a non-indigenous green algae (*Caulerpa cylindracea*), along the coasts of the Liguria Region – with a focus on the Portofino MPA (Cerrano *et al.*, 2016),
- Researchers from the University of Palermo and ISPRA (P. Balistreri, A.M. Mannino and E. Azzurro) have started the Italian section of the citizen-science project "Sea Watchers" dedicated to alien algae and fish.
- The project *Caulerpa cylindracea* in the Egadi Archipelago has updated the distribution of the alga in several localities of the 3 islands of Favignana, Levanzo and Marettimo on sand, rocks and mixed substrates between 0 and 40 m (Mannino *et al.*, 2016b).

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Lithuania

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Overview

In total, 34 species, 29 non-indigenous (NIS) and 5 crypogenic (CS), are registered in the Lithuanian waters of the Baltic Sea and the Curonian Lagoon. Of them 22 are established and maintain self-sustaining populations, 10 are not established and for one the population status is unknown. Since 2000, 7 new NIS arrived, although all new introductions are secondary ones, i.e. species entered the Baltic Sea via other countries and then spread to the Lithuanian waters either by human-mediated pathways or by natural means.

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

The IMO BWMC ratification process is not yet finalized, although the rules for ships calling to LT waters in relation to BWMC; cooperation scheme between LT institutions involved in ballast water management control, defining their responsibilities and principles of interaction as well as other relevant documents were developed in previous years (2014/2015).

2. Intentional introductions

No new intentional introductions recorded.

3. Unintentional introductions

A new Ponto-Caspian amphipod, the killer shrimp *Dikerogammarus villosus* was recorded. Earlier known from the coastal fresh-to-brackish waters the Netherlands, Germany, France and Belgium (North Sea), and Poland and Germany (Baltic Sea), the species was detected in the samples taken from the navigation buoys in the port of Klaipėda, at one littoral sampling site inside the Curonian Lagoon (approx. 20 km from the sea gates) and in the mouth of the Šventoji River (approx. 40 km to the North from port of Klaipėda). In fact, the samples were collected in 2015, while *D. villosus* was identified and reported in 2016 (Figure 1). The introduction appears to be the result of marine invasion rather than spread through the inland canals.

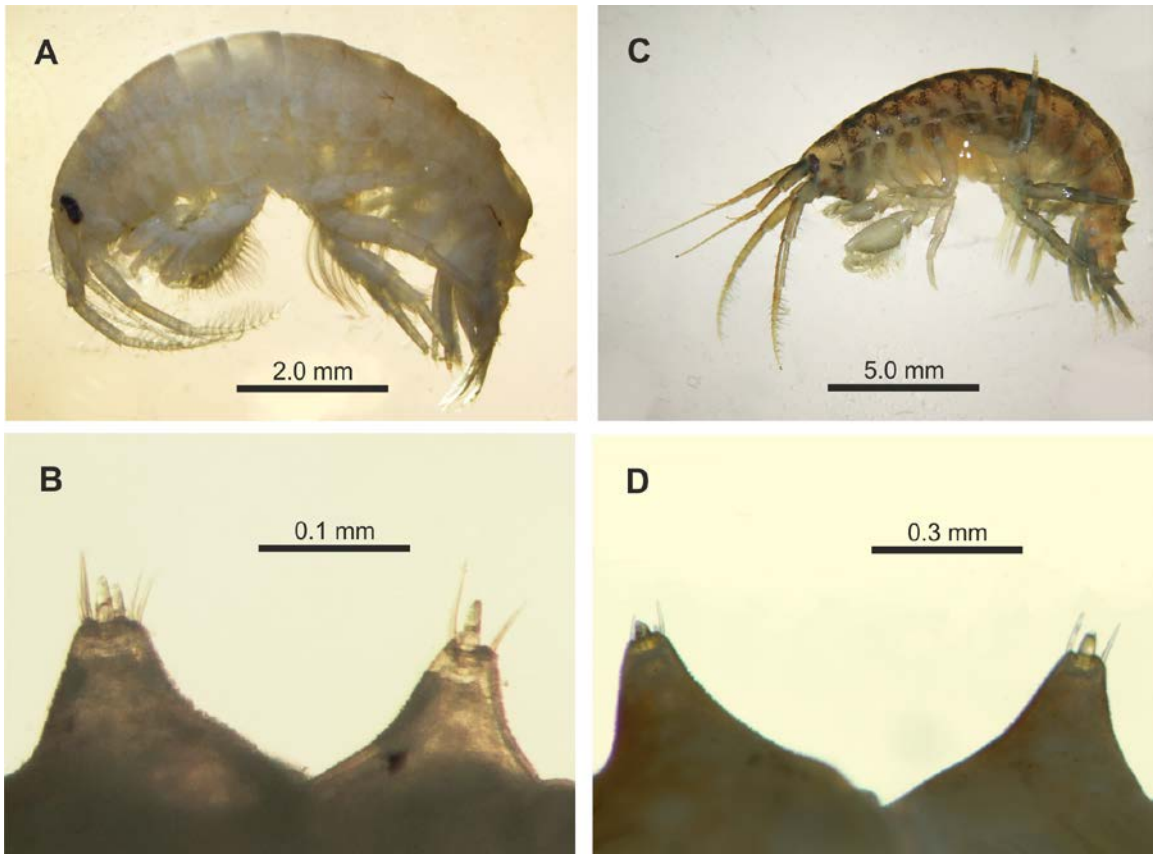

Figure 1. ***Dikerogammarus villosus*** **from Lithuanian waters: ethanol preserved 11-mm male from the mouth of the Šventoji River (A) and its urosomal protuberances (B); defrosted 21-mm male from the Curonian Lagoon (C) and its urosomal protuberances (D). Note that both specimens have only two spines on each of the protuberances, the characteristic typical of most male** ***D. villosus*** **currently observed in Lithuanian waters. Photographs by E. Šidagytė (Šidagytė** ***et al.*** **2016).**

4. Pathogens

None reported.

5. Meetings and projects

Meetings

- 41th CIESM Congress. September 12–16, 2016, Kiel, Germany. Congress Session 39 'Alien Records' (S. Olenin. Moderator).
- Marine biodiversity – the key to healthy and productive seas. DEVOTES Final Conference (17–19 October, 2016), European Comission's Directorate-General, Brussels, Belgium. (S. Olenin. How to define the environmental targets for indicators of non-indigenous species?).
- HELCOM 5th Meeting of the Working Group on the State of the Environment and Nature Conservation. November 7–11, 2016, Tallinn, Estonia (S. Olenin. Core indicator 'Trends in arrival of new non-indigenous species'; S. Olenin, M. Lehtiniemi & H. Ojaveer. Proposal for an integrated HELCOM NIS monitoring programme).

Projects:

- FP7 DEVOTES. Development of innovative tools for understanding marine biodiversity and assessing good environmental status (2012–2016). The Lithuanian team is involved in development of NIS indicators.
- BONUS BIO-C3. Biodiversity changed investigating causes, consequences and management implications (2014–2018). PI for Lithuania: Dr. A. Zaiko <anastasija.zaiko@jmtc.ku.lt>
- BALMAN – Joint Lithuania-Latvia-Taiwan cooperation fund project "Development of the ships' ballast water management system to reduce biological invasions" (2015–2017).

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Information systems

AquaNIS, 2016. Information system on aquatic non-indigenous and cryptogenic species <www.aquanis.ku.lt> Contains data on NIS and CS biological and other traits (including association with shipping vectors and availability of molecular data), salinity and temperature tolerance limits, introduction events in countries and country-regions in European regional seas, Northwest Pacific Ocean, New Zealand and Canadian Arctic.

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Norway

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With contributions from Vivian Husa, Jan H. Sundet, Ann-Lisbeth Agnalt, Ann-Margrete Hjelset, Torjan Bodvin, IMR

Summary:

- Regulations relating to alien organisms went into force january 1., 2016

  https://www.regjeringen.no/en/dokumenter/forskrift-om-fremmede-organismer/id2479700/

- Exemption for the prohibition of import of live American lobster under certain conditions.
- No further genetic clarification of the origin of the snowcrab *Chionoecetes opilio* It has previously been established that there is a significant genetic distance between the Barents Sea, and the Canada/Greenland stocks. The snow crab continues to expand its range and population density in the Barents Sea. No obvious increase in king crab *Paralithodes camtschaticus* stock from 2015The culling fishery (no quotas) W. of E 26° still seems to slow down (but not prevent) further SW migration and population growth, but there has been an increase in the catches in the eastern part of the culling/free fisheries area (W of 26°).
- Three records of American lobster in Norway in 2016. All in the Oslofjord area. Two of these were hybrids (H.homarus x H. americanus).

1. **Regulations:** Law of biodiversity. Finalised 2011 and 2012
   - Chapter IV on Alien species
   - General prohibition against releasing NIS, unless special permit is granted after RA.
   - Regulations relating to alien organisms went into force january 1., 2016
   - https://www.regjeringen.no/en/dokumenter/forskrift-om-fremmede-organismer/id2479700/
   - Exemption for the prohibition of import of live American lobster under certain conditions

While the Norwegian Biodiversity Information Centre still is the official Norwegian repository for information on Red-listed and Black-listed species (including NIS), a NIS expert group (to give advice on management) is established at "The Norwegian Scientific Committee for Food Safety"). An "ad-hoc-group" with participants from several other expert groups made its first Risk Assessment for the cultivation of the Australian red-clawed crayfish (*Cherax quadricarinatus*)

2. **Intentional**

No new alien species (*proper)* intentionally being introduced has been reported. There is quite widespread translocation (within Norwegian borders) of several wrasse species in the aquaculture industry (employed for biological de-lousing of salmon). A risk evaluation for the Aquaculture Industry was finalized in 2014 and published in 2015 (unfortunately in Norwegian only)

3. Unintentional

No new sightings

General information

Three new specimen of *H. americanus* have been detected in 2016. All caught in the Oslofjord area, one specimen in the inner basin of the city.

Two of the specimen were hybrids, (*H. homarus x H. americanus*). All specimen has been boiled and consumed.

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

Since 2000, a total catch of 33 American lobsters (+ hybrids) have been confirmed in Norway,

Previous Sightings

Range expansions:

Mnemiopsis leidyi has reappeared along the coast. Higher numbers close to the shore, lower densities offshore. *M. leidyi* is found well north of 62 °N, both young and old individuals, but it remains unclear if this means local reproduction, or transported individual from south.

Cupped oyster, *Crassostrea gigas*

No records of further spread northwards, but significant increase in numbers in areas where already established. Apparently a shift from species predominantly growing shallowly on very (wave) protected soft -bottom habitats to hard-substrate growing forms also exploiting somewhat less wave-protected areas.

Recent anecdotal information on previously unknown cultivation efforts in the Oslofjord area with possible feral individual may change the "introduction history" of. *C. gigas* in Norway. The information will be examined more closely.

Snow Crab: *Chionoecetes opilio.* First observed in Russian sector 1996, 2004 in Norw. EEZ. Still expands geographical distribution and stock is increasing both in Norwegian and Russian EEZ. In addition to continued northward and eastward range expansion, several specimens were caught E of Novaja Zemlja (Kara Sea proper).

The snow crab prefers colder water (typ. 3–4 C) than red king crab. N & E distribution, may even retract if the Arctic gets warmer. SSB for Snow crab now > 10 times the SSB for king crab. In 2015, a growing fishery with both Norwegian and Russian vessels have taken place. Is now found on the west coast of Svalbard. Contact. Jan.h.sundet@imr.no

Red King Crab (*Paralithodes camtschaticus*)

Stock size of catchable males (CL>130mm) has increased the later years, and stock net production is ABOVE level for MSY (Maximum Sustainable Yield) See results for trawl survey, Figure xx. Higher quotas to increase F (Fishing mortality) is reccommended in 2016 & 2017. Suggested Quota Sep1 -Dec31, 2016: no more than1740 tonnes

2017, Less than 2000 tonnes. Only males with CL above 130 mm can be harvested legally. (Sundet *et al.*, 2016)

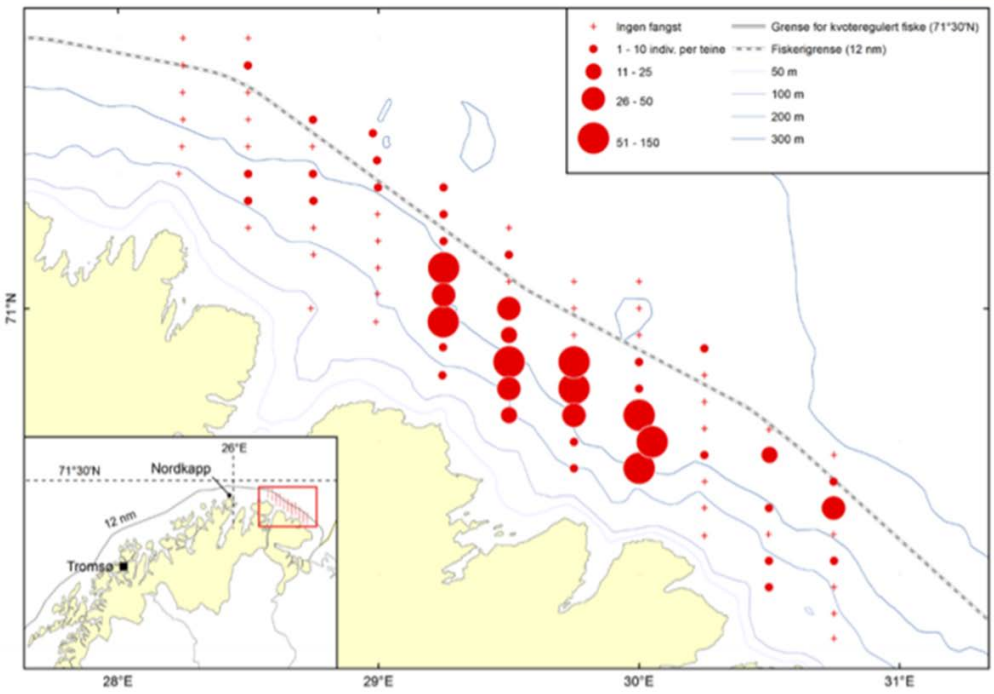

Figure 1. Pot survey stations and catch of King crab in the quota regulated area in NEZ. Catchable males pr nautical mile trawled (Sundet *et al.*, 2016).

While the free culling fishery W. of 26 E Seems to reduce the S + SW spread of the king crab, a slight increase in numbers, but moderate SW range expansion was observed in the pot fishing survey from 2014/2015, Figures xx+1 and xx+2

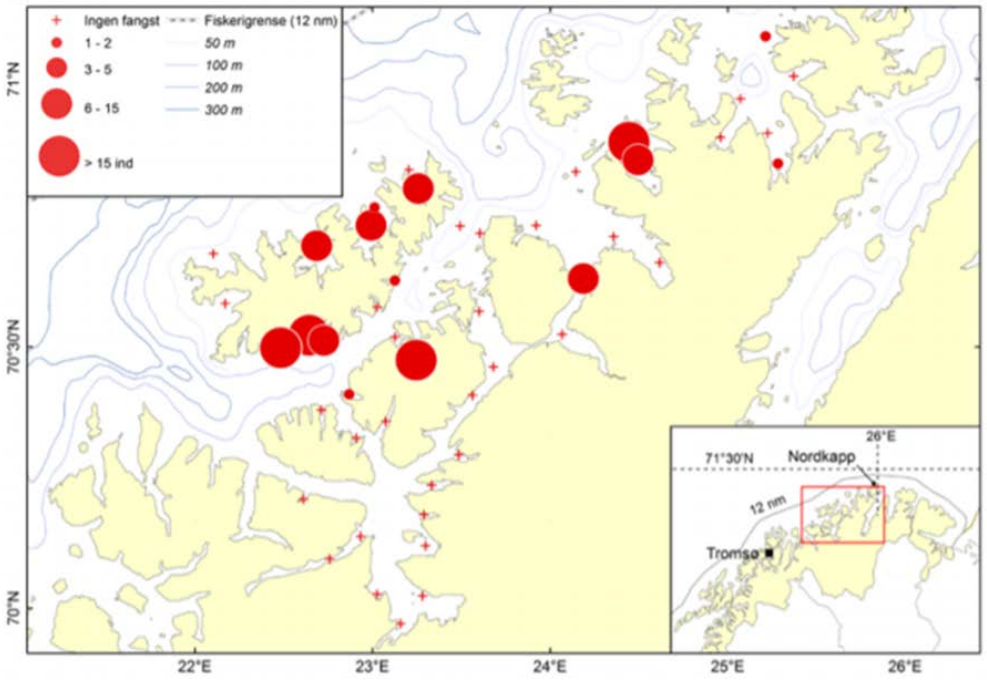

Figure 2. Number of *P. camtschaticus* per pot in fishery, june 2016 in the Free fishey/ culling zone. Note different scale on dot size/numbers, compared to Figure 1.

Erradication programmes

Crassostrea gigas: An eradication programme (funds provided for voluntary organizations like sports clubs, scouts, etc) in and adjacent to a newly created MPA Outside Arendal municipality. 58°26N, 8°50E

The result of the eradication programme will be evaluated in the following years.

During 2014, a scientific advice for management of *C.gigas* (including commercial exploitation has been produced (Bodvin, *et al.*, 2014).

Several counties in SE part of Norway consider management by a combination of commercial harvest and site selective culling (in areas of great biological value, (MPAs)), or e.g. public beaches.

***Homarus americanus**:* Not formally established or regularly funded efforts (!), but suspect specimen are collected by fishermen and are still genetically analysed at IMR. Since 2000, 33 specimen of American lobsters (3 hybrids *H. homarus* x *H. americanus*) have been found in Norway,. All have been verified as *H. americanus* (or hybrids) by DNA analysis at IMR, Norway.

Not Seen (or not confirmed) Species Yet:

One sample of suspected *Didemnum vexillum* was collected in rapid coastal surveys in 2015 (Agder counties (58 59N, 11 4E, to 59 0N, 9 5E). Confirmed as not *D. vexillum*.

Suspected specimen of *Bothrylloides violaceus* collected. Further analysis pending

Contact: V. Husa, IMR. Vivian.husa@imr.no

Import and exports:

Note that the data on export does not specify in the "non-frozen" really is alive

Prohibition on the live import of live American lobster

Exemption for the prohibition of import of live American lobster

One company (the only significant importer) sought, application was declined, it was appealed, and was allowed exemption.

Conditions which have to be fulfilled

An exemption from the ban on import is given on condition that the firm implements strict measures to prevent the release of live lobster through the activities of the firm:

No unauthorized persons shall have access to the lobsters during any temporary storage or transport.

The number/amount of live American lobsters shall be registered so that any disappearance of live lobsters is discovered in all parts of the supply chain.

After arrival at the firm´s facilities, live American lobster shall only be stored in closed facilities where escape of lobsters is not possible. No unauthorized persons shall have access to the facilities.

Live American lobsters shall be held in separate tanks apart from European lobsters and other species.

All live American lobsters shall be boiled or in other ways processed so that they without doubt are dead before leaving the firm´s facilities.

4. Pathogens

No severe Ostreid Herpes-virus µVar outbreaks reported for *Crassostrea gigas* or other mussels in 2016.

Marteilia refringens detected in Blue-mussel along the western coast- (Contact: Stein Mortensen, IMR (stein.mortensen@imr.no). The parasite may be related to severe setback in blue mussels (*Mytilus edulis*) in south-eastern Norway since 2007/2007. NIS status for the *M. refringens* variety is currently unresolved.

5. Meetings etc.

No meetings dedicated to NIS as such, but at the annual "Arctic Frontiers", themes related to biodiversity, shipping and human impacts were on the agenda: http://www.arcticfrontiers.com/program/

Public outreach initiatives. The Directorate for Nature Management funded a project to educate and involve sportsdiving clubs as informants on alien species. During 2016, five clubs scattered around the coast of Southern Norway were recruited, and a team from IMR and University of Bergen (mainly) did week-end courses consisting of a theoretical presentation (including a target lis), field work with collection of specimen, and a subsequent identification session. In general, several species on the target list were collected, but no new records.

One diving club had however a member employed by a shipping management company, and he gave access to a recently anchored diving vessel (Directly from a 6 year permanent anchoring in The Gulf of Mexico). The vessel has a large (8 x 8 m) "moon pool" with direct access through the hull. In the moon pool the divers found and documented a very diverse encrusting society and several mobile species (Fish and crustaceans). Currently more than 30 OUT has been recorded. Analysis of the documented specimen is pending

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Poland

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Overview:

Highlights of the National Report

Melita nitida Smith, 1873 (Crustacea, Amphipoda) was recorded for the first time in Poland in the Port of Gdynia (Gulf of Gdańsk, Poland) in summer 2014 (Normant *et al.*, 2017).

Acipenser baerii Brandt, 1869 (Pisces, Acipenseridae) was reported for the first time in the River Rega (Baltic Sea basin) in October 2013 (Skóra, 2016).

1. Regulations

The list of invasive alien species of the European Union concern was adopted on 13.07.2016. The list is an Annex to the Regulation No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. The Regulation entered into force on the twentieth day following that of its publication in the Official Journal. There are 37 alien plants and animals included. Depending on the phase of their invasion, actions will need to be taken to prevent introduction, early detect and rapidly response against new incursions and undertake long-term control if a species is widely spread.

New Ballast Water Management Convention enters into force. IMO confirmed, that from 8. September 2017, The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BMW - the Ballast Water Management Convention) enters into force.

The Treaty was joined by 52 Member States with a total of 35.1441% of the world fleet tonnage, which enabled them to sign the document. The Convention stipulates, that the regulations will come into effect 12 months after their ratification by at least 30 countries.

This fact means, that until 8. September 2017, all ships (i.e. vessels of any type operating in the aquatic environment, including submersibles, floating craft, floating platforms, floating storage units (FSUs) and floating production, storage and offloading (FPSO) units) will be required to:

- undertake an initial survey and be issued with an International Ballast Water Management Certificate (for ships of 400 gross tonnage and above to which the Convention applies, excluding floating platforms, FSUs and FPSOs). Ships that are registered with flag administrations that are not yet a party to the Convention will need to demonstrate compliance and may wish to undergo surveys and be issued with a document of compliance,
- have an approved ballast water management plan on board,
- maintain a ballast water record book,

•manage their ballast water on every voyage by performing ballast water exchange (or by treating it using an approved ballast water treatment system), and at a later date, ships will also be required to:

•manage their ballast water on every voyage by using an approved ballast water treatment system.

The Convention does not apply to:

•ships not carrying ballast water,

•domestic ships,

•ships that only operate in waters under the jurisdiction of one party and on the high seas,

•warships, naval auxiliary or other ships owned or operated by a state, or

•permanent ballast water in sealed tanks on ships, which is not subject to discharge.

Due to Port Survey Protocol described in the Annex 2 of the Joint HELCOM/OSPAR Harmonised Procedure on the Granting of BMW Convention Exemptions Polish Ministry of Maritime Economy and Inland Navigation, obliged authorities of three Polish seaports for performing in 2017 the studies on the presence of non-indigenous species.

2. Intentional

In 2016 deliberate releases (into the rivers flowing to the sea) of salmon *Salmo salar*, sea trout *Salmo trutta*, whitefish *Coregonus maraena* and Atlantic sturgeon *Acipenser oxyrinchus* were conducted (information from Inland Sea Fisheries Institute in Olsztyn).

3. Unintentional

Melita nitida Smith, 1873 was recorded for the first time in Poland in the Port of Gdynia (Gulf of Gdańsk, Poland) in summer 2014 (Normant-Saremba *et al.*, 2017). 13 individuals were identified as *M. nitida.* Species identification was done based on the following features: absence of dorsal teeth on the first urosome segment and the presence of a group of dorso-lateral spines on either side of the second urosome segment and on the shape of the male gnathopod 2. The crustaceans were found at water temperature between 10.5 and 19.1°C, and water salinity 7 PSU. The species is native to Atlantic coast of North America. In European waters, *M. nitida* has been previously observed e.g.: since in 1998 in The Netherlands (Faasse and van Moorsel, 2003) and 2010 in Germany (Reichert and Beermann, 2011), between 2013 and 2016 - in three localities of the French Atlantic coast: Arcachon Bay, Hossegor Lake and the Gironde Estuary (Gouillieux *et al.*, 2016).

Tubificoides heterochaetus (Michaelsen, 1926) - an annelid, representing class Clitellata was for the first time recorded in 2013 in Port of Gdynia (Gulf of Gdansk, southern Baltic Sea). This species was very abundant accounting for 64% of all collected Clitellata. Although this species has been listed by some authors as an alien species in Europe its status is still not clarified (Marszewska *et al.*, 2017).

Acipenser baerii Brandt, 1869 was reported for the first time in the River Rega (Baltic Sea basin) in October 2013 (Skóra, 2016). It naturally inhabits large rivers of Siberia situated between the rivers: Ob and Kolyma and in Lake Baikal (Sokolov and Vasil'ev, 1989 and references therein). In Poland the species is cultured since 80s of the 20th century

(Grabowska *et al.*, 2000). Their presence in the rivers is the result of escapes from fish farms and as a result of illegal introductions e.g. by aquarists (Arndt *et al.*, 2002).

Previous Sightings

Alien Naididae species (Annelida: Clitellata) are present in Polish waters, e.g.:

Potamothrix hammoniensis (Michaelsen, 1901) is present in brackish waters of Wolin Island (Legeżyński, 1971), Szczecin Lagoon (Giziński *et al.*, 1980), estuary of the Vistula River (Klekot, 1972) as well as in Vistula Lagoon (Dumnicka *et al.*, 2014). It is a species of Ponto-Caspian origin (Dumnicka, 2016).

Potamothrix moldaviensis (Vejdovský et Mrázek, 1903) is present in an estuary of Vistula (Klekot, 1972). The studies of oligochaete fauna made in various water bodies after 2000 showed numerous specimens of this species among others in one of the coastal lakes (Dobrowolski, 2001). It is a species of Ponto-Caspian origin (Dumnicka, 2016).

Potamothrix vejdovskyi (Hrabě, 1941) is the species whish the occurrence in Poland is limited to only a few water bodies at the shore of the Baltic Sea – one specimen was found in a fishing marina on Wolin Island (Legeżyński, 1971); it was also found in Vistula Lagoon (Jabłońska-Barna *et al.*, 2013), whereas in other coastal water bodies studied by Klekot (1972), Kasprzak (1973, 1978), Legeżyński (1976), Giziński *et al.* (1980) and Dobrowolski (2001), it was not recorded at all. In other European countries this species is known from brackish and freshwater habitats (Timm, 2009). It is a species of Ponto-Caspian origin (Dumnicka, 2016).

Potamothrix bavaricus (Oschmann, 1913) were known among others from an estuary of Vistula (Klekot, 1972). In recently studied water bodies with various conductivities, *P. bavaricus* formed a maximum of 34% of the oligochaete fauna in a costal lake and 2–3% in Silesian water bodies. In the Eastern part of Vistula Lagoon (Jabłońska-Barna *et al.*, 2013) this species created a few percent of benthic fauna but in the Polish part of this water body it was not found till now. It is a species of Ponto-Caspian origin (Dumnicka, 2016).

Potamothrix heuscheri (Bretscher, 1900) has been recorded solely from a few locations in Poland: among others in a fishing marina on Wolin Island (Legeżyński, 1971). Recently it was discovered also in the middle course of the Oder River (Jabłońska *et al.*, 2015). It is a species of Ponto-Caspian origin (Dumnicka, 2016).

Psammoryctides barbatus (Grube, 1861) has been found mainly in the northern and central parts of Poland (Dumnicka, 2016). It is a species of Ponto-Caspian origin (Dumnicka, 2016).

Limnodrilus cervix Brinkhurst, 1963 was recently found in the Vistula Lagoon (Dumnicka *et al.*, 2014), but this species was known from England and Wales already in the 1960s (Kennedy, 1965). It is North American species (Dumnicka, 2016).

Branchiura sowerbyi Beddard, 1892 was first found in Poland in a slightly heated water body, the Szczecin Lagoon (Legeżyński, 1976). Recently, it was also found in a middle course of the Oder River (Jabłońska *et al.*, 2015). It is thermophilic species from Asia (Dumnicka, 2016).

Tubifex blanchardi Vejdovský, 1891 has been rarely found in Poland and then usually in small numbers. It was reported from the Vistula Lagoon (Dumnicka *et al.*, 2014). It is a species from South Europe or North Africa (Dumnicka, 2016).

Quistadrilus multisetosus (Smith, 1900) was noted in Szczecin Lagoon (Giziński *et al.*, 1980) and the middle and lower courses of the Oder River (Jabłońska *et al.*, 2015). Only two findings of this species in a drainage area of the Vistula River were noted by Dumnicka and Kownacki (1988) and Jabłońska (2010, unpublished PhD thesis). It is North American species (Dumnicka, 2016).

The number of alien naidid species could increase through a direct introduction and migration (active or passive) of species along rivers, canals or seashore. Among the alien naidid species recorded in Poland *P. hammoniensis* and *P. barbatus* could be regarded as invasive species (Dumnicka, 2016).

The Chinese mitten crab *Eriocheir sinensis* H. Milne-Edwards, 1853 - non-native species reported in Polish coastal waters from 1926 (Kulmatycki, 1933) were analyzed in samples from the Gulf of Gdansk (from the period from 1999 to 2007) and from the Vistula Lagoon (from the period from 2008 to 2014).

Size and sex structure as well as biological condition of populations of *E. sinensis* were analyzed. Males were dominant over females, with a sex ratio of 1.6:1. Carapace width of all collected specimens ranged from 33.3 to 89.1 mm and the mean values for specimens from the Gulf of Gdansk and Vistula Lagoon were 62.4 ± 8.1 mm and 66.6 ±7.7 mm respectively. There were no statistically significant differences in carapace width between males and females. There were no individuals with a carapace width less than 30 mm, which may indicate a lack of an established population of this species from the eastern Polish coast. The wet weight of all specimens ranged from 30.9 to 321.9 g and the mean values for all specimens from the Gulf of Gdansk and the Vistula Lagoon were 119.4 ± 45.2 g and 141.8 ± 47.9 g, respectively. The wet weight of an individual was significantly correlated to carapace width and the exponent b reaching values close to 3 may indicate their good condition (Wójcik-Fudalewska and Normant-Saremba, 2016).

Ponto-Caspian gammarids: ***Pontogammarus robustoides*** (G.O. Sars, 1894), ***Obesogammarus crassus*** (G.O. Sars, 1894), ***Dikerogammarus haemobaphes*** (Eichwald, 1841) and ***Dikerogammarus villosus*** (Sowinsky, 1894) established and are in good condition in the Gulf of Gdansk. The wet weight of all individuals of all these Ponto-Caspian gammarids, collected in the period from 2011 to 2012, was significantly correlated to carapace width and the exponent b reaching values: *P. robustoides* (b = 2.852), *O. crassus* (b = 3.3477), *D. haemobaphes* (b = 3.7855) and *D. villosus* (b = 2.6917). Such good conditions of these organisms indicate that the brackish environment of the Gulf of Gdansk affords them excellent possibilities for growth (Dobrzycka-Krahel *et al.*, 2016).

Pirapitinga *Piaractus brachypomus* (Cuvier 1818) is an accidental alien species in Polish waters. Its native to the amazon and Orinoco rivers basins. It is highly valued as an aquaculture species and it is considered to be one of the most significant and prized species in the aquarium trade (Jegu, 2003). The first published record in central Europe, was in June 2002 in Poland (Boeger *et al.*, 2002). Since 2001, some reports of single specimens of *P. brachypomus* have been noted in Polish waters (Witkowski and Grabowska, 2012). This species have been sold in Poland in pet shops. Since 2014 the trade of *P. brachypomys* in Poland has been restricted by the Ministry of Environment, because it has been consid-

ered an alien species with a potentially negative impact on the native environment (Rozporządzenie Ministra Środowiska 2011). Więcaszek *et al.* (2016) present the biological characteristics of five individuals of *P. brachypomus* caught in north-wester Poland (Szczecin Lagoon, lake Dąbie and Pomorzany Power Plant cooling water canal in Szczecin) in 2002–2010, by recreational anglers and commercial fishermen. Additionally Więcaszek *et al.* (2016) present well documented records of *P. brachypomus* in different waters (lakes, ponds, dam reservoirs, rivers and lagoons) collected from 2001 to September 2015 by recreational fishers. Więcaszek *et al.* (2016) state that *P. brachypomus* does not tolerate water temperatures below 13°C. During winter, temperatures in open water bodies in Poland are significantly lower, while the lowest temperatures in warm effluent (Pomorzany Power Plant channel) are a little beneath the lower tolerance limit of the species (7.5–10°C).

4. Pathogens

No new sightings.

5. Meetings

Past year

3rd Fish Congress 3 March-1 April 2016 Gdynia, Poland

Congress promoted the use of more modern, which are in harmony with the environment, innovative technological solutions in fish aquaculture.

Warsaw Days of Aquarium 21 May 2016, Warsaw, Poland

Warsaw Aquatic Days is the biggest aquatic event in Warsaw, which is held annually during the Warsaw University of Life Sciences Days. III Warsaw Days of Aquarium was the event in Poland, where there were lectures supported by scientific research and achievements of Polish aquarists.

The theme of the conference was widely understood aquarium. There were lectures about fish, shrimps, crayfish, aquatic plants, water chemistry, lighting and undesirable impact on the aquarium environment (invasive alien species of Poland and Europe).

"Towards the Best Practice of River Restoration and Maintenance" 20-23 September 2016 Krakow, Poland

The Conference focused on bring together river scientists, engineers and practitioners to share and discuss recent scientific research on river functioning, river status evaluation and various aspects of river restoration, and to facilitate exchange of experiences on environment-friendly river restoration and maintenance, especially with regard to flood risk management and nature protection. Problems of fish migration in a European perspective, threats, opportunities and also salmons in rivers were discussed.

41st Trout Breeders Conference 13–14 October 2016 Gdynia, Poland

This Conference was dedicated to newest products, technologies and solutions for aquaculture and fishing industry. During the Conference such aspect as: fishing equipment, machinery, devices, cleaning products, fish tanks and many others used in aquaculture were discussed. It was a great opportunity for industry representatives to establish nu-

merous contacts, solve many problems of trout aquaculture and summary regulations in aquaculture legislation.

8th International Sturgeon Conference 23 November 2016 Warsaw, Poland

Sturgeon farmers, producers, scientists and organizational representatives from all over the world were present in Warsaw during International Sturgeon Conference. The event provided a unique opportunity to meet, talk and solve problems concerning sturgeon production. The 8th International Sturgeon Conference was a forum for exchanging practical knowledge.

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Portugal

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CCMAR - Centre of Marine Sciences, CIBIO - Research Centre in Biodiversity and Genetic Resources, EMEPC - Task Group for the Extension of the Continental Shelf, IPMA - Portuguese Institute for Sea and Atmosphere, CESAM - Centre for Environmental and Marine Studies

Overview

A list of 153 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems and there were ten new additions to the 2016 report. Five new bryozoan NIS species (*Bugula neritina, Bugullina simples, Celleporaria inaudita, Parasmittina alba* and *Parasmitina multiaviculata*) were added to the list for the Madeira islands. Two new polychaete (*Prionospio pulchra* and *Pseudopolydora paucibranchiata*) and one tunicate (*Molgula manhattensis*) NIS previously overlooked were reported in the Tagus estuary and Ria de Aveiro. The isopod *Paracerceis sculpta* was registered in the Azores islands. The nudibranch *Tenellia adspersa* was a new record for Portugal, registered at the Guadiana estuary. The weakfish (*Cynoscion regalis*) was registered at the Sado and at the Guadiana estuaries. The common two-banded seabream (*Diplodus vulgaris*) was registered for the Azores islands. Cryptogenic species are not included. Portugal has a law on introduction of non-indigenous species, published in 1999, which is currently under revision and a list of invasive marine species is included in the submitted document, which is not published yet. Surveys conducted recently in the aim of ongoing projects that address NIS confirmed the establishment of several species previously recorded, including the Manila clam (*Ruditapes philippinarum*) and the soft-shell clam (*Mya arenaria*), different bryozoans (*Watersipora subtorquata*, *Ticellaria inopinata* and *Bugula neritina*), tunicates (*Styela plicata*, *Styela clava*, *Microcosmus squamiger* and *Botrylloides violaceus*) and the chinese mitten crab (*Eriocheir sinensis)*. An effort to raise awareness and provide knowledge about non indigenous marine species and the implications of their spread in mainland Portugal, has been made through the EEA financed projects: BioMar PT and SOPHIA.

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

There are no new regulations.

Decree-law 565/99, 21th December 1999, defines the legal restrictions to the introduction of exotic species (marine species are not listed). Although this decree has been under

revision since 2009, in 2016 the lists of non-indigenous species were revised again and included invasive marine species. It has not been published yet.

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 151 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems. New additions to the 2016 report are listed in Table 1. New additions for Portuguese mainland and Azores and Madeira islands were considered separately. Possible introduction vectors were indicated based on the life cycle of the introduced species and the presence of known introduction vectors at locations where it was registered. New records were registered mainly for the Madeira, Sado, Tagus and Guadiana estuaries, as a result of revisions of specimens collected previously and recent surveys carried out in the islands and mainland Portugal.

Macrophytes

Spartina patens (Gramineae) is an American coastal grass which grows in a wide range of coastal habitats in its native area. It was recorded for the Iberian Peninsula in 1999 (SanLéon *et al.*, 1999) although it was probably introduced a long time ago. Those authors indicated its occurrence at Ria de Aveiro, Tagus estuary, Sado estuary, Ria Formosa. Duarte *et al.* (2015) confirmed its high abundance at the Tagus estuary and a recent study indicates that the introduction occurred in the end of the 19th and at the beginning of the 20th centuries, but it has been identified as *Spartina versicolor* Fabre (Baumel *et al.*, 2016). Its presence was recently visually confirmed also in other Atlantic coastal transitional systems (Ria de Aveiro, Lagoa de Óbidos, Douro and Mira estuaries), although its genetic identity was not confirmed as it was done for Tagus estuary (unpublished data). *S. patens* is also reported in the Azores, where its invasive character is not clear, however the Azorean specimens taxonomic identity should be studied under this recent context.

Hydrozoa

Cordylophora caspia (Pallas, 1771), this species was firstly recorded in the Tagus estuary in 2007, with an established population (Conde *et al.*, 2013). In 2015 and in 2016 it was recorded further south in the Guadiana estuary (Seyer *et al.* subm)

Polychaetes

Polychaetes of the family Spionidae have been recorded in monitoring projects conducted at the Tagus estuary but its identification was overlooked. A recent revision indicated the occurrence of the NIS *Prionospio pulchra* and *Pseudopolydora paucibranchiata* in the Tagus estuary (Silva, G. pers. *comm.*).

Bryozoans and Tunicates

The number of marine NIS inventoried for the Madeira island system has increased in recent times due to on-going monitoring assessments, with a particular emphasis on marinas and harbor environments (Canning-Clode *et al.* 2013). One of the most representative taxonomic groups detected in these surveys has been bryozoans with several new records discovered each year (Wirtz and Canning-Clode, 2009; Ramalhosa *et al.*, 2016;

Souto *et al.*, 2016), including previously un-described species for both Madeira Island (Souto *et al.*, 2015) and Porto Santo Island (Souto *et al.*, 2016). These new findings include *Bugula neritina* and *Bugulina simplex* for Porto Santo Island; *Celleporaria inaudita* for Madeira Island (Canning-Clode *et al.* 2013 were not totally confident about this record in 2013, but is now confirmed); *Parasmittina alba* for both Islands; and finally *Parasmitina multiaviculata* sp. nov. for the island of Porto Santo.

Surveys conducted by MARE - Marine and Environmental Sciences Centre and the Task Group for the Extension of the Continental Shelf (EMEPC), in the aim of ongoing projects, confirmed the dominance of a several species of bryozoans and tunicates in recreational marinas and harbor areas. The bryozoans *Watersipora subtorquata*, *Ticellaria inopinata* and *Bugula neritina* have been identified in samples collected along the estuarine gradient, indicating a high salinity tolerance. The tunicates *Styela plicata*, *Styela clava*, *Microcosmus squamiger* and *Botrylloides violaceus* were the most abundant, but its occurrence was restricted to higher salinity areas (Ramos-Esplá *et al.*, 2016). *Molgula manhattensis* was reported for the first time for Portugal at Ria de Aveiro in 2002 (Rodrigues, 2004), but its high abundance at the Tagus estuary was confirmed recently.

Molluscs

Ruditapes philippinarum

The Manila clam was introduced in Portugal in 1984 and currently has established populations in three estuarine systems (Ria de Aveiro, Tagus estuary and Sado estuary), two coastal lagoons (Óbidos and Albufeira lagoons) and the Ria Formosa coastal area. It was recently identified at the Mondego estuary and its abundance seems to be increasing in most of the systems were it was introduced. Recent surveys at the Sado estuary indicated that it's the 4th dominant bivalve and it is more abundant than the native species *Ruditapes decussatus* (unpublished data).

Populations of the Manila clam do not have a monitoring program and its harvesting it's only regulated at the Tagus estuary. Anecdotal evidence had been provided by harvester indicating that there is a decrease on the abundances of the Tagus estuary population, which has increased its commercial value.

A recent study on contamination by metals and metalloids indicated high accumulation by *R. philippinarum* at some areas of the Tagus estuary (Velez *et al.*, 2016).

Mya arenaria

This species was firstly recorded in the Tagus estuary in 2007, but it was identified at the Sado estuary in 2016.

Tenellia adspersa (Nordmann, 1845)

This species was recorded together with Cordyolophora caspia (Seyer, 2016) in Foz de Odeleite in the middle area of Guadiana estuary.

Crustaceans

Eriocheir sinensis

The Chinese mitten crab has been continually registered at the Tagus river basin, revealing a very abundant population, with a broad distribution along its mainstem and main

tributaries in lower Tagus (Ribeiro, F. pers. *comm.*). Its dispersion is only constrained by the presence of high dams upstream. A study conducted on polish and Portuguese populations showed that this species ingests plastic particles, including fragments of fishing gears (Wójcik-Fudalewska *et al.*, 2016).

Fishes

The weakfish *Cynoscion regalis* (Bloch & Schneider, 1801) was registered for the first time in the Guadiana estuary, near the international bridge (Morais & Teodósio, 2016).

The weakfish was initially captured in 2014 in the Sado estuary based on recreational fishermen online fora (Morais & Teodósio, 2016). In fact, weakfish was recently confirmed in the Sado estuary using morphology and molecular data (Béarez *et al.* 2016). According with Morais & Teodósio (2016), the probable arrival date of weakfish was 2012, considering the age of the collected fish, via ballast water (Morais & Teodósio, 2016).

Table 1. List of new NIS registered in Portuguese waters in 2016–2017.

Taxa	Year of first record	Location of first record	Possible introduction vector	Invasion Status	References
Bugula neritina (Linnaeus, 1758)	2012	Porto Santo	Hull fouling	Unknown	Ramalhosa *et al.* 2016
Bugulina simplex (Hincks, 1886)	2013	Porto Santo	Hull fouling	Unknown	Ramalhosa *et al.* 2016
Celleporaria inaudita Tilbrook, Hayward & Gordon, 2001	2014	Madeira	Hull fouling	Unknown	Souto *et al.* 2016
Cynoscion regalis (Bloch & Schneider, 1801)	2015 2016	Sado estuary Guadiana estuary	Ballast water	Unknown	Béarez *et al.*, 2016 Morais & Teodósio, 2016
Diplodus vulgaris (Geoffroy Saint-Hillaire, 1817)	1997	Faial, Azores	Unknown	Established	Afonso *et al.* 2013
Molgula gr. manhattensis (De Kay, 1843)	2002 2016	Ria de Aveiro Tagus estuary	Hull fouling	Unknown	Rodrigues, 2004 Ramos-Esplá *et al.*, 2016
Paracerceis sculpta (Holmes, 1904)	2014	Ponta Delgada, Azores	Hull fouling	Unknown	Marchini *et al.* (*in press*)
Parasmittina alba Ramalho, Muricy & Taylor, 2011	2014	Madeira and Porto Santo	Hull fouling	Unknown	Souto *et al.* 2016
Parasmitina multiaviculata sp. nov.	2014	Porto Santo	Hull fouling	Unknown	Souto *et al.* 2016
Prionospio pulchra Imajima, 1990	2012	Tagus estuary	Ballast water	Established	G. Silva (*com pess.*)
Pseudopolydora paucibranchiata (Okuda, 1937)	2005	Tagus estuary	Ballast water	Established	G. Silva (*com pess.*)
Tenellia adspersa Nordmann, 1845)	2016	Guadiana estuary	Unkown (probable fouling with *C. caspia*)	Unknown	Seyer (2016)

5. Meetings and projects

Meetings

Canning-Clode, J. 2016. Biological invasions in the sea: vectors, impacts, predictions and the way to move forward. Invasive Alien Species Event in the European Parliament hosted by MEP Pavel Poc & MEP Ricardo Serrão Santos. November 10, 2016. European Parliament, Brussels, Belgium. (Invited speaker).

Canning-Clode, J. 2016. Biological invasions in the sea: lessons from offshore islands and on climate change. GEOMAR Helmholtz Centre for Ocean Research Kiel. 12th October, Kiel, Germany. (Invited seminar).

Canning-Clode, J., Chainho, P., Marques, T., Haroun, R., Fofonoff, P., McCann, L., Carlton, J.T., Ruiz, G., Santos, R.S. 2016. Marine invasions in offshore islands – a perspective from the Macaronesia region. Island Biology 2016 - II International Conference on Island Evolution, Ecology, and Conservation. 18–22 July 2016, University of the Azores at Angra do Heroísmo, Terceira Island, Azores, Portugal. Abstract book, page 122.

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Chiesa S. 2016. Production, risk assessment and genetic diversity of Manila clam in Italy and Portugal: challenges for a sustainable exploitation. Invited speaker at the Workshop "Emerging and Novel Inshore Fisheries: Research and Management" organized by the Bournemouth University, 17th May, 2016, Bournemouth, UK.

Gestoso, I., Ramalhosa, P., Oliveira, P., Canning-Clode, J. 2016. Marine protected areas as biotic resistance hot-spots against non-indigenous species invasions. Island Biology 2016 - II International Conference on Island Evolution, Ecology, and Conservation. 18–22 July 2016, University of the Azores at Angra do Heroísmo, Terceira Island, Azores, Portugal. Abstract book, page 124.

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Santos, R., A. Ferreira, J. Micael, A. Costa, M. Gil-Rodriguez, M. Machin, D. Gabriel & M. Parente 2016 Barcoding non-indigenous macroalgae in the Azores. 9th International Conference on Marine Bioinvasions, Sydney, Australia 19–21 January p. 79 (poster communication)

Seyer, T. 2016. The effect of freshwater pulse on survival and dispersal of non native *Cordylophora caspia* (Hydrozoa): biological and modeling approach. Master en Océanographie, à finalité approfondie. Universitié de Liége (surpervision Flavio Martins & Maria Alexandra Teodósio, Algarve University). 55 p.

Seyer, T., Morais P., Leitão, F., Martins, F., Teodósio, MA (in review). On presence of the Ponto-Caspian hydrozoan *Cordylophora caspia* (Pallas, 1771) in an Iberian estuary: highlights on the introduction vectors and invasion routes. BIR17–019.BioInvasions Records, Rapid Communication.

Velez, C., E. Figueira, A.M.V.M. Soares, & R. Freitas. 2016. Tolerance of native and introduced species to combined effects of ocean acidification and arsenic. New European Society for Comparative Physiology and Biochemistry. 30th ESCPB Congress. 4 - 7 de September 2016.

Velez, C., E. Figueira, A.M.V.M. Soares, & R. Freitas. 2016. Seawater acidification and salinity effects on physiological and biological performance of introduced clam *R. philippinarum.* New European Society for Comparative Physiology and Biochemistry. 30th ESCPB Congress. 4 - 7 de September 2016.

Projects:

- 2015/2016 - BioMar PT - Get to know the marine environment of Portugal.

  An effort to raise awareness and provide knowledge about non indigenous marine species and the implications of their spread in mainland Portugal, has been made through the EEA financed project BioMar PT (Get to know the marine environment of Portugal), developed by IPMA (Promoter), CIIMAR and EMEPC, which provided free training coursers in priority areas for the MSFD implementation. From 2015 to 2016, courses and identification guides were provided on non indigenous macroalgae, tunicates, molluscs, bryozoans and crustaceans. The guides are available at http://biomarpt.ipma.pt/.

- 2015/2016. SOPHIA – Marine Environment literacy platform. Program PT02 – Integrated management for marine and coastal waters. Developed by the Marine and Environmental Sciences Centre (MARE), DGRM - Direção Geral de Recursos Naturais, Segurança e Serviços Marítimos, IDL and Higher School of Communication and Media Studies. Funded by EEA Grants. Training on the contents and methods for implementation of the Marine Strategy Framework Directive were provided for public and private entities that might be engaged in the implementation process. Guides are provided for key issues of the MSFD implementation (https://www.sophia-mar.pt/en/formacoes).

- 2015–2017 – PIMA Programa de implementação da Diretiva-Quadro Estratégia Marinha – Programa Invasoras Marinhas nos Açores (Regional Programme for the Implementation of the Marine Strategy Framework Directive - Marine Invasive Species Program in the Azores).
- 2016–2019: Haroum R, Abramic A, Andrade C, Gestoso I, Canning-Clode J *et al.* Bases para la PLAnificación Sostenible de áreas marinas en la Macaronesia (PLASMAR). Programa INTERREG MAC 2014–2020.
- 2016–2019: Perez R, Assunção P, Kaufmann M, Gestoso I, Canning-Clode J *et al.* Seguimiento, control y mitigación de proliferaciones de organismos marinos asociadas a perturbaciones humanas y cambio climático en la Región Macaronésica (MIMAR). Programa INTERREG MAC 2014–2020.

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 was submitted to the national authority coordinating the MSFD implementation and awaits funding.

6. Publications

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Chiesa, S., P. Chainho & F. Ruano. 2016. Country report from Portugal. Bulletin of Japan Fisheries Research and Education Agency. 42:121—123.

Chiesa S., Lucentini L., Freitas R., Nonnis Marzano F., Breda S., Figueira E., Caill-Milly N., Herbert R., Soares A.M.V.M., Argese E. 2017. A history of invasion: COI phylogeny of Manila clam Ruditapes philippinarum in Europe. Fisheries Research, 186, 25–35.

Costa, P.R., J.C. Martins & P. Chainho. 2017. Impact of invasions on water quality in marine and freshwater environments. In Impact of Biological Invasions on Ecosystem Services. Springer Invading Nature series, Daniel Simberloff (Ed), 12: 221–234.

Freitas, R., L. Salamanca, C. Velez, F.J. Wrona, A.M.V.M. Soares & E. Figueira. 2016. Multiple stressors in estuarine waters: effects of arsenic and salinity on *Ruditapes philippinarum*. Science of the Total Environment 541:1106–1114.

Gillon, A., A. Costa J. Micael 2016 *Caprella scaura* Templeton, 1836: an invasive caprellid new to the Azores Arquipélago. Marine Biodiversity doi:10.1007/s12526–016–0485–2

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Morais, P., M.P. Parra, R. Marques, J. Cruz, M.M. Angélico, P. Chainho, J.L. Costa, A.B. Barbosa & M.A. Teodósio. 2015. What are jellyfish really eating to support high ecophysiological condition? Journal of Plankton Research 37: 1036–1041. doi: 10.1093/plankt/fbv044.

Morais, P, M.A. Teodósio (2016) The transatlantic introduction of weakfish Cynoscion regalis (Bloch & Schneider, 1801) (Sciaenidae, Pisces) into Europe BioInvasions Records, 5 (4) 259–265, DOI: http://dx.doi.org/10.3391/bir.2016.5.4.11

Ramalhosa, P., Souto, J. & Canning-Clode, J. 2016. Diversity of Bugulidae (Bryozoa, Cheilostomata) colonizing artificial substrates in the Madeira Archipelago (NE Atlantic Ocean) Helgoland Marine Research, (), 1–20 (DOI:10.1186/s10152–016–0465–8)

Souto, J., Ramalhosa, P. & Canning-Clode, J. (2016). Three non-indigenous species from Madeira harbors, including a new species of *Parasmittina* (Bryozoa). Marine Biodiversity doi:10.1007/s12526–016–0592–0

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Rodrigues, C. 2004. Caracterização sazonal de uma praia estuarina da Ria de Aveiro: estrutura da comunidade e relações tróficas de espécies selecionadas. Ms.C thesis. University of Aveiro, 85p.

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Overview

Two new species were discovered in Sweden during 2016: the crab *Hemigrapsus takanoi*, in Skagerrak and the North American mussel *Rangia cuneata* in Bråviken (Baltic Sea). The first observation of zebra mussel *Dreissena polymorpha* in Bråviken occurred in 2008, not in 2012 as earlier reported. Unlike the official record of *Grandidierella japonica,* in Öresund in 2014, this amphipod was virtually discovered in samples collected during 2010. There

has been an increasing number of observations on the occurrence of Japanese shore crab *Hemigrapsus sanguineus* and American lobster, *Homarus americanus* in Sweden during 2016.

Pacific oyster *Crassostera gigas* is expanding its distribution southwards and round goby, *Neogobius melanostomus,* is still spreading in the Baltic Sea.

Content:

1. Regulations and policies

Several new actions have been undertaken by the Swedish Agency of Marine and Water Management (SwAM):

- Updating on web information and factsheets on alien species.
- Development of management plan for round goby (published in 2017).
- Risk assessment of the American lobster (approved by the EU commission IAS scientific forum in September 2016).
- Screening of alien species – first step in preparation on national risk assessment of invasive alien species.
- Proposal of a national regulation on invasive alien species – prepared by the Swedish Environmental Protection Agency in joint consultation with SwAM (will come into force in 2017).
- On the behalf of SwAM, a test and evaluation was conducted of a new monitoring protocol of alien aquatic species in harbours and vulnerable areas. This is in accordance with the needs of monitoring and assessment of good environmental status for descriptor D2 Non-indigenous Species of the Marine Strategy Framework Directive. The national sampling protocol has been developed in alignment with the Helcom ALIEN 2 project where regional monitoring program were developed for port surveys when applying for exemptions from applying ballast water management according International Convention for the Control and Management of Ships' Ballast Water and Sediments.

  A draft of the Swedish monitoring protocol was tested in second biggest harbour of Sweden, Port of Brofjorden, on the west coast. This was a continuation of the first test in the Port of Gothenburg in 2014. A total of 365 species were recorded. Five of these were considered as alien (Helcom and Ospar's Target Species List) to Swedish waters: the American comb jellyfish *Mnemiopsis leidyi*, the dinoflagellate *Karenia mikimotoi*, the red algae *Dasysiphonia japonica*, the Japanese oyster *Crassostrea gigas* and the bay barnacle *Amphibalanus improvises*.
  The results from the evaluation will contribute to improvements for a more efficient monitoring protocol that will be tested during 2017 in other Swedish ports.

EU implementing regulation:

- COMMISSION IMPLEMENTING REGULATION (EU) 2016/1141 of 13 July 2016 adopting a list of invasive alien species of Union concern pursuant to Regulation (EU) No 1143/2014 of the European Parliament and of the Council[5]

[5] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1141&from=EN

2. Intentional

No information.

3. Unintentional

New Sightings

The crab *Hemigrapsus takanoi*, has been sighted in Fiskebäckskil in Skagerrak; one small (1.5 cm) male was reported on May 20, 2016 (N 58.248352, E 11.439560) (Västerhavet 2016), another sighting was made on August 1, 2016 of a newly settled specimen (5mm across carapace) in Bovallstrand (N 58.487019, E 11.310575), 25 km north of the first sighting (Matz Berggren pers. com.).

The North American clam *Rangia cuneata* was discovered in Svensksundsviken, a marine reserve in Bråviken, the Baltic Sea, during an investigation on the 20th August and 15th September 2016 (within a range of (N 58.591692 – 58.616689, E 16.391848 – 16.428803) (Von Proschewitzs, 2017). It has probably spread by ballast water from other invaded areas in the Baltic Sea.

Previous Sightings

It has been revealed that the first observation of *Dreissena polymorpha* in Bråviken was already in 2008 and not in 2012 as earlier reported (Qvarfordt & Borgiel 2009). Likewise the official record of *Grandidirella japonica* in the Sound strait (Öresund) in 2014 was actually made on samples from 2010 (Berggren 2015; Matz Berggren pers. com). Two individuals of *G. japonica* (one male and one female) were also observed at a station on the Göta river (RT90: N 6404483, E 1270472) on the 16th June 2016.

Range expansions

Another individual of the Japanese shore crab *Hemigrapsus sanguineus* was caught 5th of April in the artificially heated cooling water from the nuclear power plant south of Gothenburg in Kattegat (Ringhalsrapporten, unpubl.). Moreover, three individuals of *H. sanguineus* were found on the 24th July (N 57.69037, E 11.63459) (Daniel Johnsson pers. com.), the 25th July (N 57.69037, E 11.63459) (Daniel Johnsson pers. com.), and the 3rd August (N 57.92575, E 11.50759) 2016 (Olof Dahl pers. com.), respectively. Later during 2016, two more individuals were caught close to Gothenburg: one individual 30 km north of Gothenburg and two individuals in Lysekil, 70 km north of Gothenburg (Matz Berggren pers. com). So far, a total of 12 individuals have been found in both the Kattegat and the Skagerrak with a peak of 8 individuals in 2016.

The Pacific oyster *Crassostera gigas* is expanding its range southwards and has now been found in Laholmsbukten/Skälderviken close to the Sound but still in the Kattegat (Jonas M. Gustafsson County board of Skåne).

During 2016, 3 new American lobsters, *Homarus americanus*, were found in the Skagerrak. In addition, an individual of *H. americanus* was found among samples collected during 2015, which was located in a fisher's freezer. All of these individuals have been confirmed by genetic analysis to be *Homarus americanus*. Hence, a total of 36 American lobsters have been verified in Sweden. Their origin is probably escapees from the food industry holding live specimens (Vidar Öresland, Swedish University of Agricultural Sciences (SLU) pers. comm.).

The round goby, *Neogobius melanostomus*, is continuing expanding its range in the Baltic Sea now commonly occurring from the site of first introduction in Karlskrona eastwards along the coast through Kalmar strait and up to Oskarshamn then a gap to the findings in Bråviken and the northernmost findings at Muskö, south of Stockholm. It is also common in several harbors around Gotland. So far, there are no confirmed findings in the Sound or at the west coast apart from close to Gothenburg (A.-B. Florin, SLU pers. com.).

4. Pathogens

No information

5. Meetings

A round goby meeting organized by SwAM, Linnaeus University, Umeå University and SLU was held 13–14 of June in Kalmar with the dual aim to inform managers and stakeholders on current status of round goby in Sweden as well as discuss potential management actions.

6. Other

7. References and bibliography

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Qvarfordt S. & Borgiel M. 2009. Inventering a vegetation på grunda bottnar i inre Bråviken 2008. Sveriges Vattenekologer AB. Rapport 2009–02–15.

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Västerhavet, aktuellt om miljön i Skagerrak, Kattegat och Öresund, 2016. http://www.havsmiljoinstitutet.se/digitalAssets/1579/1579170_vasterhavet_2016.pdf

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Highlights

Priority marine NNS monitoring and surveillance lists have been finalised by Cefas. Lists include high priority species currently present and those that are considered likely to arrive in the near future. As of April 2016 species on either the monitoring or surveillance lists have been included in regular marine biodiversity monitoring programmes.

UK and OPSAR assessments of marine INNS have been made for the MSFD. These are both based on an indicator developed by Cefas that primarily examines new introductions of marine NNS.

Outcomes of the Marine Pathways Project have now been published and are available in Tidbury *et al.* (2016) (see references for full details). The Marine Pathways Group has been involved in a number of key pieces of work on INNS. These include completion of INNS assessments for OPSAR and UK in accordance with the Marine Strategy Framework Directive (MSFD), biosecurity training and awareness raising and responses to introduction events.

Monitoring and surveillance work continues on a Scottish west coast oyster farm following an outbreak of the carpet sea squirt, *Didemnum vexillum*. A Species Control Agreement is in place and any fouled oysters moved off-site for on-growing at a different location must undergo a freshwater treatment for 24 hours prior to movement. Various additional surveys have taken place along the full shoreline of the loch and within the loch but to date *D. vexillum* has not been observed outwith the farm.

Various biosecurity workshops have been held throughout 2016. These include sessions at Associated British Ports (ABP) in London, Birmingham and Ayr and marinas along the south and east coasts of England.

Annual INNS surveys continued in marinas in Orkney and Shetland and Scottish Natural Heritage undertook a saltmarsh survey.

Range expansions include the carpet sea squirt in Loch Creran, north of Oban, Japanese Wakame in the Firth of Forth and American lobster sightings in Wales and Brighton. Visual records of the comb jelly have also been made, confirming its presence in UK waters. Various fish that have been caught throughout England include a specimen of starlet, an Atlantic and Siberian sturgeon and a European catfish.

Overview

Regulations

There were no new regulations introduced during 2016.

Intentional introductions

Fish

Summaries of imports of salmonid eggs into the UK can be found in Finfish News for England and Wales (https://marinescience.blog.gov.uk/2015/11/06/import-data-fish-fish-eu-england-wales/) and Marine Scotland Science publications for Scotland (www.gov.scot/Topics/marine/Fish-Shellfish/FHI/surveys). UK export statistics are also presented in these publications.

Invertebrates

Summaries of the imports of Pacific oysters to the UK in 2016 are in progress. Currently no data are available.

Unintentional introductions

New sightings –

Invertebrates

Fish

Previous sightings –

Invertebrates

The carpet sea squirt, *Didemnum vexillum*, was confirmed at an oyster farm at Loch Creran in September 2016 (WGS84 Latitude, Longitude: 56.527444, –5.339222). It was however suspected to be present for some time. The invasive seaweed *Undaria pinnatifida* was identified at a marina on the Firth of Forth (WGS84 Latitude, Longitude: 55.993, –3.409) in August 2016.

In July 2016, off the coast of Pwllheli on the Llŷn Peninsula, a north Wales fisherman caught an American lobster *Homarus americanus* – the first confirmed catch in Welsh waters. The Fisherman reported the catch to the Welsh Fishermen's Association and sent the lobster to Natural Resources Wales (NRW) for identification. NRW positively identified the species using the ventral tooth under the rostrum to distinguish the American lobster from its European cousin, *H. gammarus*.

Subsequent to the mass release of American lobsters off the south coast of England in 2015, three egg carrying females have been retrieved from the vicinity in 2016. Molecular analysis was conducted on the egg mass to determine parentage. Two of the females were carrying eggs fertilised from American male lobsters, which could have been via stored sperm received while the animals were still in their native range, but the third female was carrying eggs that had been fertilised by a European male lobster providing evidence of potential hybridisation. These results were validated by colleagues in Norway.

Visual evidence of *M. leidyi* found in UK waters in 2016 – confirming presence of the species previously detected using eDNA methods.

Fish

In January 2016, a specimen of sterlet *Acipenser ruthenus*, said to be about 36 cm long, was captured from Parklands lake, Upminster, Essex, RM14 2EX (WGS84 Latitude, Longitude: 51.542978, 0.244733). On 13 June 2016, an Atlantic sturgeon *Acipenser oxyrinchus* of 190 cm length (weight = 80–100 kg) was reported (D. Pascoe, pers. comm.) captured near Newlyn, Cornwall (Latitude/Longitude: 50°09′34′′N/05°47′06′′W). In September 2016, a Siberian sturgeon *Acipenser baerii* of 12.7 kg and a European catfish *Silurus glanis* of 16.3 kg were captured from the Thames at Chertsey Bridge, London (Latitude/Longitude: 51°23′25.0′′N/0°30′26.7″W) (K.J. Wesley, pers. comm.).

Species not yet reported or observed

Cefas has finalised priority marine NNS monitoring and surveillance lists. These includes high priority species currently present and those that are considered likely to arrive in the near future. These lists are not currently available. As of April 2016 species on either the monitoring or surveillance lists have been included in regular marine biodiversity monitoring programmes. This is part of the continued development of NNS marine monitoring, with further developments being made in 2017.

Pathogens –*Sightings/records*

General information

In 2016, the aquatic invasive species screening kit (AS-ISK), which was released in October 2015 (www.cefas.co.uk/nns/tools/), was described (Copp *et al.* 2016c), with an example assessment of Manila clam *Venerupis philippinarumi.* During 2016, two European applications of AS-ISK were undertaken, in both cases in the form of a comparison of AS-ISK with its predecessor (Glamuzina *et al.* 2017; Tarkan *et al.* 2017), the Fish Invasiveness Screening Kit (summarized in Copp 2013). This new decision-support tool is applicable to all plants and animals from marine, brackish and fresh waters, regardless of climate zone. AS-ISK combines the FISK framework with enhanced protocols derived from the generic risk screening module of ENSARS, the European Non-native Species in Aquaculture Risk Assessment Scheme (Copp *et al.* 2016a, 2016b), which was developed with several WGITMO delegates involved. During the WGITMO meeting in March 2016, several delegates agreed to provide trial assessments of AS-ISK on a range of aquatic organisms with respect to a variety of risk assessment areas in Europe, North America and a few locations further afield (i.e. China, Brazil). The data from these assessments began to be collated in 2016, with analysis and reporting of the outcome anticipated for the WGITMO meeting in March 2017. For further information contact Gordon H. Copp (gordon.copp@cefas.co.uk).

The Marine Pathways Project, which aimed to reduce the risk associated with pathways by which marine invasive non-native species may be introduced into the British Isles, finished in 2015, with the outcomes presented in Tidbury *et al.* (2016). Cefas continues to coordinate the Marine Pathways Group, which is a follow on from the Marine Pathways Project. Since 2015 the Marine Pathways group has taken on a more advisory role, aiding in the development of OSPAR and UK assessments and indicators. The group now functions as an expert group providing technical support and guidance to HBDSEG, while maintaining an overview of and co-ordinating current work in relation to marine INNS. The group aids communication and collaboration between experts in the field of INNS across different organisations and countries. It also offers a platform by which stakeholders can input into INNS work. The Marine pathways group has been involved in a number of key pieces of work on INNS. These include completion of INNS assessments for OPSAR and UK in accordance with the Marine Strategy Framework Directive (MSFD), biosecurity training and awareness raising and responses to introduction events. In November 2016 the group met in London to discuss the MSFD, specifically its requirements and processes and the progress made by the UK towards achieving targets. During the meeting, gaps were identified and potential work programmes to bridge these were identified.

(www.nonnativespecies.org/index.cfm?sectionid=105)
For further information contact Hannah Tidbury (hannah.tidbury@cefas.co.uk) or Paul Stebbing (paul.stebbing@cefas.co.uk).

UK and OPSAR assessments of marine INNS have been made for the MSFD. These are both based on an indicator developed by Cefas which primarily examines new introductions of marine NNS. For more information on the assessments contact Hannah Tidbury (hannah.tidbury@cefas.co.uk) or Paul Stebbing (paul.stebbing@cefas.co.uk).

Cefas has continued in the further development of methods to control invasive species of crayfish. Methods currently being developed include male sterilisation and chemical control, with a PhD student currently conducting field trials on male sterilisation methods. Population level computational modelling simulations are a key element to the process of examining the effectiveness of control methods over long time periods without the need for lengthy and expensive field trials. A long term trapping study, which, in part, was used to validate the population models has finished with the final report currently being peer reviewed and will be available shortly. For further information contact Paul Stebbing (paul.stebbing@cefas.co.uk).

A PhD student supervised by Alison Dunn (Leeds University) and Paul Stebbing (Cefas) is examining perceptions and attitudes towards biosecurity amongst stakeholders, with the aim of identifying means to encourage best practice. For further information contact Paul Stebbing (paul.stebbing@cefas.co.uk).

Research and development of molecular tools continues at Cefas for the detection of non-native species, in particular the use of environmental DNA (e-DNA) and substratum scrapes. The eDNA approach (Davison *et al.* 2016) has been applied to assess to efficacy of an attempt to eradicate topmouth gudgeon (*Pseudorasbora parva*) from an angling pond in southeastern England (Davison *et al.* 2017). Using a robust sampling protocol, eDNA analysis of water samples from the pond revealed that topmouth gudgeon was still present, and subsequent intensive trapping at the detection locations revealed a small number of specimens. Marine work has focused on the detection of target species relevant to the MSFD and WFD, and methods have been field validated. The marine-based DNA analysis of substratum scraps is continuing, and the work on inland still waters will be expanded in April 2016 to include the detection of non-native freshwater and diadromous fishes in running waters. For further information on the detection of marine species, contact Paul Stebbing (paul.stebbing@cefas.co.uk) and for freshwater and diadromous fishes contact Gordon H. Copp (gordon.copp@cefas.co.uk).

A *Didemnum vexillum* outbreak at an oyster farm on the west coast of Scotland continues to be monitored by Marine Scotland and the Scottish Working Group on Marine Invasive Non-Native Species. Molecular sequencing from collected samples on the farm confirmed the identification. To date it has been observed growing on oyster shells and seaweed that is fouling the oyster trestles. Various surveys were carried out during 2016 including the oyster farm, shoreline surrounding the farm, shorelines around the loch, dive surveys with the loch and a RIB survey of floating structures within the loch. To date it has only been observed growing within the oyster farm. A literature review of treatment methods for eradicating *D. vexillum* from shellfish was undertaken and currently a freshwater bath treatment of all fouled oyster shells must take place before any movement of oysters off the farm that are to be used for on-growing at other locations. A Species Control Agreement detailing this is currently in place. Monitoring and surveillance of both the farm and loch will be on-going and will be coordinated through the Working Group. The Science division of Marine Scotland has recently had a new invasive species project approved, to start at the beginning of April. This will be developed further over the coming weeks. For further information contact Lyndsay Brown (lyndsay.brown@gov.scot).

In September 2016, Japanese Wakame, *Undaria pinnatifida*, was observed at a marina in the Firth of Forth, by Scottish Environment Protection Agency staff during routine work,

where it was seen fouling the pontoons. Although present in the rest of the UK (Humber Estuary, Wyre Estuary, Isle of Man and the previous most northerly record of Carrickfergus in Northern Ireland) this is the first record for Scotland. Given that the *U. pinnatifida* strands were of different growth stages and showing reproductive fronds it is confirmed that the seaweed is established and breeding at this site. The pathway to the Firth of Forth has yet to be confirmed, but it has been noted that barges and construction traffic for the new road bridge are based adjacent to the new *U. pinnatifida* site. Scottish Environment Protection Agency and Marine Scotland staff visited the marina and spoke to the site owners about how to identify it and provided advice on how to remove it from the pontoons and to continue to look out and clear any new growth. They were also encouraged to communicate with yacht owners whose vessels are currently berthed at the marina. For further information contact Janet Khan (janet.khan@sepa.org.uk) or Lyndsay Brown (lyndsay.brown@gov.scot).

Orkney Islands Council is continuing with their annual marine non-native species monitoring programme. A total of ten non-native species (NNS) have been recorded so far during the 2016 monitoring season (identification of samples will be finished 31 March 2016). Of the ten species identified so far all have been previously recorded in Orkney. In autumn 2016 a non-native species preventative measures assessment was started for Kirkwall and Stromness marinas. The objectives of this study are: (1) Preventing non-natives arriving in the marinas; and (2) Limiting the transference of NNS between vessel hulls (vectors), pontoons and natural habitat. The project aims to explore these two objectives by: Providing a descriptions of the submerged portions of Kirkwall and Stromness marinas; Providing advice on the policies and infrastructure required to improve marina biosecurity with consideration for policies and infrastructure already in place; Providing advice on the 'housekeeping' actions to improve marina biosecurity and help guard against the anthropogenic introduction of new and highly invasive non-native marine species; Providing advice for 'biological emergency' planning, control and eradication measures for invasive non-native marine species located in the marinas with consideration for emergency planning already in place; Providing recommendations for future work including the implementation of future preventative measures. This work is still on-going. For further information contact Jenni Kakkonen (jenni.kakkonen@orkney.gov.uk).

Biosecurity plan training sessions funded by Natural England were delivered by Sarah Brown and Robin Payne at various marinas on the south and east coasts of England. Robin Payne is currently progressing with a report following a Churchill Travelling Fellowship, investigating marine biosecurity in Australia and New Zealand. For further information contact Robin Payne (robin923@btinternet.com).

A Marine Biosecurity Sharing Good Practice event organised and hosted by Scottish Natural Heritage and Scottish Association for Marine Science was held at Dunstaffnage Marine Laboratory in August. 65 participants representing Government, aquaculture industry, marina operators, port authorities and local interests attended. For further information contact Robin Payne (robin923@btinternet.com).

A pilot Pentland Firth and Orkney Waters Marine Spatial Plan has been developed by a working group consisting of Marine Scotland, Orkney Islands Council and Highland Council to pilot the process of regional marine planning in Scotland. The pilot Plan is non statutory and sets out an integrated planning policy framework to guide marine devel-

opment, activities and management decisions, whilst ensuring the quality of the marine environment is protected. One of the general policies within the Plan will deal with invasive non-native species. The Plan was approved in March 2016 and will be used by the three organisations as a material consideration in the determination of relevant marine licences, consents and planning applications. It will also be used to inform the development of the statutory Regional Marine Plan for Orkney. For further information contact Tracy McCollin (tracy.mccollin@gov.scot).

Two PhD studentships are currently underway at the Scottish Association for Marine Science. One is looking at freshwater in particular as a biosecurity control in marinas and INNS legislation for INNS in conjunction with the University of Edinburgh. The second is looking at the probability of offshore floating wind turbines and associated vessels acting as vectors for the transfer of marine INNS in conjunction with Statoil, Environmental Research Institute in Thurso and University of St. Andrews. An extensive rapid assessment survey of marinas throughout Scotland was also undertaken in 2016 and full results of this will be made available shortly. For further information contact Liz Cook (elizabeth.cottier-cook@sams.ac.uk).

Monitoring work is continuing across Shetland and no additional NNS records have been observed. However, a pacific oyster was found growing on a mussel line by a mussel famer in an area previously used to farm pacific oyster (but some years ago), suggesting they are now reproducing in Shetland at lower temperatures than is optimal for the species. The record has just been published in BioIvasions Records (see references). For more information contact Rachel Shucksmith (rachel.shucksmith@uhi.ac.uk)

Meetings

Past year (2016)

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

Canadian Conference for Fisheries Research (St John's, Newfoundland, Canada; 8–10 January 2016) (www1.uwindsor.ca/glier/ccffr/past-programsabstracts).

27th USDA Interagency Research Forum on Invasive Species (Annapolis, Maryland, USA; 12–14 January 2016).

Mississippi River Basin Panel on Aquatic Nuisance Species Meeting (Gulfport, Mississippi, USA; 13–14 January 2016)

9th International Conference on Marine Bioinvasions (Sydney, Australia; 19–21 January 2016)

ICAIS 2016 – 19th International Conference on Aquatic Invasive Species (Winnipeg, Manitoba, Canada; 10–14 April 2016)

13th GB Stakeholder Forum on Non-Native Species (York, England, 8 July 2016).

Freshwater Invasives (FINS-II) – Networking for Strategy (University of Zagreb, Croatia; 11–14 July 2016)

International Society of Limnology (SIL) – Alien species ecological impacts: from genomics to macroecology (Turin, Italy; 31 July – 5 August 2016)

Sharing Good Practice: Marine Biosecurity Workshop (Dunstaffnage Marine Laboratory, Oban, UK; 31 August 2016).

Neobiota 2016 – 9th European Conference on Biological Invasions: "Biological Invasions: interactions with environmental change" (Vianden, Luxembourg; 14–16 September 2016).

Meetings in 2017

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

Canadian Conference for Fisheries Research (Montréal, Canada; 6–8 January 2017)(www.uwindsor.ca/glier/ccffr/).

North American Invasive Species Forum (Savannah, Georgia, USA; 9–11 May 2017)(www.invasivespecies2017.org/)

Island Invasives Conference - Scaling Up to Meet the Challenge (Dundee, Scotland; 10–14 July 2017) (www.islandinvasives2017.com/)

ICAIS 2016 – 20th International Conference on Aquatic Invasive Species (Fort Lauderdale, Florida, USA; 22–26 October 2017)(www.icais.org/)

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United States

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Overview

There were no reports of new non-native species arrivals. A recent paper (Savoie and Saunders, 2015) revealed that *Neosiphonia harveyi* is native to the Northwest Atlantic but that two other species, *N. japonica* and *Polysiphonia akkeshiensis* were present in the samples and not identifiable morphologically. Both are non-native and were present prior to 2007, if the analyses are correct. Ranges of four red alga (*Agardhiella tenera*, *Dasysiphonia japonica*, *Gracilaria vermiculophylla,* and *Grateloupia turuturu*), one shrimp (*Palaemon elegans*), and a toxic form of a scyphozoan (*Gonionemus vertens*) were reported during 2016.

New Regulations

Although they are not regulations, Presidential Executive Orders may support the issues addressed and result in. On December 5, 2015, Executive Order 13751 "Safeguarding the Nation From the Impacts of Invasive Species" addressed previous acts that are intended to prevent the introduction of invasive species and provide for their control, and to minimize the economic, plant, animal, ecological, and human health impacts that invasive species cause. The Executive Order confirms previous orders and retains the National Invasive Species Council definitions, as well as several Federal agencies required to meet quarterly that includes agencies managing invasive species from terrestrial, marine and freshwater ecosystems. It appears to emphasize interagency coordination, impacts to human health and ecosystems, emerging priorities including climate, and integration of new technology along with many of the previous recommendations. Because this is an Executive Order, it can be revoked.

Intentional

None reported.

Unintentional

No new arrivals were reported during this time.

Range Expansion of Previously Reported Species

Ceramium secundatum Lyngbye 1819, Fort Wetherill, Jamestown, Rhode Island 2007. *Ceramium secundatum* (Rhodophyta) is a red alga native to the Northeast Atlantic from Iceland and Norway, to Morocco, and the Mediterranean and Black Seas. Molecular studies of *Ceramium* sp. in East coast waters found a population of *C. secundatum* in Narragansett Bay, in samples collected in 2007 and 2010. The extent on the range of *C. secundatum* on the East coast is unknown. The most common species on the East Coast, *C. virgatum* is widespread in the North Atlantic, from Norway to Canary Islands, and Newfoundland to Virginia (Guiry and Guiry 2016). *Ceramium secundatum*.. It is widely misidentified as *C. rubrum* (Humm 1979; Maggs *et al.* 2002; Van Patten 2006).

Dasysiphonia japonica has become extremely abundantly between Georgia and southern, Maine (albeit the NS record). Locally it is forming massive drift populations within both coastal and estuarine areas from southern MA to southern ME.

Gonionemus vertens A. Agassiz, 1862 (Cnidaria: Hydrozoa) (Clinging Jellyfish, Northwestern Pacific strong-stinging form. New Jersey Shrewsbury River, Manasquan River, Barnegat Bays (2016)/

Gonionemus vertens is a hydrozoan native to North Pacific. It was first reported in Eel Pond, Woods Hole, Massachusetts in 1894, and became abundant in local waters but apparently disappeared after a massive, widespread, Eelgrass (*Zostera marina*) die-off in 1931 (Edwards 1976). Sever stinging was not reported for *G. vertens* from the northeast Pacific, and introduced populations in New England and Europe. Sporadic occurrences were reported on Cape Cod in the 1960s, and 1970s. In the 1990s-2000s, scientists and others working in Cape Cod and Martha's Vineyard, Massachusetts, reported severe stings and health symptoms, including muscle cramps, chest tightness, and swollen throats, and received hospital treatment (Govindarajan and Carman 2015). These were traced to blooms of *G. vertens*. Severe stings are associated with a form of *G. vertens* from the Northwest Pacific, probably introduced to the East Coast of North America.

In June, 2016, several specimens were collected in Shrewsbury River, Manasquan River, and Barnegat Bays were collected (Gaynor *et al.* 2015; Goldman 2016). Genetic barcoding indicated that these specimens were a close match with "*G. vertens*" from China (Gaynor *et al.* 2016). Severe stinging, due to this jellyfish, has not been reported in New Jersey, to our knowledge.

Species of Interest, Status Unknown

Mediopyxis helysia (Bacillariophyta) Kühn, Hargreaves & Halliger 2006. Booth Bay Harbor, Maine 1996.

Mediopyxis helysia is a morphologically distinct diatom, relatively large (~100 um) and chain-forming, discovered in Boothbay Harbor in 1996 (Kuhn *et al.* 2002). It was found in the Wadden Sea, Germany in 2002 (Kuhn *et al.* 2006; Meir *et al.* 2015), and considered a probable introduction. It was found in the Bay of Fundy in 2002 (Martin and LeGresley 2008), Scotland in 2005 (McCollin 2008), Iceland in 2008 (Thorarinsdottir *et al.* 2014). Since 2009–2011, *M. helysia* has become a dominant species in the Wadden Sea (Meir *et al.*

2014). Boothbay Harbor, and the Wadden and North Seas are well-studied waters. In Germany, in particular, diatom studies began in the 19th century, so an appearance of a new distinct species is notable.

Currently, NEMESIS includes 3 planktonic diatoms *Coscinodiscus wailesii*, *Odontella sinensis*, and *Thalassiosira punctigera*, originally known from the Pacific and appeared first in European waters and later in North American coastal waters. *Mediopyxis helysia* would be a cryptogenic or an invader of unknown origin. Ballast water would be the likeliest vector, but there are no reports of being found near major East Coast seaports. This species is distinctive, and has become a prize-winning photo-subject http://www.nikonsmallworld.com/galleries/entry/2012-photomicrography-competition/38 (photo from Germany)]. Nonetheless, local experts have not agreed on whether to call *M. helysia* a new introduction or classify it as cryptogenic (P Fofonoff 2017; J Carlton 2017 pers. comm.).

Neosiphonia harveyi has recently been removed as a non-native species in the Northwest Atlantic and two new species, *Neosiphonia japonica* and *Polysiphonia akkeshiensis* were identified as non-native species. In addition several other species

Neosiphonia japonica Harvey. Fort Wetherill, Jamestown, Rhode Island 2007.The taxonomy and biogeographic status of the *Neosiphonia harveyi* complex has changed drastically in the past two decades. The red alga *Neosiphonia harveyi* (in older literature, *Polysiphonia harveyi*, Choi *et al.* 2001) was described from Connecticut in 1848 (Taylor 1957). Closely related species, *N. japonica* Harvey 1857, and *P. akkeshiensis*, both from Japan, and *P. acuminata* Gardner 1927, from California, were described. Features of cell structure and DNA sequences suggested that these forms constituted a single species of northwest Pacific origin, introduced into the Atlantic Ocean by the early 18th century (Maggs and Stegenga 1999; McIvor *et al.* 2001). However, later work supports the separate status of these three species (Savoie and Saunders 2015).

Neosiphonia japonica is a cryptic invader in the Northwest Atlantic, collected in a molecular survey of the *N. harveyi* species complex in 2007–2012. Five specimens of *N. japonica* were found in two locations at the mouth of Narragansett Bay, at Fort Wetherill, Jamestown, on the East Passage, and Hazard Avenue, Narragansett. (By comparison, 9 specimens of *N. harveyi* were collected at these two locations.) An additional *N. japonica* specimen was found in a GeneBank sequence from North Carolina (Savoie and Sanders 2015). While only a few purebred specimens were found at two locations, internal transcribed spacer (ITS) data suggested more widespread introgression of *N. japonica* genes, with a decreasing frequency of *japonica* genes north of Cape Cod, with some recombinants occurring in the Bay of Fundy and Atlantic Nova Scotia (Savoie and Sanders 2015). Further molecular sampling will be needed to determine the geographical extent and abundance of *N. japonica*. Ballast water and fouling are the most likely vectors of introduction.

Polysiphonia akkeshiensis Segi 1951 (Rhodophyta) Hazard Avenue, Narragansett, Rhode Island 2012.

Polysiphonia akkeshiensis belongs to a tribe (Polysiphoniae) of red algae, with many of morphologically similar species. Genetic and morphological studies suggested that *Polysiphonia akkeshiensis** was conspecific with *N. japonica* and from *N. harveyi*, described from Connecticut in 1848. *Neosiphonia harveyi* was proposed to be an early introduction from

the Atlantic to the Pacific (Maggs and Stegenga 1999; McIvor *et al.* 2001). Recent research indicates that the three species are separate, with *N. harveyi* most likely native to the northwest Atlantic, with *N. japonica*, and *P. akkeshiensis* originating from the North or Northwest Pacific. The situation is complicated by the recent discovery of *N. japonica* in Rhode Island, North Carolina. Spain, and California, and the molecular identification of a specimen of a single specimen of *P. akkeshiensis*, collected in Narragansett RI in 2012 (Savoie and Saunders 2015). In 2012, one specimen of *P. akkeshiensis* was collected in Narragansett RI, near the mouth of Narragansett Bay, and identified by molecular methods (Savoie and Saunders 2015).

Note: **Polysiphonia akkeshiensis* was not included in a study () which transferred some former *Polysiphonia* into the new genus *Neosiphonia*. Its generic position, together with many other *Polysiphonia* need to be re-evaluated (Savoie and Saunders 2015).

Since completing the *Seaweeds of the Northwest Atlantic* manuscript (in winter, 2015) some important new findings have appeared based on molecular studies (Arthur Mathieson pers. comm. 2017).

Using mitochondrial COI-5P and chloroplast rbcL, Griffith *et al.* (2016) reported that the red alga *Champia parvula* in southern New England is genetically distinct and designated the taxa as *Champia farlowii* Griffith *et al.* 2016.

Using DNA barcoding, Morrill and Saunders (2016) documented the presence in the Bay of Fundy of *Ulva fenestrata* that was previously unknown in the NW Atlantic.

Verbrugen *et al.* (2016) employed *tuf*A bar coding and morphometric data and found that *Codium fragile* subsp. *fragile* was probably composed of two distinct taxa. However, they refrained from making any formal taxonomic changes (segregations) because their *tuf*A data did not correspond with previous rps3-*rpl*16 barcoding results (Maggs and Kelly 2007a; Provan *et al.* 2007).

Using cultured isolates and barcoding (COI: cox3) analyses of substratum samples from Baffin island, Canada, Küpper *et al.* (2016) identified the brown alga *Phaeostroma longisetum* (Lund) Petersen and a new *Desmarestia* taxon that is closely related to *D. viridis*.

Further, Küpper *et al.* (2016) found a unique (i.e. cryptic) species of *Dictyosiphon* that was different than any of the above taxa in studies of eastern Canadian Arctic seaweeds.

Not yet seen

Hemigrapsus takanoi (also identified as *Hemigrapsus penicillatus*) has not been reported anywhere in the US. Although present in Europe from 1945 and earlier, *Austrominius modestus* has still not been found in the US.

Emerging Issues

A number of US federal agencies have begun to explore the potential future application of "gene drive" technologies for the control of invasive species. These technologies, mostly based now on the CRISPR-Cas9 system, theoretically enable researchers to rapidly modify entire wild populations or even entire species by introducing genetic elements that exhibit nearly 100% inheritance despite selective disadvantage. The National Acad-

emies of Sciences, Engineering, and Medicine recently published a report, "Gene Drives on the Horizon" that outlines technical, social, and ethical issues related to these technologies. Control of invasive species is one of the most obvious applications of gene drives, and researchers are already exploring the possibilities in terrestrial systems, with a focus on invasive rodents in island ecosystems. However, applications in aquatic systems will almost certainly also be investigated; Momose & Concordet (2016) recently published a review on the use of CRISP/Cas9 in marine organisms. In addition to invasive species control, it is also very likely that these technologies will be explored as means to enhance populations of aquaculture species. In the context of the WGITMO Code of Practice it may thus be worth considering these advances and their implications for both invasive species management and general release of genetically modified organisms in the future.Pathogens

No new marine pathogens were reported.

Meetings

9th International Tunicate Meeting; 17–21 July 2017, New York University; https://2017-tunicate-meeting.bio.nyu.edu/home/presentation-guidelines/

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Annex 5: Presentation Abstracts

ToR a) Advance research, develop collaborations and address surveillance and knowledge gaps in issues related to the introduction and transfer of marine organisms, through annual reviews of national/international activities and responding to advice requests. (See also Annex 4 National Reports)

Development of a Wadden Sea Monitoring Programme for Alien Species

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In 1978, the trilateral Wadden Sea Cooperation (TWSC) was founded by the Netherlands, Germany and Denmark in order to "achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way". In 1982, the "Joint Declaration on the Protection of the Wadden Sea" was signed and updated in 2010. Monitoring and assessment the quality of the Wadden Sea ecosystem in collaboration with national and regional authorities and scientific institutions was identified as a basis for effective protection and management. Therefore, the Trilateral Monitoring and Assessment Programme (TMAP), the common monitoring program for the Wadden Sea, was initiated. The results are published in Quality Status Reports.

In 2011, the three Wadden Sea states decided to develop a common strategy for dealing with alien species in the Wadden Sea. The report "Neobiota in the Wadden Sea" was basis for a strategic framework for dealing with alien species.

In 2014 it was agreed to develop a trilateral alien species management and action plan on the basis of this strategic framework. It should comprise both, the terrestrial and marine environment. Responsible for the development was the Working Group Alien Species (WG-AS). WG-AS initiated a project to develop a proposal for A common Trilateral Monitoring and Assessment Program for Alien Species (Van der Have and Lenselink, 2017).

During a trilateral workshop in November 2016, a group of experts discussed the main components of a monitoring program for alien species based on the project report. The results of the report and the workshop were combined in the proposal for a harmonised monitoring program of alien species in the Trilateral Wadden Sea area.

As guiding principles for the AS monitoring, the following aspects have been identified:

- Instruments have to be appropriate and cost-effective
- Marine and terrestrial habitats are to be considered
- For early detection and rapid response the temporal resolution should be at least once a year
- For high probability of detection, the spatial resolution should concentrate on „hot spots"
- To harmonize the programme, standardized protocols such as HELCOM/OSPAR JHP and extended Rapid Assessment should be used.

Legal frameworks for the management of AS in the Wadden Sea are:

- Trilateral strategic framework for alien species management
- EU Marine Strategy Framework Directive (MSFD)

- EU Water Framework Directive (WFD)
- EU Bird and Habitat Directive/ Natura 2000
- EU Invasive Alien Species Regulation
- IMO Ballast Water Management Convention (BWMC)

Under these frameworks, there are at least partly monitoring activities for non-indigenous species developed or already in place. Necessary resources will be/are provided by the countries. Nevertheless, there are national differences in the implementation of the European Regulations and Directives.

„General" monitoring targeted at e.g.benthos also comprises information on non-indigenous species (NIS) but is i) not frequent enough for early detection and ii) not carried out at hot-spot locations for species introductions like e.g. ports. It doesn't cover all organism groups (e.g. jellyfish, zooplankton), and doesn't cover all habitats in all countries. Infrequent sampling of high-risk (hotspot) areas in the Dutch Wadden Sea, and the absence of high-risk area sampling in the Danish Wadden Sea leads to a low probability of early detection of alien species in the Wadden Sea.

The following recommendations for a harmonized alien species monitoring in the Wadden Sea are based on the above mentioned findings and arguments:

- Monitoring should focus on **introduction hotspots** (e.g. ports, marina's, aquaculture plots) and specific natural hotspots (e.g. oyster reefs) on a **yearly basis**
- Knowledge gathered in national programs should be shared and utilized in the development of a trilateral monitoring program
- The minimum requirement is extended Rapid Assessment (eRAS)
- Innovative methods, such as eDNA, should be explored and developed
- Sharing efforts, knowledge and experiences will enhance and accelerate innovation
- Existing programs and databases (e.g. AquaNIS) should be used to the extent possible
- Communication, update of the trilateral alien species list should be implemented in close cooperation following defined processes by national and the trilateral alien species focal points.

The recommendations are provided to the Trilateral Wadden Sea Board in spring 2017 for approval.

NIS Monitoring system/framework for HELCOM

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Objectives and aims. Several legal and administrative instruments aimed to reduce the spread of potentially harmful non-indigenous species (NIS) were developed at international and national levels, such as the International Convention for the Control and Management of Ship's Ballast Water and Sediments (2004); the ICES Code of Practice on the Introductions and Transfers of Marine Organisms (2005); the EC Regulation on Invasive Alien Species (2014) and the Marine Strategy Framework Directive (2008). At the regional scale, the HELCOM Baltic Sea Action Plan (BSAP) sets the environmental management

objective "…No introductions of alien species from ships…" (HELCOM, 2007). The only possible way to measure the effectiveness of the above-mentioned legal and administrative instruments is a regionally harmonized, scientifically based NIS monitoring program).

The main aims of NIS monitoring program are: 1) early detection of NIS in high-risk invasion areas and dispersal hubs, along with determination of the pathways and vectors involved; 2) assessment of new arrivals at different geographical scales, from a country coast within the Baltic Sea to the entire sea basin, and even to a larger biogeographical scale (Baltic and the North seas together); 3) determination of spread and rate of expansion of established NIS, along with evaluation of the long-term trend of NIS population abundance/biomass; 4) evaluation of environmental effects of NIS on the structure and function in the invaded ecosystems.

Methods for the integrated NIS monitoring program. The NIS monitoring program should integrate all types of surveys and approaches, which may provide information on NIS findings, establishment and spread, including routine HELCOM biological monitoring (HELCOM COMBINE) and Port Biological Baseline Surveys (HELCOM/OSPAR). The proposal (HELCOM, 2016) considers opportunities to use various methods and approaches for the purpose of the NIS monitoring program, such as: HELCOM coastal fish monitoring; Baltic International Trawl Surveys; young fish and gill-net surveys; ornithological surveys; underwater habitat mapping programs; rapid assessment survey; biological monitoring of marine protection areas; environmental DNA assessment (molecular methods); involvement of citizen science and biopollution level index.

Data reporting, storage and analysis. A centralized database is the key element of the proposed integrated NIS monitoring system. There is little value in monitoring NIS unless the knowledge obtained is timely and can be directly used by research and management. It is recommended to use AquaNIS, the Information system on Aquatic Non-Indigenous and Cryptogenic Species for the integrated NIS monitoring program.

Reference

HELCOM 2016. Proposal for an integrated HELCOM NIS monitoring programme. Baltic Marine Environment Protection Commission, Working Group on the State of the Environment and Nature Conservation. Document code 5J-X. Submitted by Lithuania, Estonia and Finland. Tallinn, Estonia, 7–11 November, 2016.

Global Applications of AS-ISK to Identify Potentially Inasive Aquatic Species

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Risk-based identification and assessment of non-native species is an essential process for the implementation of legislation and regulatory controls to manage invasive species and avoid or mitigate their adverse impacts. This process is facilitated by electronic decision-support tools, such as the recently-released "Aquatic Species Invasiveness Screening Kit" (AS-ISK), which is available for free download at: www.cefas.co.uk/nns/tools/. This new decision-support tool is applicable to virtually all climatic zones and all aquatic plants and animals regardless of ecosystem, and it is compliant with the 'minimum requirements' for use with the new EU Regulation on invasive alien species of EU concern; this includes questions that require the assessor to evaluate the potential impact of predicted future climate conditions on the risk assessment. Contributing to the WGITMO terms of

reference, the study involved 36 assessors, including delegates from several ICES countries as well as other non-WGITMO scientists from four continents (Asia, Europe, North America and South America). AS-ISK was applied across various taxonomic groups of non-native aquatic organisms for 28 risk assessment (RA) areas. This study comprised two assessment groups. Firstly, single or duplicate assessments were undertaken of a wide range of aquatic species (27 freshwater, 9 brackish, 14 marine) that are not native to the RA areas selected by the assessors, including species and RA areas in. Basic AS-ISK scores ranged from –5.5 to 55 (mean = 22.7), but when the likely influence of climate change on the assessments was considered, the Climate Change Assessment scores ranged from –9.0 to 67 (mean = 27.4). Secondly, multiple assessments were undertaken of the Manila clam *Ruditapes philippinarum* for RA areas across the globe. Basic AS-ISK scores for Manila clam ranged from –18.0 to 42.5 (mean = 36.6), with Climate Change Assessment scores ranging from 18.0 to 52.5 (mean = 41.6). The study outcomes will provide a basis upon which to consider the use of AS-ISK for identifying which non-native species require full risk assessment and thus assist and inform decision makers and environmental managers in the allocation of increasingly scarce resources in the battle against invasive species.

ToR b) Evaluate the impact climate change may have on the introduce tion and spread of non-indigenous marine organisms, including the Arctic environments.

eDNA Metabarcoding as a New Surveillance Tool for Coastal Arctic Biodiversity

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Aim. Because significant global changes are currently underway in the Arctic, creating a large-scale standardized biodiversity database for Arctic marine biodiversity is particularly pressing. Environmental DNA (eDNA) metabarcoding, which involves less challenging and intrusive field methods than classical marine monitoring method, could be a revolutionary tool for overcoming the lack of extensive biodiversity data. However, eDNA metabarcoding from metazoans has mainly been used in freshwater systems and its efficacy for detecting biodiversity shift needs to be evaluated in other ecosystems. Our goal was to evaluate the potential of eDNA metabarcoding in assisting with sustainable development in coastal areas of the Canadian Arctic by generating new biodiversity monitoring tools for the marine ecosystem.
Location. Two Arctic Canadian ports: Churchill and Iqaluit.
Methods. The eDNA was extracted from ~80 water samples per port and amplified using two COI primer pairs. We: (i) evaluated the efficacy of eDNA metabarcoding to assess coastal biodiversity in Arctic commercial ports, (ii) contrasted community structure among sampling locations (i.e. water column depths and tide pools) and (iii) evaluated seasonal variability for the same sampling locations.
Results. We successfully used eDNA metabarcoding of water samples to monitor coastal metazoan species in the Arctic. We showed that eDNA is spatially and temporally heterogeneous within ports and that the efficiency of the eDNA monitoring surveillance is improved when sampling under-ice cover.
Main conclusions. By allowing rapid sample collection by inexperienced or novice individuals, reducing the cost associated with data collection/shipping and reducing manipu-

lation of organisms, the analysis of eDNA from water samples could be a revolutionary tool to increase the power of detection, spatial coverage and frequency of sampling, thus improving detection of biodiversity shifts in large coastal Arctic ecosystems.

Evaluating Risks Associated with Ballast Water Release by Domestic Vessels Transiting to Canadian Arctic waters

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Although regulations exist for international ships, domestic vessels navigating between Canadian ports are currently exempt from ballast water management regulations. Currently, much of the domestic ballast released in the Arctic is brought in by ice-class vessels capable of travelling throughout much of the year. These vessels frequently conduct voluntary exchange in northern Canadian coastal waters to reduce the risk of non-indigenous species (NIS) introductions; however there are questions regarding the effectiveness of exchange and how this varies by season. To address these questions, a 3-year study aimed at better understanding risks associated with the currently non-regulated domestic shipping pathway was recently initiated with the MV Arctic, a domestic vessel that regularly transits (from June-February) between Quebec City/Montreal and Deception Bay, Quebec (Nunavik). Objectives were to: 1) evaluate seasonal variation in plankton abundance and diversity within ballast to assess seasonal changes in risk for introduction of NIS through ballast release; 2) experimentally evaluate efficacy of voluntary exchange by comparing plankton communities before and after ballast exchange in control tanks (unexchanged water) as well as from tanks exchanged at two different locations. There was a strong effect of season on both propagule pressure and species composition with plankton abundance being highest in in ballast water pumped into tanks or exchanged in July and August. Plankton abundance and diversity did not differ statistically among exchange sites in different areas of the Gulf of St. Lawrence, however there was a large difference in both abundance and species composition in exchanged versus control (unexchanged) tank immediately after exchange and upon arrival in the destination port of Deception Bay. Exchange resulted in the replacement of freshwater plankton with marine species and resulted in much higher propagule pressure of both native and NIS of plankton relative to unexchanged control tanks. Locations currently used for exchange are in areas of upwelling with high summer productivity and thus may increase potential for uptake and transfer on marine NIS with potential to survive in the marine destination port of Deception Bay. Future studies should examine the potential for use of other exchange sites that may have lower productivity and fewer NIS such as off the Labrador Shelf. Information from this study can improve our abilities to understand and manage ballast-mediated species introductions, help guide voluntary ballast management practices by industry and feed into regulatory decisions by Transport Canada.

The Arctic Shipping Route: a New Species Introduction Corridor

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Several non-indigenous species (NIS) have been spread between northern oceans mainly from stocking and aquaculture activities. This has enabled some NW Pacific species, and

their associates, to successfully colonise North Atlantic waters; and some will have passed the other way. Few NIS are known to have spread between these regions with shipping, either because of the persistent high latitude surface ice-barrier or intolerance of the warm water or tropical seas. As Arctic ice recedes a corridor is expected to enable a seasonal passage of vessels through and to this region. Both incremental poleward expansions of NIS can be expected as well as long distance transmissions. We present scenarios where NIS might become spread by different shipping related pathways to and through Arctic seas arising from sea-ice depletion. For example, a shipping route from Rotterdam to Yokohama currently is 11 200 nm, but only 6500 nm on the northern route with savings in distance to exceed 40%. Between San Francisco and Rotterdam the northern route would be ca. 2000 nm (ca. 25 %) shorter. Considering also the canal fees, fuel, and other costs, Arctic routes could cut the cost of a single voyage by a large container ship from ca. $17.5 million to $14.0 million.

We expect that the NE Atlantic is more susceptible to North Pacific NIS as the eastern side of continents (e.g. Asia) have more extreme environments which provides NIS originating there with an advantage when arriving in less extreme environments (e.g. Europe). Further, Europe will receive more shipping from Asia via the Russian polar route compared to the US East Coast because of the larger shipping route shortcut from Asia to Europe via Russia rather than from the Pacific to the Atlantic via polar Canada.

Shipping will not be the only responsible mode for the arrival of NIS in Arctic Seas. Climate warming is set to further human activities at progressively higher latitudes to involve varied forms of transport, exploitation, aquaculture, ranching and recreational activities. There will be direct movements of NIS by ships between temperate regions of either northern oceans via the shorter routes in addition to a slower creeping natural spread to form a cold-water route which will not have existed for over four million years.

There are three principal invasion patterns likely to take place, i.e., by a gradual range expansion (natural range expansions, fishery discards), by progressive steps from one locality to another (local transport, modules associated with mineral and oil exploration and natural range expansion) or passage by ships between the more temperate regions of the two northern oceans though, and to, Arctic seas.

ToR c) Investigate biofouling as a vector for the introduction and transfer of aquatic organisms on vessels and artificial hard structures, their pressures and impact on the ecosystem with a comparison of prevention and selective mitigation methodologies.

Marine Non-native Species Preventative Measures: Marina's in the Orkney Islands

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Marine non-native species (NNS) monitoring surveys have been conducted at Orkney Islands by Orkney Harbour Authority since 2013. In 2014 the three Orkney marinas, Kirkwall, Stromness and Westray, were included in the monitoring programme. Two of the marinas, Kirkwall and Stromness, were deemed to be 'hot spots' for NNS due to the high number present. A decision was made at Orkney Harbour Authority to look into the NNS preventative measures in the marinas and to prepare a contingency plan for a worst case scenario. The project explored options to prevent marine non-native species arriving in Orkney and limit the transference of NNS between marinas and natural habitats in

Orkney by considering the following i) Quantifying the submerged portions of Kirkwall and Stromness marinas, ii) Policies and infrastructure required to improve marina biosecurity, iii) 'Housekeeping' actions to improve marina biosecurity and iv) 'Biological emergency' planning, control and eradication measures for invasive non-native marine species. Once the report for the project is finalised, feasibility of implementing the recommended measures will be considered in collaboration with the decision makers and stakeholders including the Marina Managers. It is envisaged that an implementation timescale, project planning and budgetary requirements over the short-term and long-term will be established.

Didemnum vexillum Outbreak at a Scottish Oyster Farm

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The invasive colonial tunicate *Didemnum vexillum* is found at several sites throughout the UK. Until recently it has only been present in Scotland in and around the vicinity of Largs marina on the west coast. In February 2015 Marine Scotland Fish Health Inspectorate were informed of a possible population present at an oyster farm in Loch Creran, roughly 100 miles north of Largs. It was also suspected to be fouling the unique serpulid reef within the loch that is protected under the EU Habitats Directive, however a dive survey did not find any evidence of this. During the summer staff from the Scottish Association for Marine Science surveyed part of the shoreline and oyster farm where *D. vexillum* was visually confirmed. Molecular analysis of collected samples confirmed the identity and monitoring and surveillance practices were put in place, coordinated by the Scottish Working Group on Marine Invasive Non-Native Species. Further shore-based surveys, dive surveys of the protected reef and a RIB survey of all floating structures within the loch were carried out to determine the extent of the establishment. However no further observations of *D. vexillum* out with the oyster site were made. Fouling on the site included metal work of the trestle tables, algae also attached to the metal work, oyster bags and on live oyster shells. As it is an offense to knowingly spread (or allow to spread) a non-native species in Scotland, a treatment trial for oyster shells was undertaken by Marine Scotland, as a substantial part of this oyster farm's business is selling of stock for on-growing at other locations throughout the country. After a literature review of various treatment methods, a 24 hour freshwater soak of fouled oysters placed into clean bags was selected as the preferred treatment method. This was based on a successful field and lab-based treatment trial, time scales, environmental issues and practical issues on site. This treatment has been written into a Species Control Agreement which the farm owner has voluntarily entered into. The agreement also includes notification to the FHI of all future movement plans by the owner. The Working Group will continue to monitor Loch Creran for any future spread and surveys of receiving waters will also be carried out to determine baselines prior to any oyster movements.

Do wind farms favour introduced hard substrata species?

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Offshore wind farms, like other artificial structures in the marine environment, are hypothesised to favour introduced species and as such pose a threat to the native fauna. However, this has so far never been investigated for offshore wind farms. We investigat-

ed introduced species on Belgian offshore wind farms with particular interest in (1) the position of introduced species on offshore wind farms in relation to other hard substrata in the Belgian part of the North Sea (BPNS), (2) the distribution of introduced species in the subtidal versus intertidal zone and (3) the potential of offshore wind farms for future flourishment of the introduced species. Therefore we compared different hard substratum communities, both natural and man-made, on the relative importance of introduced species in the subtidal and intertidal communities. Overall we detected eleven introduced and two cryptogenic species on the wind turbines, seven of which are intertidal species (i.e. *Balanus (Amphibalanus) improvisus, Crassostrea gigas, Elminius (Austrominius) modestus, Hemigrapsus sanguineus, Jassa marmorata, Megabalanus coccopoma* and *Telmatogeton japonicus*) and four are subtidal species (i.e. *Corophium (Monocorophium) sextonae, Crepidula fornicata, Diplosoma listerianum* and *Fenestrulina delicia*). We found that, all but one introduced species observed on the offshore wind farms in Belgian waters (i.e. *F. delicia*), were already known from the BPNS. Clear colonisation patterns occurred in both wind farms and this can be considered a confirmation that the observed patterns are consistent and may hence be expected similar in other wind farms in the southern North Sea. In the subtidal zone, the offshore wind farms will only marginally contribute to the further spread of introduced species given the vast amount of both natural and artificial hard substrata already available in the North Sea, which already contain established populations of the same introduced species. However, for the intertidal zone, the wind farms may have the potential to substantially increase the risk of the further spreading of introduced species, given that offshore intertidal habitat still is relatively rare. Wind farms will indeed drastically increase the available habitat to intertidal introduced species. It is however expected that offshore wind farms may significantly contribute only to the spread of clear water, intertidal introduced species, as such nuancing the introduction and invasion risk posed by offshore wind farms.

Biofouling Overview and Strategic Planning

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The dominating species introduction vectors may be different in different regions, but the key vectors world-wide are ballast water, biofouling and species imports for aquaculture. Examples were ballast water was seen as more prominent compared to biofouling exist for Germany (Gollasch 1996), ICES member countries (Minchin *et al.* 2005) and Europe (Gollasch 2006). In contrast, biofouling was seen more important than ballast water in San Francisco Bay (Cohen & Carlton 1995), New Zealand (Cranfield *et al.* 1998), GloBallast data (Gollasch 2000), Port Phillip Bay (Hewitt *et al.* 2004), Hawaii (Carlton & Eldridge 2009, Loope 2011), North Sea (Gollasch *et al.* 2009) and California (Williams *et al.* 2013). However, the some of the most "critical" species arrive in ballast water (HAB, human pathogens, *Dreissena*, *Mnemiopsis*)! Fouling species also have strong impacts (e.g. *Teredo*, *Balanus*, *Dreissena*, *Didemnum*, *Undaria*, *Crassostrea*, *Cordylophora, Ficopomatus, Hemigrapsus*).

IMO adopted the 2011 Guidelines for the control and management of ships´ biofouling to minimizing the transfer of invasive aquatic species. This instrument and other recommendations address biofouling management plans and record books and choosing the anti-fouling system. It was further suggested that dry-docking support blocks should be varied at each docking, or ensure that areas under these blocks are anti-fouling painted at

least at alternate dry-dockings. It was further noted that bow, stern and other thrusters are prone to coating damage and that rudder hinges and stabilizer fin apertures should be routinely maintained at dry-dockings. Lastly, in-water inspections and cleaning should be considered with a risk assessment approach not that NIS are released by these activities. In 2012 IMO released the Guidance for minimizing the transfer of invasive aquatic species as biofouling (hull fouling) for recreational craft, which refers to in-water cleaning, trailered craft, coating checks etc. In June 2013 Australia and New Zealand have released new anti-fouling and in-water cleaning guidelines developed in consultation with industry stakeholders.

The last comprehensive biofouling study on larger commercial vessels conducted in Europe seems to be the Germany study (Gollasch 1996). More recent European studies include Ashton *et al.* 2006 (Scottish recreational vessels), McCollin & Brown 2014 (Scottish drydocks with vessels <5000 DWT or GT (<100 m length, regional)). The studies documented that not only sessile organisms were found, but also mobile species. In the German study in maximum 107 barnacles and 64 mussels were found in 100 cm² heavily fouled vessel surface. This was calculated to be 12.2 kg wet weight per m². The highest diversity was 23 different species in a sample. The most heavily fouled vessel had a fouling which in parts was 30 cm thick, developed by tube forming polychaetes. The most commonly found species was *Balanus improvisus.* Three other species are highlighted here as interesting cases. Firstly, *Diadumene lineata.* It is a well known cryptogenic species, which colonized Atlantic and Pacific coasts of North America and NW Europe, Baltic as well as Mediterranean Seas. The first European record was documented in the UK in 1899. During the period 1920–24 it was also found in Germany (North Sea) in one location, but got later extinct. Our finding of this species in the 1990s indicates that it may become re-introduced. The second example is *Hemigrapsus penicillatus.* It was first recorded in Europe 1994 in France, but we found it on a vessel already in 1993 with 2 males and 4 females on 30 cm² scraped vessel surface. Possibly the vessel we samples introduced this species to Europe. Thirdly, we found a species new to science! This was named after the „habitat", where it was found as *Cryptostylochus hullensis* (flat worm). This account was not easy to publish as „type locality" was a vessel! It is listed in WoRMS and the co-author of this paper was Faubel, who is a flatworm expert and he described the Genus in 1983.

It may be interesting to note that the first time ever a ship was send away because of the biofouling situation. The Indonesian bulk carrier *DL Marigold* has been ordered to leave the Port of Tauranga, New Zealand waters after its hull was judged to be threat to biosecurity (10 March 2017). Ministry of Primary Industries (MPI) divers discovered dense fouling (barnacles, tube worms). The ship was given 24 hours to depart the port. Steve Gilbert, border clearance director at the MPI, said "The longer the vessel stayed in New Zealand, the greater chance there was for unwanted marine species to spawn or break away from the ship. So we had to act quickly". The vessel is not allowed to return until it is clean. New rules require all international vessels to arrive in New Zealand with a clean hull from May 2018 (http://www.marinelink.com/news/ordered-zealand-dirty422900).

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Marine Debris as a Vector for Invasive Marine Species: Transoceanic Dispersal of Coastal Marine Organisms by Japanese Tsunami Marine Debris

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The arrival onto the shores of North American and Hawaii of a vast flotilla of materials (ranging from large docks to medium-sized vessels to small baskets and buoys) generated from the shores of Japan on March 11, 2011 by the Great East Japan Earthquake and Tsunami offered an opportunity to study ocean-scale dispersal of potentially invasive species on marine debris. Hundreds of objects, landing from Alaska to California and in the Hawaiian Archipelago, have been sampled between 2012 and 2017 with 100s of living Japanese species. A Special Issue of *Aquatic Invasions* and other papers are in preparation documenting the scale of this phenomenon, and its implications for the current and future roles of the increasing amount of marine debris as a dispersal vector.

U.S. Biofouling Meetings

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In August 2016, experts on biofouling from Australia, Canada, New Zealand (NZ), and the United States (US) met at the Smithsonian Environmental Research Center (SERC) in Edgewater, MD. A series of several meetings was held to establish a quadrilateral partnership in marine biosecurity research among the four countries. The purpose of the partnership is not only to seek greater alignment of research but also collaboration in areas of common interest.

One of the events in the series was a two-day meeting organized by the Maritime Environmental Resource Center (MERC). Part one was convened to consider approaches to characterize and quantify biofouling. Part two was convened to identify and discuss existing approaches used for in-water cleaning of vessels, as well as a means to quantify the efficacy of cleaning. This report summarizes the presentations, discussions, and conclusions from these two days. The main lessons learned were:

- Across administrations and regions, similar gaps and challenges exist—no standardized procedure for testing the efficacy of cleaning technologies exists, nor does a procedure for assessing ships' compliance with biofouling standards.

    - The group agreed universal standard procedures would be ideal, and existing procedures and lessons learned can inform the development of such practices.
- All administrations use paperwork as a first gate to know if biofouling management has occurred.
    - There is a need to standardize a method to determine if biofouling management procedures were used appropriately.
- There should be a focus on an approach to assess and remove fouling in niche areas.
    - The relationship of the extent of fouling between niche areas and the flat hull surfaces should be investigated.
- A means to distinguish between living and dead organisms is needed.
- This group should continue to meet annually in person and investigate links to other organizations (e.g., International Council for the Exploration of the Seas [ICES] or the Institute of Marine Engineering, Science and Technology [IMarEST]).

There is a need to create a central data repository for current regulations, protocols, and reports.

Hull Biofouling Research

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Abstract not available

Biofouling Risk in the Canadian Arctic

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Many aquatic species colonize external surfaces of ship hulls (i.e. biofouling) and can dislodge and/or reproduce at later ports. While ship biofouling is recognized as a major transport vector of aquatic nonindigenous species (NIS) globally, its magnitude in the marine Arctic is little studied and poorly understood. Arctic sea ice may scape hulls, negatively impacting biofouling organisms; conversely, scraping or abrasion may release organisms into the water, thus increasing invasion risk. Therefore, we surveyed the hulls of eight naval and 13 commercial ships to characterize biofouling assemblages (alga and invertebrate taxa) delivered to Canadian Arctic ports in the summers of 2009 to 2012. We also used a questionnaire to obtain data on ships' operation profiles and hull maintenance practices, variables that may be related to biofouling, for the broader population of all ships entering Canada's Arctic during the summers of 2015 and 2016. Using these data, we (i) determined the composition and survivorship of biofouling assemblages delivered to the Canadian Arctic via biofouling; (ii) identified factors that influence biofouling extent on ships, and (iii) incorporated results from dive surveys with questionnaire findings to evaluate the potential for ships to transport NIS to the Canadian Arctic via biofouling. Our study addresses the knowledge/data gaps on the biology of biofouling organisms on ships operating in Arctic waters and provides insights into ship biofouling risk in an Arctic environment.

ToR d) Advance knowledge base to further develop indicators to evaluate the status and impacts of non-indigenous species in marine environments.

Evaluation of environmental impact of non-indigenous species to serve the EU Marine Strategy Framework Directive

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An ongoing initiative is addressing Descriptor 2 of the EU-MSFD, in particular Indicator 2.2.1 regarding impact of Invasive Alien Species (IAS), for which there is not yet agreement among member countries. We aim at evaluating available literature information on impacts of 11 selected invasive taxa, encompassing plankton, benthos and nekton: *Mnemiopsis leidyi*, *Acartia tonsa*, *Caulerpa* spp., *Ruditapes philippinarum*, *Crassostrea gigas*, *Marenzelleria* spp., *Didemnum vexillum*, *Rhithropanopeus harrisii*, *Eriocheir sinensis*, *Neogobius melanostomus*, *Siganus* spp.

Literature has been searched for relevant articles referred to IAS impacts in EU marine waters; articles are classified for geographical coordinates, type of environment (physical, chemical, abiotic), type of study (qualitative information only, presence-absence comparison, correlative study, controlled field experiments, etc), habitat/substrate type, response variable measured and process responsible for the impact (bioturbation, filtration, oxygen consumption, etc). The confounding factors that could affect the results of the surveyed studies study are also being considered. Final goal is to develop a new indicator of impact that can be proposed for the implementation within the Marine Strategy Framework Directive.

AquaNIS Status Update

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Aim and status. AquaNIS is an online information system on aquatic non-indigenous (NIS) and cryptogenic (CS) species. Its aim is to store and disseminate information on NIS introduction histories, recipient regions, taxonomy, biological traits, impacts, and other relevant documented data. Since 2014, AquaNIS is recommended to assemble, store and disseminate comprehensive data on NIS recorded in ICES Member States. The system also contains data on species findings in ports and their vicinities. The national updates are being made at least annually. In 2016, the HELCOM WG on the State of the Environment and Nature Conservation agreed to use AquaNIS database as the data source for the NIS indicator evaluation within the holistic assessment (HOLAS II) of the environmental status of the Baltic Sea. They considered using AquaNIS in the future for the storage of NIS monitoring data and for the purpose of the Ballast Water Management Convention exemptions. The meeting also acknowledged the ICES WG ITMO for providing data for the indicator.

Current data coverage. AquaNIS contains data on 1455 species involved in 4502 introduction events in recorded 19 Large Marine Ecosystems (LMEs) or LME-like systems, such as the Caspian Sea. All data, except the Mediterranean Sea is freely available online; in the latter only Italian data is for open access. In 2016, 83 new species were added, 129

species accounts were edited (changes in species taxonomy, corrected name, adding data on biological traits, etc.) and 122 new introduction events registered.

System upgrade. New functions have been developed to make AquaNIS more user-friendly and useful for research and management. On the front page, the "LAST UPDATED INTRODUCTION EVENTS" option shows 10 most recent additions to the database with links providing further details on the updates made. A new option "PAPERS BASED ON AQUANIS DATA" provides links to the scientific articles, which findings are based on data stored in AquaNIS. A new tool under icon "SERVICES" contains two options. The "NEW ARRIVALS" option retrieves the list of NIS which are new arrivals at different geographical scales, i.e. recorded for the first time in: a) a particular recipient region (country coast) within the LME, b) a country (including coasts of the same country in different LMEs), c) particular LME and, d) larger biogeographical region, including, e.g. two or more neighboring LMEs. The "MOST WIDESPREAD SPECIES" option provides the list of NIS and CS which were recorded in 10 or more recipient countries worldwide. Another option, "LIBRARY", was developed to store primary information sources supporting data records. This option is available only for registered users, which can receive copies (pdf-s) of the background publications. Finally, an option was developed to store geo-referenced data on NIS findings, including those registered in ports and their vicinities.

ToR f) Contribute regional text to new ecosystem overviews for (i) Iceland, (ii) Norwegian Seas, (iii) Azorean ecoregions and (iv) the Oceanic north-east Atlantic ecoregion in relation to the rate of discovery of invasive species where information is available.

Ecosystem Overview for Iceland

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Trends in non-indigenous species

This ecoregion has 22 non-indigenous and cryptogenic (obscure or of unknown origin) species. The majority (12 species) of the non-indigenous species have arrived between 1950 and 1999, with 6 species arriving since the beginning of the 21st century. Consequently, the annual rate of discovery increased from 0.2 per year during 1950–1999 to 0.4 per year during 2000–2016. At least one of the recently arrived non-indigenous species, the Chilean crab *Cancer plebejus*, is not yet registered in the neighboring areas (Faroe Plateau, Barents Sea, North Sea and Norwegian Sea).

The main pathway for introductions is vessels, either through ballast water or ship hull fouling. Aquaculture, life food trade and coastal water currents (secondary spread from neighbouring areas) are considered to account for a few non-indigenous species introductions. Ecological impacts caused by the non-indigenous species in this region is very poorly known.

Overview for Azorean Ecoregion

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Trends in non-indigenous species

The ICES ecoregion of the Azores has currently inventoried 71 marine non-indigenous species (NIS). Until the late 1970s, the number of accumulated NIS registered was 20. Since then, the number of NIS detected has been increasing exponentially, particular in recent years (2000s) where monitoring campaigns and amplified sampling effort has been taking place in several Azorean islands (Figure 1A).

The most representative taxonomic group on the Azorean NIS list is macroalgae, particularly Rhodophyta with 23 records until 2015 (Figure 1B). Other groups are also well represented such as ascidians (Chordata), bryozoans and crustaceans (Arthropoda).

The main vector of introduction in the region is most likely through vessels, in the form of hull fouling in recreational and commercial vessels. In addition, other vectors such as rafting could have facilitated other introductions in the Azores over the years.

There were some observed ecological impacts, particularly at the vicinity of Horta harbor with the spread and dominance of the green algae *Caulerpa webbiana*.

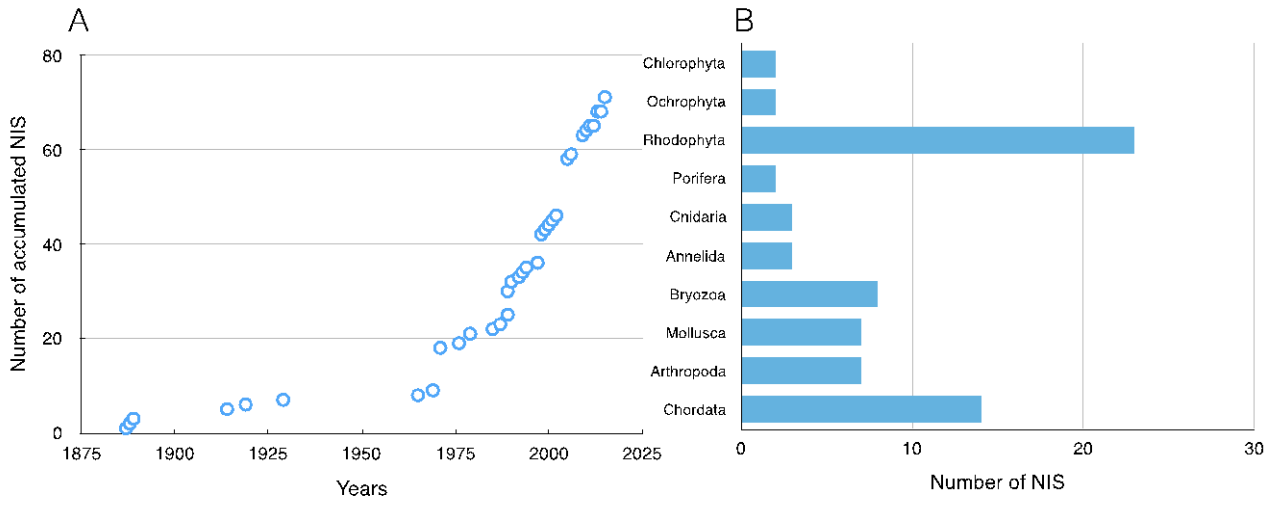

Figure 1. Patterns of distribution of non-indigenous species (NIS) in the Azores Ecoregion. A – number of accumulated NIS over time. B – Most representative taxonomic groups.

Other Presentations

The Suez Canal and Mediterranean Marine Invasions: report on media coverage

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We report updates on the media coverage of the bioinvasions problem in the Mediterranean Sea due to the Suez Canal, and its recent enlargement. We explored news websites of 29 different countries, mainly from Europe, but also including countries in Africa, Asia and America, using the "Google news" search engine, as well as our own collections of newspaper and magazine articles relevant for this subject.

Our starting point for the search was September 2014, one month after the announcement of the doubling of some tracts of the Suez Canal, and corresponding to the online publication of a letter of concerned scientists.

Overall, we analysed 282 sources. Three main types of articles were found: (1) local findings of alien species or articles focused on single "high risk" species, such as the lionfish; 2) general articles about alien species, briefly mentioning the Suez canal as one of the possible pathways; (3) articles specifically dealing with the canal enlargement, and discussing its geopolitical aspects. The species most often mentioned in the news are those harmful to humans: *Lagocephalus sceleratus*, *Rhopilema nomadica*, *Pterois miles*. Surprisingly, the fact that the Suez Canal has been enlarged is mentioned only by 60% of the sources; it is unclear if this omission is due to lack of information, or it is intentional.

So far, despite the media have highlighted increasing threats to the environment and to human health, no action has been taken by the official bodies to control this vector.

Annex 6: ICES ASC 2017 Bioinvasion Theme Session

Theme session B

ICES-PICES-CIESM session: Bioinvasion trajectories and impacts in contrasting marine environments

Conveners:
Henn Ojaveer (Estonia)
Cynthia McKenzie (Canada)
Thomas Therriault (Canada)

The intentional or accidental introduction of non-indigenous marine species can have serious ecological and economic impacts, contributing to the global loss of biodiversity and negatively affecting coastal communities. These impacts are not, however, equal among organisms or invaded ecosystems due to differences in native biodiversity, vectors, and ecosystem characteristics.

Recognizing and understanding the contextual nature of marine invasions will thus enable better management decisions, especially for data-limited systems such as the Arctic, and can inform policy development that could slow the rate and/or impacts of invasions.

Comparing and contrasting invasion trajectories and impacts in different marine ecosystems around the globe will provide a clearer understanding of the most important factors contributing to invasion success while providing a standardized interpretation of the EU MSFD Descriptor 2 on non-indigenous species.

The three organizations supporting this session have long histories of working on marine non-indigenous species issues in the Atlantic, Pacific, and Mediterranean respectively, and this session will draw on this unique expertise to contrast marine invasions in these different systems. With continued interest in marine invasions, especially in the Arctic, this session is timely in terms of revisiting this global problem.

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

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