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

7–9 March 2018

Madeira, Portugal

ICES
International Council for the Exploration of the Sea

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Executive summary

The 44th meeting of the Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was held in Caniçal, Madeira, Portugal, 7–9 March 2018. This meeting included a joint day with the Working Group on Ballast Water and Other Ship Vectors (WGBOSV). The meeting was hosted by João Canning-Clode (Portugal) and chaired by Cynthia McKenzie (Canada). The meeting was attended by 34 scientists, from 21 countries; six additional scientists participated in person, and five participated by webconference on the joint meeting day with WGBOSV. 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 in 2017 on ToRs a (detection and surveillance methods) and c (biofouling).

This interim report for year two of the current cycle provides a summary of the 19 National Reports (reports attached in Annex 4), the 19 presentations provided by members and chair invited members in support of term of reference objectives (abstracts provided in Annex 5), discussions, achievements, limitations and recommendations. 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. They also provide discussion points for methodologies, collaborations and knowledge gaps that need to be addressed by the group (ToR a) with discussions on potential new ToRs to be considered in 2019. In addition to national reports, two special sessions were held on: 1) Molecular tools for detection and monitoring (within ToR a); and 2) Marine invasive species screening tools (ToRs a&b - impact). The AquaNIS database continues to be updated (Appendix 6 for 2017 summary) and includes additional interactive tools.

WGITMO considered two ToRs jointly with the Working Group on Ballast Water and Other Ship Vectors (WGBOSV): Examining biofouling as vector for the introduction and transfer of aquatic organisms on small boats and large ships; and Examining the effect of climate change on the establishment of aquatic species in the Arctic. The Groups addressed a request for information on ship-mediated introductions of harmful algal bloom species in the Arctic from the Working Group on Harmful Algal Bloom Dynamics (WGHABD), and produced the preparatory document for an ICES VIEWPOINT on *Evaluating and Mitigating Introduction of Marine Non-native Species via Vessel Fouling*.

The ICES viewpoint was developed as a result of the theme session for the 2017 ICES ASC on bioinvasion trajectories and impacts in contrasting marine environments, organized by WGITMO as a collaboration between ICES-PICES-CIESM. One of the recommendations from that session was to "prioritize investigation on one the most important non-native species transfer pathway – hull fouling and niche areas, both on commercial ships and recreational vessels, and through this contribute to IMO request for scientific information on use and effectiveness of IMO Biofouling guidelines globally"(Appendix 5 ASC Session report).

1 Administrative details

Working Group name

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

Year of Appointment within current cycle

2017

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

2

Chair(s)

Cynthia McKenzie, Canada

Meeting venue

Caniçal, Madeira, Portugal

Meeting dates

7–9 March 2018

2 Terms of Reference

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.

3 Summary of 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

- The preparatory document for an ICES VIEWPOINT on *Evaluating and Mitigating Introduction of Marine Non-native Species via Vessel Fouling*, was reviewed and produced jointly with WGBOSV.
- Organized and co-chaired ICES – PICES – CIESM session at 2017 ICES ASC " *Bioinvasion trajectories and impacts in contrasting marine environments"* resulting in eight research priorities and collaborations that would strengthen ICES, PICES and CIESM activities on bioinvasions, including priority on biofouling vessels that led to the Viewpoint on biofouling.
- Linkages continue with GloFouling and Project COMPLETE and other biofouling focused groups to develop and improve biofouling management guidelines and practices, and to support the evaluation of the international guidelines at the IMO.
- Discussions continue on activities and collaborations between ICES, PICES and CIESM with active participation of PICES and CIESM representatives at the WGITMO meetings.
- PICES will work to get existing data into a format that could be uploaded to AquaNIS and would enhance information exchange, expanding the ICES AquaNIS to a global marine invasive species database and information exchange portal.
- Jointly PICES and ICES will host a theme session at the 4th Climate Change Conference in Washington, DC in June 2018.
- Jointly with WGBOSV, a scientific paper reviewing the status and risks of introduced species in the Arctic was initiated, and is expected to be submitted before end of 2018.
- A request from WGHABD concerning the role of shipping as a vector for the introduction of harmful algal bloom organisms in the Arctic was addressed, jointly with WGBOSV, by conducting a review and presenting the information to the ICES WGHABD annual meeting
- Presentation to be given at the 18th International Conference on Harmful Algae. October 12–16, 2018 Nantes, France, highlighting the linkages between ICES WGITMO and WGBOSV and Harmful algae - McKenzie, C.H. 2018. Harmful Algae Networking with ICES Working Groups on Introduction and Transfer of Marine Organisms and Ballast Water and Other Ship Vectors.
- A review of national activities (19 countries) was conducted to advance research, develop collaborations and address surveillance and knowledge gaps related to the introduction and transfer of marine organisms.
- Working sessions on molecular method tools for detection and monitoring with discussions on how the WG can provide information or recommended guidelines for this rapidly emerging multifaceted tool.
- The AquaNIS database/dataset continues as the main repository of new 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. Interactive tools for data inquiry have been added this year. (www.corpi.ku.lt/databases/index.php/aquanis)

- Working group members reviewed the AS-ISK (UK) and CMIST (Canada) risk assessment tools, including implications for use for non-indigenous species risk for regulatory purposes.

5 Progress report on ToRs and workplan

ToR a) Advance research, develop collaborations and address surveillance and knowledge gaps in issue related to the introduction and transfer of marine organ-sims, through annual reviews of national/ international activities and responding to advice requests

The 19 National Reports provide an overview of the priorities, findings, meetings and publications for each country (Annex 4). In addition, it provides discussion points for methodologies, collaborations and knowledge gaps that need to be addressed by the group. New species sightings and spread of established species are noted in the reports and tabulated in the AquaNIS annual summary.

The AquaNIS database continues to be updated and the data is now georeferenced with additional interactive tools. The 2017 AquaNIS summary is included in Appendix 6. There were three additional presentations under this term of reference addressing molecular methodology for detection and surviellence of non-indigenous species.

Molecular tools for detection and monitoring. A report from the Commission assessing Member States' monitoring programmes under the MSFD pointed out in 2017 a lack of monitoring data and knowledge for some descriptors, notably D2, and the need for a clear acceleration. However, addressing the MSFD requirements is a challenging task with traditional methods (e.g. decline in taxonomic expertise, numerous cryptic species, issues with the habitat accessibility etc.). Molecular tools, notably using barcoding and metabarcoding are in this context promising tools. Three examples of the use of molecular tools were presented (Annex 5). A closed or targeted list of species (10) showed the metabarcoding method to be sensitive and the results obtained similar to traditional methods in a study in the Western English Channel. In the Canadian Arctic, environmental DNA (eDNA) methods were used to enhance detection of more difficult to sample organisms including benthic and fouling taxa, and provide robust baseline genetic information as a reference point for current native biodiversity prior to significant change. The goals were to: 1) evaluate the potential of eDNA as a cost-effective biodiversity monitoring tool to assist in detecting large-scale coastal biodiversity shifts in sensitive Arctic areas; 2) characterize spatial distribution of eDNA; and 3) evaluate eDNA sources through comparison of water and sediment samples versus classical port survey methods. The study found that eDNA was spatially and temporally heterogeneous within ports and that the efficiency of the eDNA recovery was improved when sampling under-ice cover. Comparisons among different sampling approaches demonstrated that eDNA detects a wide range of taxa from the water column that includes not only holo- and meso-plankton, but also benthic species that lack pelagic larvae and may not be detected

with methods such as plankton nets tows. DNA metabarcoding was also studied in a Spanish project as a cost-effective tool to provide data for port baseline surveys. They sampled the commercial port of Bilbao (Spain) during the four seasons to collect fouling organisms attached on port structures, benthic macroinvertebrates living on sediment and filtered water containing zooplankton, phytoplankton and expelled material such as feces, cells, and tissues released from larger organisms. They found that metabarcoding enhanced detection sensitivity, provided a time saving and cost-efficient alternative to visual identification and was easily standardizable and reproducible.

There are thus potentially several benefits for molecular approaches in support of surveillance programmes, notably because i) they are standardized procedures with no need for taxonomic expertise (once reliable reference data have been made available); ii) they are particularly useful when morphological traits are tricky to use (e.g. early stages, e.g., larvae, spores); and iii) for metabarcoding, they allow to process a large number of specimens and samples. It does not mean that such approaches are free from limitations and biases. Some examples of important issues were provided, notably regarding unreliable reference database in public database as well as problems with false negative (species that are present but not recovered by the technique used). Although further improvements are needed, these DNA-based approaches are promising, and already effective for active surveillance of specific/targeted species for which the above mentioned limitations had been overcome.

Given the importance of this issue and the expertise of several of the working group members in this area, the working group discussed how this group of experts can provide information or recommended guidelines for this rapidly emerging multifaceted tool. The revised workplan will now include ToR e and will address genomics and molecular tools in the early detection and monitoring of non-native species. *ToR e) Evaluate the development and utilization of DNA- and RNA-based molecular tools for early detection and monitoring of non-native species.* (See revisions to the workplan in section 6).

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

In response to the request from WGHABD concerning the role of shipping as a vector for the introduction of harmful algae bloom (HAB) organisms in the Arctic, work was conducted intersessionally, jointly with WGBOSV and external experts, to conduct a preliminary review on the current status and knowledge of HABs in the Arctic. The preliminary review revealed that there was little data on HABs in the Arctic, with most available data collected from waters near Greenland or in the Candian Arctic (Annex 5). Approximately 25% of the species reviewed to date are potentially harmful, but many are considered rare or occur only occasionally in the Arctic. Given these initial finding, WGITMO recommend WGHABD investigate this issue further and suggest a special session on HABs in the Arctic at one of their future meetings (See recommendations). Significant progress was also achieved on the compilation of a comprehensive list of introduced species in the Arctic, with the aim to evaluate the risk associated with current and future vectors of introduction, to identify knowledge/data gaps, and to serve as guidance for future research and management efforts related to NIS in the Arctic. A scientific review paper has been drafted and is expected to be submitted for publication in a peer-reviewed scientific journal in 2018. The Group discussed the need to continue to identify and monitor activi-

ties of the Arctic Council under the ARIAS strategy, with a view to providing advice or scientific information in the near future. Due to the rapidly changing climate and exponential growth of human activities in the Arctic, both Groups identified the need to continue to assess risks of species introductions and mitigation strategies

Marine invasive screening tools. 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. Two screening tools were reviewed by the group, the Aquatic Invasiveness Screening Kit (AS-ISK developed by Cefas) and the Canadian Marine Invasive Screening Tool (CMIST developed by Fisheries and Oceans Canada) with additional case studies provided for each risk assessment tool (Annex 5). A comparison of CMIST and AS-ISK provided similar results for each tool (G. H. Copp). Following the global applications of the Fish Invasiveness Screening Kit (FISK), Cefas, WGITMO and the University of Łódź led in the development of FISK's transformation into a decision-support tool, 'AS-ISK' (www.cefas.co.uk/nns/tools/), which is generic for screening aquatic species regardless of their taxonomic status and the climate type of the risk assessment area. AS-ISK was developed to be compliant with the 'minimum standards' for use with the new EU Regulation on invasive alien species of EU concern, including questions on socio-economic and ecosystem services impacts as well as six additional questions through which the assessor evaluates the potential impact of predicted future climate conditions on the AS-ISK assessment. During 2017, in the framework of an EC-funded study, ten species were evaluated, including three fishes, the Lessepsian fish *Plotosus lineatus* and collectively the freshwater mosquitofishes *Gambusia affinis* and *G. holbrooki*. This study demonstrated how the application of the adapted EU Risk Assessment scheme can help Member States in implementing the EU IAS regulation (1143/2014).

The Canadian Marine Invasive Screening Tool (CMIST), a tool for assessing risk of invasion by nonindigenous species in the marine environment aims to simplify and improve the assessment process. CMIST has 17 questions based on the sequence of events in the invasion process: arrival, survival, establishment and spread as well as the species' potential impacts in the assessment area. To evaluate CMIST, 60 species/ecoregion combinations of nonindigenous marine invertebrates known to have been introduced to three Canadian marine ecoregions were scored and compared the results to scores from MI-ISK (Marine Invertebrate Invasiveness Scoring Kit). Assessment scores from both tools were then compared to the results of an expert opinion survey about the level of ecological risk posed by these species. The scores returned by the two tools were generally similar, had comparable levels of inter-assessor variability, and correlated well with the results of the expert opinion survey for two of the three ecoregions. For all ecoregions, CMIST scores were more strongly correlated with expert opinion scores than were MI-ISK scores. Further, CMIST easily distinguishes both elements of invasion risk (likelihood and impact), has fewer questions to score (17 compared to 49 for MI-ISK) and could easily be adapted for other taxa. The tool is now available publicly at www.bio.gc.ca/science/monitoring-monitorage/cmist/index-en.php. A Canadian Arctic study identified a suite of AIS (benthos, zooplankton, macroalgae) with the greatest likelihood of introduction and using the Canadian Marine Invasive Screening Tool (CMIST). The top twenty three riskiest species were then modelled to predict the potential spatial distributions at Arctic and global scales using the Maximum Entropy (MaxENT) habitat

model. When separated by taxa, benthic invertebrates and macro algae showed a higher percentage of habitat gain than planktonic species under future climate scenarios. When the same analysis was done at a global scale, the projections showed that by 2050 and 2100, there will be an overall habitat loss (- 4% and - 4.2%, respectively). These results suggest that most of the modelled species will find better environmental conditions in colder regions, with a trend towards a positive pole-ward shift in future distributions. This approach will aid in the identification of present and future high-risk areas for AIS in response to global warming.

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 methodologies

Considerable progress was made on this ToR with presentations during the annual meetings and intersessional work culminating in the development of a preparatory document for an ICES VIEWPOINT on *Evaluating and mitigating introduction of marine non-native species via vessel fouling*. The documentt summarizes the current state of knowledge about the risk of biofouling as a pathway for introduction of non-native marine species, and recommends that active management be undertaken to reduce biofouling of commercial and recreational vessels as an urgent priority. The joint Groups discussed potential areas of collaboration with the IMO GloFouling project, with a view to providing advice or scientific information to IMO in the near future. The Groups determined that additional research is needed to develop and improve biofouling management guidelines and practices, and to support the evaluation of the international guidelines at the IMO.

In addition to the work conducted on the joint day, WGITMO addressed vessel and artificial structure biofouling in marinas and harbours. A study on non-indigenous species (NIS) richness in Mediterranean marinas (50) found the highest NIS richness were Heraklion, Crete, Greece (27), Villa Igiea, Sicily, Italy (20) and Port Camargue, France (18). The following factors were significant in shaping NIS richness in marinas: sea surface temperature, number of berths, proximity to Suez Canal, proximity to aquaculture sites, proximity to commercial harbours, absence of pontoons, biogeographic sector and climate type. Knowledge of these factors can help priorize monitoring and management efforts to control the introduction of biofouling organisms in marinas. Another more targeted harbour study in Canada demonstrated the mitigation and management efforts under the new Canadian Aquatic Invasive Species Regulations, emphasizing the importance of communication and stakeholder planning for successful rapid response and control of an invasive tunicate.

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

Results from the theme session for the 2017 ICES ASC on bioinvasion trajectories and impacts in contrasting marine environments (Appendix 5) chaired by WGITMO in collaboration with PICES and CIESM were presented and discussed. The ASC session hosted ten oral and seven poster presentations, with presenters provided the opportunity to give a short introduction of their posters during the session. A general discussion on bioinvasion trajectories, impacts and other topics relevant to the subject was held at the end of the session. The contributed presentations covered Atlantic and Pacific Oceans,

Arctic and the Mediterranean Sea. Presentations included introduction vectors, population structure and dynamics, environmental impact, application of genetic methods, and several applied aspects (incl. risk assessment and marine conservation) of marine bioinvasions. The discussion session was focussed on identifying broad future research needs in the field of marine bioinvasions, of potential interest of ICES, PICES and CIESM, including Arctic. The outcome of the discussion which emphasized collaboration and strength of joint ICES-PICES-CIESM activities, included eight research needs and areas for collaboration (Appendix 7) including: Prioritize investigation on one the most important non-native species transfer pathway – hull fouling and niche areas, both on commercial ships and recreational vessels, and through this contribute to IMO request for scientific information on use and effectiveness of IMO Biofouling guidelines globally; Invasion trajectories and vectors are a common theme between regions and collaborative studies to investigate specific routes and vector risk would benefit from multi-region studies, particularly with regard to the Arctic; Devleop applications of molecular methods (e.g. e-DNA), including the study of genetical structure of non-indigenous species populations (e.g. early warning). Further, we need to determine how these results should/will be used by management agencies. This is especially true for 'shared waters' where integration is critical for success.

Information on the HELCOM Baltic Review and Monitoring Guidelines and the Project COMPLETE were presented and discussed, particularly in respect to monitoring NIS, impacts and how to develop a roadmap for harmonized biofouling management (Annex 5). The project COMPLETE (Completing management options in the Baltic Sea Region to reduce risk of invasive species introduction by shipping) is an INTERREG Baltic Sea Region (BSR). The overall goals relevant to WGITMO are a) Proposal (roadmap) for a regional biofouling management strategy; and b) Consistent regional monitoring of non-indigenous species. There are 12 full partners in the project, including nine research institutes and universities (Finland, Estonia, Latvia, Lithuania, Poland and Sweden), a Federal agency (Germany), an NGO (Finland) and an intergovernmental environmental organization (HELCOM). The Lead Partner is the Kotka Maritime Research Association, Finland. Eight people representing full project partners are members of the ICES/IOC/IMO WG BOSV and/or ICES WGITMO. Results from this project are expected to provide information for the expert group to provide advice to the IMO on the effectiveness of the biofouling guidelines.

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

Due to lack of information on HABs in the Arctic, it was decided that a CRR would be premature at this time. WGITMO is working with WGHABD and WGBOSV to obtain additional information to further this topic (see recommendations). Expanding the report to include harmful algae as a group in the Arctic is being considered.

Other Business

Cooperation with PICES

PICES and ICES have a long history of collaborating on many important marine issues, including non-indigenous marine species. PICES now has a longer-term expert group (an Advisory Panel in PICES lingo) related to non-indigenous marine species. This group met for the first time at PICES -2017 in Vladivostok and has a Term of Reference specifically dedicated to working with ICES and other international organizations to better understand and share information related to marine invasions.

In 2017, PICES, ICES, and CIESM hosted a joint theme session at the 2017 ICES Annual Science Conference in Fort Lauderdale, FL (Annex 5). In October 2018 PICES will be supporting the 10th International Conference on Marine Bioinvasions in Argentina and PICES and ICES will host a joint theme session at the 4th Climate Change Conference in Washington, DC in June 2018.

Understanding marine invasions is complex but PICES and ICES have worked well together (and with other organizations) in the past and there are many avenues for continued collaboration on this topic. Many joint theme sessions have been organized/are planned and there is ongoing dialogue and participation in each other's meetings. One specific action item following discussions at the ICES WG meetings in Portugal is using AquaNIS as a global marine invasive species database and information exchange portal. PICES will work to get existing data into a format that would be uploaded to AquaNIS that would enhance information exchange.

Global approach

A discussion on the need to assess the merits of a global approach to issue advice on Marine Invasive Organisms (MIO) was initiated for consideration. The conversation was focused on the opportunity for the WGITMO to lead a discussion on the benefits of working with a Global Organisation to develop common terminologies, methodologies and principles on the management of MIO. A discussion on the practicality of a global approach and broader mission vs a step-wise approach to provide advice and effect change was held and will be further considered intersessionally.

6 Revisions to the work plan and justification

Owing to lack of information on HABs in the Arctic, it was decided a CRR would be premature at this time. WGITMO is working with WGHABD and WGBOSV to obtain additional information to further this topic (see recommendations). ToR e will now address genomics and molecular tools in the early detection and monitoring of non-native species as discussed in the special session on this topic:

ToR e) Evaluate the development and utilization of DNA- and RNA-based molecular tools for early detection and monitoring of non-native species.

Background: There are potentially several benefits for molecular approaches in support of surveillance programmes for non native species, however, this does not mean that such approaches are free from limitations and biases. Although further improvements are needed, these DNA-based approaches are promising, and already effective for active

surveillance of specific/targeted species for which the above mentioned limitations had been overcome. Effective use of these new tools will be evaluated for detection of non-native species.

Science plan topic addressed: 27, 28.

Duration: 1 year.

Expected Deliverables: Input on the effective utilization of these methods for international and national regulators through meeting participation, correspondence group and/or technical paper.

7 Next meetings

The WGITMO proposes to meet in Weymouth, UK, 4–6, March 2019 hosted by Gordon Copp and Paul Stebbing at the Weymouth Laboratory of the Centre for Environment, Fisheries and Aquaculture Science (Cefas - United Kingdom). A joint full day meeting with WGBOSV is proposed for 6 March 2019.

Annex 1: List of participants

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Annex 2: Recommendations

RECOMMENDATION	ADRESSED TO
1. WGITMO to meet jointly with WGBOSV for one full day, annually, to progress ToRs of joint interest.	WGITMO & WGBOSV
2.WGHABD special session on Arctic HABs at next meeting	WGHABD & WGITMO

Annex 3: Agenda

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

7– 9 March 2018

	WEDNESDAY 7TH MARCH **JOINT MEETING WITH WGBOSV**	
08.30	Set Up Computers	.30
09.00	Welcoming remarks: **Sarah Bailey, Cynthia McKenzie** (Co-Chairs), **João Canning-Clode** (Host)	.15
	Welcoming remarks from the Secretary of the Environment, **Dr. Susana Prada**	.15
	Introduction of Participants	.10
	Review WGBOSV/WGITMO Joint Day Agenda	.5
09.45	**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: Cynthia McKenzie***	
	Review ToR objectives and deliverables	.10
	Presentation: IMO GloFouling Activities – **Teo Karayannis** (IMO)	.20
	Questions	.10
10.30	**Morning break**	.30
	Presentation: Overview of biofouling work in U.S. – **Lisa Drake**	.10
	Questions	.10
	Presentation: ICES Biofouling Viewpoint – **Bella Galil/Cynthia McKenzie**	.20
	Questions And Discussion on Viewpoint	.20
	Discussion and Reporting under ToR c) & WGBOSV ToR e); Planning	.30

ITMO BOSV ToRs /deliverables (2019 - 2021)

12.30	**Lunch break**	.60
1:30	**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 nonin-digenous species, particularly with respect to the Arctic ***ToR Lead: Cynthia McKenzie/Sarah Bailey***	
	Review ToR objectives and deliverables	.10
	Request from WGHABD concerning the role of shipping as a vector for the introduction of HAB organisms to the Arctic	.5
	Presentation: HABs in the Canadian Arctic – **Kim Howland & Christine Michel**	.20
	Questions	.10
	Presentation: Early Results of Review Paper on AIS risks to the Arctic – **Farrah Chan** (Remotely by WebEx)	.20
	Questions	.10
	Discussion – Response to WGHABD	.15
15.00	**Afternoon break**	.30
	Discussion and Reporting under ToR b) & WGBOSV ToR d); Planning ITMO BOSV ToR and deliverables	.30
	Resolution of Any Outstanding Issues	.15
	Any Other Business • Update on relevant PICES Activites – **Tom Therriault** • Baltic NIS monitoring strategy –**Sergej Olenin** • Location of next meeting – **Stephan Gollasch and Gordon Copp**	.30
17.00	**End of Joint Meeting Day**	

Thursday 8TH MARCH		
08.30	Set Up Computers	.30
09.00	Welcoming remarks: **Cynthia McKenzie** (Chair), **João Canning-Clode** (Host)	.5
	Introduction of Participants	.5
	Review WGITMO Agenda	.5
09.15	**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***	

Review ToR objectives and deliverables,

Welcome of New Participating Countries – Croatia and Latvia

National reports for 2017 (10 minutes each)

- Belgium **Francis Kerckhof**
- Canada **Cynthia McKenzie**
- Croatia **Josip Mikus**
- Denmark **Kathe Jensen**
- Estonia **Henn Ojaveer**
- Finland **Maiju Lehtiniemi**
- France **Amelia Curd**
- Germany **Stephan Gollasch**

10.30	**Morning break**	.20

- Greece **Argyro Zenetos**
- Israel **Bella Galil**
- Italy **Anna Occhipinti-Ambrogi**
- Latvia **Solvita Strake**
- Lithuania **Sergej Olenin**
- Norway **Anders Jelmert**
- Poland **Monika Normant**
- Portugal **Paula Chainho**

12.30-	**Lunch break**	.60

- Sweden **Rahmat Naddafi**
- United States **John Darling**
- United Kingdom **Gordon Copp**

Questions and Discussion Including Multi-year reporting for 2019

15.00	**Afternoon break**	.30
15.30	**ToR a): Continues**	
	Presentation: Molecular tools for NIS detection and monitoring: promises and challenges - with an illustration in the context of the European Union MSFD requirements **Frederique Viard**	.20
	Presentation: eDNA as a surveillance tool and how this compares with standard NIS monitoring methods in the Canadian Arctic – **Kim Howland**	.20
	Presentation: Implementing DNA metabarcoding as cost-effective tool to provide biological data for port baseline survey - **Anais Rey**	.20
	Panel Discussion: Use of molecular techniques for early detection and surveys for AIS	.30
17.00	**End of Day 2**	

	Friday 9TH MARCH	
08.30	Set up Computers	.30
09.00	**ToR b):** Evaluate the impact climate change may have on the introduction and spread of non-indigenous marine organisms, incl. in Arctic environments	
	Presentation: Presentation from host country **Joao Canning-Clode**	.20
	Presentation: Results of the WGITMO-led global trial of the Aquatic Invasiveness Screening Kit (AS-ISK) **Gordon Copp**	.15
	Presentation: Risk assessment protocols towards implementation of the EU Regulation (1143/2014). **Agyro Zenetos, Marika Galanidi & Gordon Copp.**	.15

		.15
	Presentation: CMIST the Canadian Marine Invasive Screening Tool – **Cynthia McKenzie and Tom Therriault**	
	Presentation: Identification and ranking of key ship-mediated NIS in the Canadian Arctic using the Canadian Marine Invasive Screening Tool.- **Kim Howland**	.15
	Discussion on Screening tools and Reporting under ToR b	.10
10:30	**Morning Break**	.30
11:00	**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. **ToR Lead: Stephan Gollasch**	
	Presentation: Abiotic factors related to high NIS richness in Mediterranean marinas **Agnese Marchini**	.20
	Presentation: Biofouling prevention and AIS control – A Harbour Case study – **Cynthia McKenzie**	.15
	Further discussion on ICES Biofouling Viewpoint	.20
	Discussion and Reporting under ToR c)	.15
12.30	**Lunch break**	.60
13.30	**ToR d):** Advance knowledge base to further develop indicators to evaluate the status and impact of non-indigenous species in marine environments ***ToR Lead: Henn Ojaveer***	
	Review ToR objectives and deliverables	.10
	Presentation: Global Approach to Marine Invasive Organism Management- **Thomas Landry**	.20
	Presentation: COMPLETE beyond shipping vectors- **Sergej Olenin**	.20
	Discussion and Reporting under ToR d	

		.20
15.00	**Afternoon break**	.30
15:30	**ToR e) Alien Species Alert Report for ICES CRR on Harmful Algae in Arctic Regions**	
	Review ToR objectives and deliverables	.10
	Review Harmful Algae in the Arctic overview for CRR expand from only one genus?	.20
	Discussion of CRR and alternate ToR	.20
16:30	**Future Planning**	
	Other business or issues	.20
17.00	**Close of WGITMO 2018**	

Annex 4: National Reports (ToR a)

Belgium

Report prepared By:
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Highlights

The barnacle *Balanus glandula* (Kerckhof *et al.* 2018) is now common on hard substrata in the intertidal zone all along the Belgian. The Manilla clam *Ruditapes philippinarum* is being reported more and more. The copepod *Pseudodiaptomus marinus* (Deschutter *et al.* 2018) is found in Belgian waters.

1. Laws and regulations

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

2. Intentional introductions

There is no information available on intentional introductions if any.

3. Unintentional introductions:

The demersal Asian copepod *Pseudodiaptomus marinus* was found in samples collected in the framework of the LifeWatch project that were taken between February 2015 and February 2016 on 3 stations in the Belgian part of the North Sea as well as in samples taken in the harbours of Zeebrugge and Nieuwpoort. Station 120 was close to Nieuwpoort (51° 11′ 1″ N, 2° 42′ 07″ E), station 700 close to Zeebrugge (51° 22′ 6″ N, 3° 12 ′2″ E) and station ZG02, further offshore near the harbour of Nieuwpoort (51° 20′ 0″ N, 2° 30′ 0″ E) (Deschuttere *et al.* 2018.).

The species was already known from the region at Gravelines and in Calais harbour, France (Brylinski *et al.*, 2012). *Pseudodiaptomus marinus* is native to the Northwest Pacific, and it is, like many other copepods of its genus, characteristic of coastal waters including harbours and the mouth of estuaries.

The species seems to be present in the coastal waters from June to November and in the winter the species seems to completely disappear. The dynamics differ by station and densities up to 110 ± 41 ind / m^3 were found. In the port of Zeebrugge this species occurs in large numbers, with abundances up to 560 ± 163 ind / m^3.

The invasive barnacle *Balanus glandula*, was found during recent surveys of hard substrata biofouling communities in Belgian marine waters. This species is new to the European marine fauna. The species was first encountered in 2015 in biofouling on the RV Belgica. In October 2016 the species proved to be common on navigational buoys from Belgian coastal waters and after a dedicated search the species was discovered on many groynes along the Belgian coast. At least two generations were present, indicating that *B. glandula*

had settled during 2015 - probably the first year of its presence – and also in 2016 and 2017. The distribution of *B. glandula* was originally limited to the pacific coast of north America, but in the past decades *B. glandula* successfully invaded subsequently the coasts of Argentina, Japan and South Africa. Given its invasion history elsewhere, it looks that *B. glandula* is on the brink of invading European shores (Kerckhof *et al.*, 2018.)

All introduced species that were reported during previous years are still present and seem to be well-established and thriving except for the barnacle *Megabalanus coccopoma* of which there are no recent records anymore. The Manilla clam *Ruditapes philippinarum* is becoming more and more common.

4. Pathogens

No information available

5. Meetings

6. Research projects:

The BELSPO project Tracking Invasive Alien Species (TrIAS) that aims to build an open data-driven framework to support policy on invasive species to inform policy (Vanderhoeven *et al.*, 2017) and https://www.belspo.be/belspo/brain-be/projects/TrIAS_en.pdf

7. References and bibliography

Brylinski, J.-M.; Antajan, E.; Raud, T.; Vincent, D. (2012). First record of the Asian copepod *Pseudodiaptomus marinus* Sato, 191 (Copepoda: Calanoida: Pseudodiaptomidae) in the Southern Bight of the North Sea along the coast of France. *Aquat. Invasions 7(4)*: 577-584. hdl.handle.net//10.3391/ai.2012.7.4.014

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Deschutter, Y.; Vergara, G.; Mortelman, J.; Deneudt, K.; De Schamphelaere, K.A.C.; De Troch, M. (2018). Distribution of the invasive calanoid copepod Pseudodiaptomus marinus (Sato, 1913) in the Belgian part of the North Sea. Bioinvasions Records 7(1): 33-41

Vanderhoeven S, Adriaens T, Desmet P, Strubbe D, Backeljau T, Barbier Y, Brosens D, Cigar J, Coupremanne M, De Troch R, Eggermont H, Heughebaert A, Hostens K, Huybrechts P, Jacquemart A, Lens L, Monty A, Paquet J, Prévot C, Robertson T, Termonia P, Van De Kerchove R, Van Hoey G, Van Schaeybroeck B, Vercayie D, Verleye T, Welby S, Groom Q (2017) Tracking Invasive Alien Species (TrIAS): Building a data-driven framework to inform policy. Research Ideas and Outcomes 3: e13414. https://doi.org/10.3897/rio.3.e13414

Canada

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Overview:

The European sea squirt (*Ascidiella aspersa*) was first detected in Atlantic Canada in 2012 (Lunenburg harbour, Atlantic Coast of Nova Scotia) and detected again in 2016 and 2017. It was also found at new locations in 2016 (Shelburne, Nova Scotia) and in 2017 found further south at (Clark's Harbour in southwest Nova Scotia), *Ascidiella aspersa* is now considered established in Atlantic Canada. The compound sea squirt *Diplosoma listerianum* was first reported in the Magdalen Islands in 2008 and in Nova Scotia in Lunenburg Harbour in 2012. *D. listerianum* was detected for the first time in Southwest New Brunswick in 2016 and confirmed again in 2017 at several locations. This species was also detected for the first time (2017) at Tiverton, Southwest Nova Scotia and as of 2017, it is considered established in Atlantic Canada.

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

Canada's new Ocean Protection Plan includes policies, funding and activities to address the issue of derelict vessels which have been found to be a source of pollution and of biofouling including Non-Indigenous Species (NIS). Transport Canada's program applies to larger commercial vessels and Fisheries and Oceans Canada (DFO) Small Craft Harbour (SCH) program applies to smaller fishing and recreational vessels. The goal is to remove these vessels as part of Canada's commitment to protecting the ocean environment.

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 June 17, 2015. (http://gazette.gc.ca/rp-pr/p2/2015/2015-06-17/html/sor-dors121-eng.php).

Canada's new Ocean Protection Plan includes policies, funding and activities to address the issue of derelict vessels that have been found to be a source of pollution and of bio-fouling including Non-Indigenous Species (NIS). Transport Canada's program applies to larger commercial vessels and Fisheries and Oceans Canada (DFO) Small Craft Harbour (SCH) program applies to smaller fishing and recreational vessels. The goal is to remove these vessels as part of Canada's commitment to protecting the ocean environment.

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 and 2017, see

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 or 2017.

Spread of established AIS species-

Newly established

Ascidiella aspersa was first detected in Atlantic Canada in 2012 (Lunenburg harbour, Atlantic Coastal Nova Scotia). In 2016, *A. aspersa* was found at a new location in Shelburne (Atlantic Coast of Nova Scotia). In 2017 it was found at Clark's Harbour, Southwest Nova Scotia and is now considered established in Atlantic Canada, though its distribution is contained within South shore Nova Scotia

Diplosoma listerianum was first reported in the Magdalen Islands in 2008, no colonies have been found until 2016. This species was found for the first time in Nova Scotia in Lunenburg Harbour in 2012 and not observed since that time. In 2016, *D. listerianum* was detected for the first time in Southwest New Brunswick at nine locations (Sephton *et al.* 2017). Species was confirmed from microscopic identification, *Diplosoma listerianum* was detected along the Bay of Fundy on Southwest New Brunswick for the first time in 2016, confirmed in 2017 in the same area and for the first time at Tiverton, Southwest Nova Scotia.

In 2017, this species was found in SW New Brunswick and Magdalen Islands and is now considered established in Atlantic Canada.

Established and Spreading

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 by genetic analysis of samples collected within the Bay of Fundy (Greville near Parrsboro, Nova Scotia) from a colony attached to mussels and lemon weed bryozoan (*Flustra foliacea*). In 2017, it was also confirmed by genetic analysis

of samples collected within the Bay of Fundy (near Minas Channel) from colony attached to small rock.

Carcinus maenas continues to spread along shores of Prince Edward Island (PEI) and the Gulf of St. Lawrence (GSL) coast of Nova Scotia (confirmed reports of green crab in 2017 include: Wood Islands and St. Chrysostome, PEI; and, Merigomish, Nova Scotia). The northern limit of its distribution along the NE coast of New Brunswick remains Pokemouche harbour. Abundances of green crab in 2016 and 2017 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, and two in 2017. Cold winters or control efforts are potential factors that could explain 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. Due to intense mitigation efforts (2014-2017) this species has not spread beyond this limited area and abundance in harbours is greatly reduced (see ToR c presentations McKenzie *et al.*) 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 GSL shore of Nova Scotia. *C. intestinalis* is only observed in one harbour 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 harbours along the south and SW coast of mainland Nova Scotia, as well as in coastal Cape Breton and the Bras D'Or lakes, the GSL shore of Nova Scotia, Prince Edward Island and the Magdalen Islands. It is well established in SW New Brunswick and continues to spread into the NE of the province, where the northern limit has been extended to Miscou Island (first occurrence in 2017). It was detected for the first time in Gaspésie, Quebec on collector plates in 2012 but was never observed in that area since that time and then not considered to be established in that area. 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, while its occurrence in the NE portion of the province remains limited. *B. violaceus* has established in most bays on the northern shore of Prince Edward Island and is spreading to eastern and southern shores of the island (confirmed in Egmont Bay in 2017). *B violaceus* is also present in the Magdalen Islands and along the Atlantic and GSL coasts 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 and southern shores of this province (confirmed in South Rustico in 2016 and Egmont Bay in 2017). *S. clava* was reported for the first time in Nova Scotia in 2012 at a few locations within Halifax Harbour and at Lunenburg harbour. In 2013 it was found at all these sites and in addition recorded at several sites within Chedabucto Bay and this species appears to be established within all these areas as they have been found at the same locations every year including 2017.

Caprella mutica is well established on the Atlantic coast of Canada since the 1990's. In 2016, *C. mutica* was observed for the first time in the Bay of Sept-Îles located on the West Coast of the GSL and it is spreading to new locations within the southern GSL (confirmed in Shediac Bay, NB and in Egmont Bay, PEI in 2017).

Membranipora membranacea is well established on the Atlantic coast of Canada since the 1990's. In Quebec, this invasive bryozoan is found in the Magdalen Islands, Gaspe Peninsula and on the West coast of the GSL. Low densities have been detected in eastern PEI, the GSL and Atlantic coasts of Nova Scotia, and SW New Brunswick. *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 PEI) 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. Research and Monitoring Programs

Research Needs

- Research is needed to develop better management practices for biofouling, such as remotely-operated devices for risk assessment and cleaning with particle retention.
- A baseline data set for Canadian Arctic plankton and benthos by marine ecoregions has been collated, but species records for different taxa should be incorporated into a consistent, standardized database format and ideally published/archived in a way that they can be made publicly available.

Research Gaps

- DNA barcode reference libraries to catalogue biodiversity of lower trophic level taxa and provide a basis for the use of new genetic tools for the detection of changes in biodiversity and detection of new species.
- Risk assessment for recreational boating as a vector of AIS to Arctic region
- Population genetics studies of cryptogenic species found in port surveys, to better understand origins (native versus introduced)

Research and Monitoring projects and programs

1) Fisheries and Oceans National AIS Monitoring Program – Atlantic Canada Zone (2005-ongoing)

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Fisheries and Oceans Canada (DFO) has included a monitoring component in its Aquatic Invasive species (AIS) framework since 2005. The Atlantic Zone (Nova Scotia, New Brunswick, Newfoundland and Labrador, Prince Edward Island, Quebec). Monitoring program has been conducting surveys, rapid response, and outreach projects for non-native and invasive species since that time using standardized methods and protocols. Using a combination of harbour surveys (settling plates, video and SCUBA) for detection and spread of biofouling organisms and trapping for invasive green crab, a baseline distribution of AIS in the Atlantic zone has been compiled. Ongoing surveys and monitoring projects are aimed at prevention and early detection, mitigation strategies and providing advice for management of AIS in Canada. Data collected from these surveys are included in the ICES AQUANIS database.

2) In-transit survival and post-arrival performance of hull fouling aquatic invasive species (2017-2019)

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Ships may act as vectors of introduction for aquatic invasive species (AIS) through hull fouling. However, there is limited understanding of the survival of fouling species following short-term in-transit changes in environmental conditions. Normally, last port-of-call (LPoC) information is used to assess the relative risk of introduction of AIS. However, species present in hull fouling communities may be very different from those in the LPoC given that organisms may have accumulated over time through voyages to multiple destinations subjected to a variety of environmental conditions. Further, it is typically assumed that individuals from populations of a given hull fouling species across a range of latitudes have similar probabilities for survival in novel receiving environments, although studies of other organisms show that physiological performance and capacity for adaptation may vary substantially depending on population of origin. This study used a two-step approach for studying

the environmental tolerances for survival and post-arrival performance of fouling organisms. The first will evaluate AIS survival and recovery following exposure to short-term changes in salinity and temperature simulating pathways with transitions between marine and freshwater and back to marine environments, or vice-versa. The second will evaluate the performance and acclimation capacity of fouling AIS populations from different latitudes to the full range of expected temperatures in Canadian waters (temperate-polar). The results of this project will provide a better understanding on fouling vectors and the response of species to changes in environmental conditions. This can contribute to the development of more complete and realistic hull fouling risk assessments.

3) Control of the invasive vase tunicate, *Ciona intestinalis*, on the Burin Peninsula, NL to prevent the spread through vessel vectors (2015-2018)

Cynthia McKenzie, Fisheries and Oceans Canada, NL Region Cynthia.mckenzie@dfo-mpo.gc.ca
Darrell Green, R&D Coordinator Newfoundland Aquaculture Industry Alliance
Bobbi Reese, Provincial Department of Fisheries and Land Resources, Government of Newfoundland and Labrador.
Marguerite Farrell-Drake Harbour Authority, Burin, NL Canada

A three year project to remove and control the vase tunicate (Ciona intestinalis) in Little Bay, Burin Peninsula has been completed. The project was funded by DFO SPERA (Strategic Program for Ecosystem-based Research Advice) and the Provincial Department of Fisheries and Aquaculture with additional support from DFO Oceans, Memorial University and NAIA. The purpose of the project was to remove and control vase tunicate in the areas (Little Bay, Marystown) where early detection made removal feasible. Eradication in an open marine environment is not possible, but control of this invasive tunicate species appears to be very effective. Although harbours in Little Bay and Marystown have been mitigated and controlled in the area, the harbour in Burin which was not part of the mitigation project continues to be invaded by the vase tunicate. It is particularly important to control the spread from this active fishing harbour before it is spread to other areas. Currently, Burin is the only non-controlled area for this invasive tunicate in NL. In order to prevent the introduction or spread from this source harbour, the vectors (movement through boating) and source populations required a rapid response while the temperature is low and the invading species are not reproductive. These vectors include stationary infrastructure, floating infrastructure, vessels and gear. This project provided trials to treat (remove from the water or clean) the floating docks and vessels (which were also treated with antifouling paint. These control actions are allowed and recommended within the Aquatic Invasive Regulations for the Canadian Fisheries Act.

4) Evaluating ship biofouling as a potential pathway for the introduction and spread of aquatic invasive species (AIS) into the Canadian Arctic (2015-2018)

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The primary objectives of this project are: (1) To characterize biofouling extent and management practices of ships operating in Canadian Arctic waters; (2) To evaluate

the importance of ship biofouling as a pathway for the introduction and spread of AIS into the Canadian Arctic. Using a questionnaire that follows the IMO Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species, this project will collect information about voyage history, hull husbandry practices, and results from recent dry docking or in-water biofouling inspection/cleaning. Surveys were distributed to all ships entering the Canadian Arctic in the summers of 2015 and 2016 via the Canadian Coast Guard. Data will be cross-referenced with global positioning information to determine the longer history of vessel activity in order to conduct a risk assessment.

5) Development of community-based program for monitoring and early detection of aquatic invasive species in the Canadian Arctic – preparing for increased shipping related to resource development and climate change (2015-2018)

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Increased shipping in the Canadian Arctic associated with resource development and climate warming will inevitably result in unwanted species introductions. Preventative measures, such as ballast water exchange and treatment and reduction of vessel fouling, are key components for management of aquatic invasive species (AIS). However, these measures are not 100% effective. Thus, in addition to prevention, management should focus on strategies for monitoring and early detection, especially where AIS have not yet established or population levels are still low, as in the Canadian Arctic. Monitoring improves the likelihood of detecting invasions at early stages when there is a greater chance for successful eradication, containment, or to prepare to adapt to the presence of a new species. Through this project we are developing a foundation for the development of a monitoring and early detection system in the Canadian Arctic. This includes the following elements and is extending past research efforts by DFO and the Canadian Aquatic Invasive Species Network (CAISN): 1) Identification and ranking of key ship-mediated AIS for early detection and monitoring, and geographic locations with highest probability for establishment; 2) Development of genetic early detection methodologies (e.g., environmental or eDNA) for AIS in high risk ports; 3) Establishment of a community based monitoring network/capacity. In 2015-2017, collection of port samples (including eDNA samples) and training programs were conducted in the Arctic Ports of Churchill, Iqaluit, Deception Bay and Pond/Milne Inlet. Lab analysis of these samples and identification/genetic analyses are currently ongoing. Results on zooplankton and dinoflagellates have been incorporated into two master theses (ongoing work).

6) An investigation of the risk posed by marine recreational boating as a vector in the introduction and spread of aquatic invasive species in Canada (2011-2016)

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A national marine recreational boating risk assessment was conducted in 2015 to assess the risk of this vector poses to marine systems on both the east and west coasts in Canada. The risk assessment includes information on the level of infestation of NIS in the different Canadian and international ecoregions, the probability that boat vectors will be fouled with NIS – based on extensive surveys and statistical models, information on boat movements, and environmental similarity of source and receiving ecoregions. This is combined with information on annual boat traffic to estimate the relative risk of NIS due to boating in the different Canadian marine ecoregions. This research document and corresponding scientific advice have been published (Simard *et al.* 2017; DFO 2017). A primary paper on an assessment of recreational boating as a vector for marine non indigenous species on the Atlantic Coast of Canada has been submitted.

7) **Rapid and sensitive eDNA methods for early detection and mitigation of AIS and monitoring of aquatic species at risk. (2017-2019)**

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A collaborative project with the Gulf Region's Molecular Biology Unit (funded by the Genomics Research and Development Initiative (GRDI)) was initiated in 2017 to further develop environmental DNA (eDNA) methods for early detection of AIS.

The detection of species using environmental DNA (eDNA) in water samples is a promising approach in support of traditional field surveys for the management and conservation of aquatic species. The method is also gaining popularity as an early detection tool. While traditional monitoring techniques can be limited in morphologically identifying cryptic species or larval life stages, eDNA detection can help resolve these problems, as it is sensitive, rapid and specific. As such, eDNA testing has great potential in aquatic ecosystems to monitor aquatic invasive species (AIS), as well as rare and elusive species e.g. the Brook Floater (*Alasmidonta varicosa*, a species of Special Concern under COSEWIC and SARA). To that end, the goal of this project is to evaluate, develop and optimize eDNA based tests for a list of ~ 24 AIS (9 established and 15 potential), as well as a species of special concern, the Brook Floater. The specific objectives are to:

1) Develop and validate species-specific molecular tests for an initial list of 25 aquatic species (24 AIS and 1 ASAR)
2) Develop and optimize eDNA capture methods (e.g. water sampling, collector plates) optimal for each of the targeted aquatic species
3) Evaluate and compare the eDNA monitoring approaches to other traditional methods such as field surveys in terms of sensitivity, rapidity and cost.

This work will advance AIS early detection ability and sensitivity during routine

surveillance and targeted rapid assessment work, which will provide timely and essential information required for management of aquaculture introductions and transfers under Section 56 of the Fisheries (General) Regulations. Results from this work can be applied to all Atlantic regions of DFO (Gulf, Maritimes, Quebec, NL). There is a need for this type of monitoring, which can increase the surveillance several folds for the same costs currently allocated to these activities.

6. Meetings

2018

- National Aquatic Invasive Species Monitoring Meeting Ottawa, ON 19-22 February, 2018
- Northeastern Aquatic Nuisance Species (NEANS) Panel meeting, Grand Isle, Vermont, United States, 12-13 April, 2018
- 3rd International Conference on Marine and Freshwater Invasive Species, Aquatic Ecosystem Health and Management Society, Beijing, China, 27-29 August, 2018
- International Conference on Marine Bioinvasions X , Puerto Madryn, Patagonia, Argentina, 16-18 October, 2018
- Northeastern Aquatic Nuisance Species (NEANS) Panel meeting, New Hampshire, United States, 3-4 December, 2018

2017

- National Aquatic Invasive Species Monitoring Meeting Ottawa, ON 23-24, February, 2017
- ICES-PICES-CIESM special session: Bioinvasion trajectories and impacts in contrasting marine environments. ICES Annual Science Conference, Fort Lauderdale, USA, 18-21 September, 2017
- 20th International Conference on Aquatic Invasive Species (ICAIS), Fort Lauderdale, USA, 22-26 October, 2017

2016

- 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.
- 19th International Conference on Aquatic Invasive Species (ICAIS), Winnipeg, Canada, 10-14 April, 2016
- Northeast Aquatic Nuisance Species (NEANS) Panel meeting, Providence, Rhode Island, United States, 11-12 May, 2016
- Biofouling Workshop: Approaches to Quantifying Biofouling and Considerations of Hull Cleaning. Edgewater, USA. 24-25 August, 2016.
- Northeast Aquatic Nuisance Species (NEANS) Panel meeting, New Haven, Connecticut, United States, 30 November – 1 December, 2016

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Croatia

Not available - Country presentation can be found on the WGITMO SharePoint site.

Denmark

Report prepared by:

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Overview

A new Action Plan for Invasive Species has been published (in Danish). The Environmental Protection Agency continues the work on implementation of EU legislation on invasive species, the Marine Strategy Framework Directive and the Ballast Water Convention. The escape of about 200 female Coho salmon from a mariculture facility and subsequent capture by sport fishers caused supervision of mariculture facilities to be intensified. A thematic issue of biology teachers' magazine focused on alien species.

Content

Regulations:

The agencies of the Ministry of Environment and Food of Denmark have again been reorganized during 2017. As of February 2017, the Agency for Water and Nature Management has been merged with the Environmental Protection Agency (EPA), and the latter is the official name for the agency (Miljøstyrelsen in Danish). In November 2017 the Fisher-

ies Agency was moved from the Ministry of Environment and Food to the Foreign Ministry. This has influence on aquaculture permits and monitoring as well as fisheries.

A new Action Plan for Invasive species has been published in Danish (Miljø- og Fødevareministeriet. Miljøstyrelsen 2017a; available at http://mst.dk/media/143350/handlingsplan_invasive-arter_juni17.pdf). In connection with this, a series of fact-sheets (in Danish) for the invasive species have been published on the web-site of the EPA. Also, the Danish Center for Environment and Energy (DCE), Aarhus University has published a technical report (in Danish) assessing distribution and impacts of invasive species in Denmark (Strandberg, 2017).

The Danish Parliament (Folketinget) approved the law of Marine Strategy (LBK 117 of 26 Jan. 2017). An action program has also been published (Ministry of Environment and Food. Miljøstyrelsen 2017b). In connection with implementation of the Marine Strategy Framework Directive (MSFD) two reports have been published by NIVA Denmark (Andersen *et al.*, 2017a,b), and an "official" list of introduced marine species in Danish waters has been approved by the EPA (though not yet publicly available) after consultations with a group of experts (including the present author). Also, Technical Guidelines have been made by DCE for including monitoring of introduced species in the marine monitoring program (NOVANA) (Fossing & Stæhr, 2017).

Legislation regulating mariculture has been changed several times during 2017; one reason for these changes is the fear of introducing parasites to salmonid species in low salinity waters (<25 ppt). Apparently the people who had applied for permits have now withdrawn their applications.

Intentional introductions

Legislation requires special permits to release non-indigenous species in the wild. No such permits have been issued. However, unintended escapes from culture facilities with permits to culture non-indigenous species have taken place (see below).

Imports and exports of live fish and shellfish

(data from https://www.statistikbanken.dk/).

Import:

Live American lobster (*Homarus americanus*): ca. 100 t from USA and Canada

Salt water aquarium fishes: toral 16 t; of these 7.7 t from Indonesia, 2.5 t from Kenya; 3 t from the Netherlands, and 1.8 t from Sri Lanka.

Live oysters: total 61.3 t; from France (and Monaco) 24 t; from the Netherlands 37 t

Mytilus spp. Mussels, live: total 12 t; of these 10 t from the Netherlands

Apparently Denmark imported 6 t of *Perna* mussels from Sweden (must be re-exported)

For crabs they do not distinguish between live and cooked: 15 t imported almost exclusively from Norway and Sweden.

Export:

Mussels (*Mytilus* spp.) alive, fresh, refrigerated: 18,274 t – mostly to the Netherlands (11, 350 t) and other EU countries.

Flat oysters (*Ostrea* spp.) alive 40g/pc or less 906 t – to same as above.

Eels (*Anguilla* spp.) alive 458 t larger than 20 cm and 7 t smaller – the smaller mostly to Germany, larger to the Netherlands and other EU countries.

Salmonids (*Onchorhynchus* spp., *Salmo salar*), alive 38 t – of this 25 t to Israel, remaining to EU countries.

Trout (*Onchorhynchus* spp., *Salmo trutta*), alive 5,615 t – mostly to Germany (>5,000 t) and other EU countries.

Unintentional introductions

New

The only new species reported in 2017 is the Coho salmon (*Oncorhynchus kisutch*) which was captured by sport fishers near Horsens (northwestern Belt Sea) in September 2017. After appearing in several press releases (see e.g. , https://www.tvsyd.dk/artikel/soelvlaks-fanget-i-danmark-stammer-fra-havbrug-ved-hjarnoe and http://fiskeatlas.ku.dk/nyheder/Ny_dansk_fisk_-_s_lvlaks_fanget_ved__stjylland.pdf), it was concluded that they were escapees from mariculture, that they were all females – and that it was questionable whether the facility in question had the proper permits and licenses. This in turn led to increased supervision of all mariculture facilities to ensure that they comply with all regulations and have up-dated, valid permits for all activities as well as equipment.

New sightings of species previously recorded (records with WGS84 coordinates supplied by M. Macnaughton):

Dasya baillouviana artificial boulder reef in central canal of harbour – WGS84 coordinates 55.680399 12.595821, 19 September 2017.

People continue to report sightings of *Mnemiopsis leidyi* to the SNM, EPA and to H.U. Riisgård, but there is still no proper monitoring program. We can just report that the species occurs commonly to abundantly throughout Danish waters.

Ficopomatus enigmaticus was found in 4 different places in the harbour area of Copenhagen during the summer of 2017 (May-September): WGS84 coordinates 55.717654 12.586904 (semi-enclosed basin in northern part of harbour used by small boats), 55.684868 12.612266 (this is an enclosed basin formerly part of the defense system of Copenhagen city), 55.654979 12.553163 (a narrow canal slightly north of the original locality in the southern harbour area), 55.64336 12.552946 (near former sluice-gate separating southern harbour basin from central canal). The original locality was not surveyed in 2017.

Rhithropanopeus harrisii was observed at one locality in the harbour of Copenhagen (the enclosed former military basin – see above for coordinates).

There have been the usual couple of catches of mitten crabs (*Eriocheir sinensis*): two from different localities in Randers Fjord (which connects to the longest "river" system in Denmark), and one in the archipelago south of the island Fuhnen (Fyn).

Crassostrea gigas. The occurrence in the northern part of the harbor of Copenhagen was confirmed by photos and video, which means that they survived at least one winter.

WGS84 coordinates 55.717654 12.586904. Other records besides the well-known occurrences in the Wadden Sea and the Limfjord: Helsingør (northern entrance to the Sound (Øresund)) and Humlebæk, some km south of Helsingør. Fyns Hoved (northernmost part of island Fuhnen (Fyn), near entrance to Great Belt (Storebælt). Also, this species may be moving eastwards in the Limfjord; two new records are from Venø Bay and Thisted Broad (Bredning). The latter records have been taken from the web-site of the Environmental Protection Agency (https://invasive-arter.dk/Menu.aspx).

Round goby, *Neogobius melanostomus*, found at artificial boulder reef at northern part of Copenhagen harbor (WGS84 coordinates 55.679221 12.594876) on 27 May 2017. Several other records from straits and fjords where it has been found in previous years.

A major escape incident of rainbow trout happened at a mariculture facility at northestern Great Belt (Storebælt) in December 2017. About 20,000 individuals about to be harvested escaped, and local sport fishers' organizations feared that they would destroy breeding grounds of native trout before they were either captured or died (see e.g. https://www.tveast.dk/artikel/70-tons-oerreder-er-undsluppet-udgoer-reel-trussel-vilde-oerreder).

Not yet seen: Nothing to report

Pathogens: No information available

Research and Monitoring programs

An NGO report analyzing Danish compliance with the Aichi-goals of the Biodiversity Convention concluded that only 2 goals had been achieved, one of which was concerning invasive alien species (Danmarks Naturfredningsforening (DN) og WWF Verdensnaturfonden, 2017; available at http://www.dn.dk/media/25152/biodiversitetsbarometer-2017.pdf).

A thematic issue of the biology teachers' magazine Kaskelot, on invasive species was published in May 2017. See articles listed below for individual species.

A study on *Gracilaria vermiculophylla* from a Danish estuary (Fyns Hoved, near northwestern entrance to Great Belt) showed that it not only needs high nutrient concentrations, but also has larger capacity for storing nutrient than other fast-growing algae, and thus is able to grow even during low nutrient seasons (Pedersen & Johnsen, 2017).

A book chapter published in 2016 was overlooked in last year's report. It deals with ecological impacts of alien marine plants and animals on native marine plants, and impacts of alien marine plants on native plants or animals (Thomsen *et al.*, 2016).

The ecology, especially food web interactions, of the invasive ctenophore *Mnemiopsis leidyi* has been examined in two papers (Bading *et al.*, 2017; Tiselius & Møller, 2017). The invasion history through 10 years has been reviewed (Riisgård, 2017), and a popular article on the same was included in the thematic issue of the biology teachers' magazine (Riisgård *et al.*, 2017).

Genetic studies have shown that Danish and Swedish populations of *Crassostrea gigas* are similar to one another, whereas Norwegian populations are different, indicating separate introduction events and probably different source populations (Anglès d'Auriac *et al.*, 2017). Another study, however, found that there is some similarity between some Nor-

wegian populations and the Swedish and Danish populations, and that the Danish populations are the most likely source for the Swedish ones (Faust *et al.*, 2017). Impact assessment in various habitat types for invasions of *C. gigas* have been carried out to develop management strategies (Mortensen *et al.*, 2017). A popular article on invasive "shellfish" (*Crassostrea gigas, Ensis directus* and *Ocinebrellus inornatus*) was included in the thematic issue of the biology teachers' magazine (Petersen *et al.* 2017). In this connection, it should be mentioned that *Ocinebrellus inornatus* is now again the accepted name for this species (Barco *et al.*, 2017) – see also WoRMS.

One specimen from a Danish population of *Rhithropanopeus harrisii* was included in a study on invasion genomics of this species in the Baltic Sea (Forsström *et al.*, 2017). The study showed that different populations existed, and the Danish specimen clustered with the Estonian population. A popular article on alien crabs was published in the thematic issue of the biology teachers' magazine (Tendal & Jensen, 2017).

The project on salinity tolerance of the round goby, *Neogobius melanostomus*, has resulted in several publications. One studied dispersal potential in relation to osmoregulation (Behrens *et al.* 2017a), another the physiological effects of acoustic tags (Behrens *et al.*, 2017b). A third publication is on the development of an ecological model for management of invasive species, focusing on the round goby in the Baltic Sea (Samson *et al.* 2017). Two popular articles on the round goby have also been published (Krebs & Behrens, 2017; Olsen Alstrup *et al.*, 2017).

Meetings

There have been 3 meetings of the advisory group of experts on invasive species: 4 April 2017 on implementation of EU regulation, risk assessment, Danish action plan discussion; 19 April 2017 on scoring of selected aquatic species, especially rainbow trout; 29 November 2017 on status on EU regulation and lists.

20 October 2017, meeting at the EPA on selecting of target species for monitoring in connection with Ballast water convention; CASE study – discussion of connectivity model.

1-day thematic meeting on MSFD in Denmark, 26 October 2017. Organized by Danish Society for Marine Biology.

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Estonia

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Overview:

Three important findings were obtained in 2016-2017: i) record of the first alive individuals of the gulf wedge clam (*Rangia cuneata*) in Pärnu Bay (NE Gulf of Riga), ii) the second observation of the signal crayfish (*Pacifastacus leniusculus*) in Päru Bay, and iii) single finding of the mud crab *Rhithropaneopeus harrisii* at the southeastern coast of the Gulf of Finland (Narva-Jõesuu). Based on the results of the non-indigenous species monitoring program, abundance/biomass of the zebra mussel *Dreissena polymorpha*, the cirriped *Amphibalanus improvisus*, the clam *Mya arenaria* and the polychaete *Marenzelleria neglecta* are high or very high essentially in the Gulf of Riga, showing often the highest values in the record. 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. In contrast, the Chinese mitten crab (*Eriocheir sinensis*) faces low population size, evidenced of lack of findings in the monitoring area in the SW Gulf of Finland. 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).

1. **Regulations:**

The IMO BWMC ratification process is not yet finalized.

2. **Intentional:**

To enhance the exploitable fish stocks, salmon (*Salmo salar*, 173.1 thousand individuals), sea trout (*Salmo trutta*, 3.3 thousands) and whitefish (*Coregonus lavaretus*, 33.81 thousands) were released to the wild either directly to the marine environment or rivers discharging to the Baltic Sea in 2016.

In 2017, salmon (*Salmo salar*, 179.5 thousands), sea trout (*Salmo trutta*, 2.5 thousands) and whitefish (*Coregonus lavaretus*, 6.9 thousands) were introduced.

All data are available at http://www.envir.ee/et/statistika

3. **Summary of sighting**

Unintentional:

Three important findings were obtained in 2016-2017: i) record of the first alive individuals of the gulf wedge clam (*Rangia cuneata*) in Pärnu Bay (NE Gulf of Riga), ii) the second

observation of the signal crayfish (*Pacifastacus leniusculus*) in Päru Bay, and iii) single finding of the mud crab *Rhithropaneopeus harrisii* at the southeastern coast of the Gulf of Finland (Narva-Jõesuu).

Based on the results of the non-indigenous species monitoring program, abundance/biomass of the zebra mussel *Dreissena polymorpha*, the cirriped *Amphibalanus improvisus*, the clam *Mya arenaria* and the polychaete *Marenzelleria neglecta* are high or very high essentially in the Gulf of Riga, showing the highest values in the record for one or several years since 2016. However, this is not the case for the Gulf of Finland, where these species have shown low to very low population levels (Anon. 2018). 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.

The spatial distribution of the non-native *Palaemon elegans* was wider and abundance higher than that of native species, but nevertheless the novel species had narrower niche space. The results also revealed significant differences in habitat preferences between native and non-native shrimp species. *P. elegans* was associated with habitats characterized by lower salinity and higher concentrations of nutrients, relative to *P. adspersus*. Experiments also demonstrated that the non-native shrimp had higher affinity to vegetated substrates compared to native species (Kuprijanov, 2018).

Two years after the establishment of *Gammarus 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.

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 (Anon 2018).

The round goby *Neogobius melanostomus* continues to increase in population abundance in Estonia. However, abundance of the fish seems to have decreased in the areas colonized for a long time, evidenced by decreased CPUE (Anon 2018). 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).

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, the fish is most abundant at the southern coast of Saaremaa (Kõiguste) in the northern Gulf of Riga. While in the west-Estonian Archipelago area, the gibel carp has showed relatively high/increasing CPUE values, decrease has been observed in the Gulf of Riga and Gulf of Finland (Anon. 2018).

By exploiting the species introduction event data stored in the online information system on aquatic non-indigenous and cryptogenic species, sumamry 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 information 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 (Ojaveer *et al.* 2017).

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). The framework proposal document was further advanced in 2017, by jointly preparing with S. Olenin and M. Lehtiniemi 'HELCOM NIS monitoring programme in the introduction of the Monitoring Manual' the updated introductory part (HELCOM 2017).

4. **Pathogens**

None investigated/monitored

5. **Research and Monitoring Programs**

Research

1. Biodiversity changes – *investigating* causes, consequences and management implications (BONUS BIO-C3; https://www.bio-c3.eu/)

BIO-C3 will investigate causes and consequences of changes in biodiversity, effects on ecosystem functioning, food web dynamics, productivity and assesses implications for environmental management and sustainable use of ecosystem goods and services. Planned biodiversity analyses will apply an integrated approach at species, genotype,

population, community and ecosystem levels. Essential Baltic Sea features are low numerical species diversity, many recent immigrants, glacial relicts and simple food webs that nevertheless sustain goods and services of high economic and societal value. BIO-C3 will i) investigate genetic adaptation, eco-physiology, colonisation and role of native versus non-indigenous species, ii) advance understanding of functional links between biodiversity, external pressures and food-web interactions, and iii) improve future projections of trends in biodiversity. Biodiversity is dynamic, responding to various drivers that operate at different temporal and spatial scales. Spatio-temporal biodiversity responses will be analysed and evaluated by hindcasts and projections considering abiotic/biotic /anthropogenic drivers (climate change, eutrophication, species invasion, fisheries) and their interactions. Identified factors and processes will feed into impact assessments, guiding management policies to improve indicators of Good Environmental Status, efficacy and management of Marine Protected Areas and to conceptualise and design management evaluation frameworks.

2. Round goby in Estonian coastal waters: applied research for developmenting further action plan

Project funded under Estonian Environmental Investments Centre. Contact: Kristiina Nurkse, Estonian Marine Institute, University of Tartu. Email (kristiina.nurkse@ut.ee)

3. Planned Research: BIODIVERSA project proposal

Uniting stakeholder needs and scientific practice to tackle the challenges to biodiversity and ecosystem services caused by invasive species: A multi-continental study of round goby invasions (ASSESS).

Monitoring

The specifically dedicated and governmentally funded national alien species monitoring program, started in 2010, was continued in 2015, 2016 znd 2017. The alien species monitoring consists of three major sub-components: 1) monitoring of high risk areas of primary invasions; 2) tracking long-term performance of selected most important alien species and 3) evaluation of ecological and socioeconomic impacts caused by alien species. Monitoring of high risk areas of primary invasions – vicinity of ports – has been conducted in Port of Tallinn (since 2010) and Port of Sillamäe (since 2012), both located in the Gulf of Finland. Several stations were sampled in port vicinity and also in more distant localities called also as reference sites. Importantly, all data and annual reports are freely available, though unfortunately written in Estonian only (Anon. 2018).

Research Needs

TBD

6. **Meetings**

Presentations were made at the following meetings:

- ✓ 51st European Marine Biology Symposium. Rhodos, Greece 26-30 September 2016.
- ✓ National BONUS BAMBI/BIO-C3/INSPIRE seminar on 'The new challenges in management of the Baltic Sea'. Tallinn, Estonia, 27 April 2016.

- ✓ IX ICMB. Sydney, Australia 19-21. January 2016.
- ✓ 41 th CIESM Congress, Kiel, Germany, 12-16. September 2016
- ✓ 11th Baltic Sea Science Congress. Rostock, Germany, 12-16. June 2017.
- ✓ ICES ASC 2017. Fort Lauderdale, USA, 18-21. September 2017
- ✓ BONUS symposium 'Science delivery for sustainable use of the Baltic Sea living resources'. Tallinn, Estonia, 17-19 October 2017.

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Finland

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Overview:

Highlights of the National Report

A first observation of *Sinelobus vanhaareni*, a little crustacean has been made from Inkoo Archipelago, south coast of Finland in 2016 (identified 2018). The origin of the species is unknown but it is assumed to have spread via shipping. 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 entered into force 8 September 2017. Information on NIS arrivals to Finnish waters was compiled for the second reporting period for the European Commission (MSFD). NIS indicator data set completion for the second HELCOM assessment (jointly with HELCOM secretariat, Lithuania, and co-leads Germany and Sweden) was compiled and the indicator report written for the Baltic Sea area. A proposal on non-native species monitoring framework to HELCOM (jointly with Lith-

uania and Estonia) was done. This work continues to more concrete actions in the project COMPLETE.

1. **Regulations:**

Finland 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 entered into force 8 September 2017.

Finnish law on non-native species took into force 1.1.2016. It implements the EU IAS Regulation (2014).

Information on NIS arrivals to Finnish waters 2011-2016 was compiled for the second reporting period for the European Commission (MSFD).

2. **Intentional:**

Deliberate releases into the Baltic Sea were (including rivers draining into the Baltic) for fisheries and fish stock enhancement purposes in 2016/2017 as follows: 0.001/0.01 million newly hatched and 1.3/1.6 million older salmon (*Salmo salar*), and 0.4/0.2 million newly hatched and 0.8/0.9 million older sea trout (*Salmo trutta* m. *trutta*), ca 35.6/32.9 million newly hatched and 7.1/7.5 million older whitefish (*Coregonus lavaretus*).

3. **Summary of sighting.**

Unintentional:

New Sightings

General information

Sinelobus vanhaareni

A first observation of *Sinelobus vanhaareni*, a little crustacean has been made from Inkoo Archipelago, south coast of Finland in 2016, and identified 2018. The order Tanaidacea, in subphylum Crustacea is new to the Baltic Sea and has no close relatives. The observed individual was an egg carrying female. Sampling site was 3 m deep with a rocky bottom. The genus *Sinelobus* (family Tanaididae) was originally considered to consist of only one cosmopolitan species, *S. stanfordi*. It has been reported as a new alien species in Europe. Later the European individuals were shown to belong to a new species, *Sinelobus vanhaareni*. The origin of the species is unknown but it is assumed to have spread via shipping.

Sinelobus vanhaareni

lat: 59.99461, lon: 24.05713 (WGS 84)

Previous sightings:

General information

Lepomis gibbosus

Observations on pumpkinseed, *Lepomis gibbosus*, were for the first time made in southwestern Finland from five different closed freshwater bodies (first observation in 2014, the rest 2017). These observations seem to be the northernmost ones, at least in the Eu-

rope. The territorial, defensive behavior and the occurrence of at least two year-classes in one of the ponds refer to a reproductive population.

Pomacea spp.

A large apple snail (*Pomacea* spp.) was photographed in 2015 by an underwater photographer in Lake Saimaa in the eastern Finland. The photo was picked up by the Finnish taxonomic expert group on gastropods in 2017, and recognized to belong to the apple snail genus *Pomacea.* Worldwide the apple snails are highly invasive aquatic animals outside their native distribution area in South America. During last decades they have spread in North-America and Asia. From 2009 onwards also in River Ebro in Spain. High densities and biomasses (1 kg/m^2) of apple snails have been estimated to consume half of the rise production in Spain. The costs for fighting against snails are huge worldwide. Due to this Spain banned apple snails and after that (2012) European Commission published a Commission Implementing Decision, "measures to prevent the introduction into and the spread within the Union of the genus *Pomacea*" officially banning all imports and spread within EU. All species in this genus are on the alert list of the EC and every observation should be reported to the Commission. Thus divers went to check the lake area in the Eastern Finland in October 2017 without making any observations of the snail. It is possible that the northern winters are too cold for the species to survive.

Pomacea spp.

lat 61.15064, lon: 28.22100 (WGS 84 coordinates)

Rhithropanopeus harrisii

The mud crab (first found in 2009 in the Archipelago Sea, South-Western Finland) has continued to spread towards north in the Bothnian Sea and also towards the outermost archipelago south from its densest occurrence areas. It was noticed in 2017 that mud crabs are very abundant in the Olkiluoto nuclear power plant area in the Bothnian Sea. This warm water discharge area probably acts as an adaptation and spreading center for the northward spread.

4. **Pathogens**

No investigations on pathogens during 2016 or 2017.

5. **Research and Monitoring Programs**

1. Completing management options in the Baltic Sea Region to reduce risk of invasive species introduction by shipping, COMPLETE (2017-2020).

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The project is led by Kotka Maritime Research Association, Finland and funded by INTERREG Baltic Sea Region Programme. There are 12 project partners from seven Baltic Sea countries. Finland is represented by five partner institutes (Kotka Maritime Research Association, Finnish Environment Institute, University of Helsinki: Dept of Environmental Sciences, Keep Archipelago Tidy and Kymenlaakso University of Applied Sciences). Project is tackling several knowledge gaps: the need to take into account rights and obligations of involved stakeholders; approaches for NIS monitoring and surveillance for EU Marine Strategy Framework Directive (MSFD) and Ballast Water Management Convention

(BWMC); risk assessment based exemptions from ballast water management requirements; legal aspects; regional cooperation and information exchange. Project results will provide comprehensive knowledge for decision making to understand the different antifouling practices in maritime and leisure traffic. Based on this knowledge, recommendations will be compiled which enable the development of harmonized biofouling management strategies for the entire Baltic Sea region. The project aims at developing a roadmap for a harmonized approach by involving all relevant stakeholders from the beginning of the project. SYKE is leading the work package 2 in the project where the aim is to develop and test new methods for NIS monitoring that could be taken into routine use in the Baltic Sea countries and to complete the development of the harmonized monitoring program for the Baltic Sea area.

2. BONUS BLUEWEBS (2017-2020)

Laura Uusitalo, Finnish Environment Institute: Contact: laura.uusitalo@ymparisto.fi

BLUEWEBS is designed to deliver an assessment of the consequences of simultaneously achieving the good environmental status and providing blue growth (i.e. the capability of Baltic Sea food webs to sustainably produce ecosystem goods and services). Global climate change will likely result in novel climates, leading to combinations of physical oceanographic conditions never encountered before in the Baltic Sea. These will affect ecosystems in addition to the regional anthropogenic impacts of eutrophication, fisheries exploitation, invasions of non-indigenous species and accumulation of hazardous substances. These cumulative impacts have already (and will likely continue in the future) cause novel food webs that significantly differ in structure and function from historical predecessors. Novel food webs in concert with novel climates will likely render present management tools and measures unsuitable and hence challenge the ability of society to achieve GES while safeguarding BG potential.

3. Proposal for listing, prioritization and management of unintentional introduction pathways concerning EU Regulation on Invasive Alien Species

(VISAKE - VIERASLAJIEN VARHAISVAROITUS- JA SEURANTAJÄRJESTELMÄN KEHITYS JA TAHATTOMIEN LEVIÄMISVÄYLIEN HALLINTA) **completed in March 2017**

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The project aimed at analyzing and prioritizing the potential unintentional pathways for EU listed invasive species to Finland and inside Finland and suggesting management for the prioritized pathways to meet the requirements of the EU Regulation 1143/2014 on Invasive Alien Species.

6. **Meetings**

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

- Bonus conference in Tallinn in October 2017

- HELCOM/OSPAR TG Ballast meeting in November 2017

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Highlights:

The completion of the first evaluation cycle of the Marine Strategy Framework Directive has led to an update of the national non-indigenous species lists. Since 2016, 19 new introductions and six range expansions have been reported along the French coasts. MSFD monitoring and surveillance programmes are being defined and will prioritise hot-spots

of introduction and high-risk locations. Several projects using DNA-based molecular tools for monitoring biofouling assemblages in ports and marinas are underway. The number of projects contributing to awareness-raising and/or with citizen involvement are increasing, particularly in the Mediterranean.

1. Regulations:

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 monitoring program results. During 2016, the French MSFD scientific pilots liaised with the European Commission to update the new GES commission decision 2017/848, which was officially published in May 2017.

This new decision builds on existing obligations and developments within the EU legislation. The decision is still based on 11 descriptors, 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

Only the D2C1 criterion is currently associated with a sufficiently developed European methodological standard to enable a quantitative assessment. In 2017, France revised the initial assessment of GES for its marine sub-regions, based on the new definition of the GES. The national list of NIS was updated through a compilation of scientific literature over the 2012-2017 reporting cycle. The indicator (NIS3 – trends in arrival of new NIS) was calculated based on this information, giving a semi-quantitative and partial evaluation of the D2C1. Despite several biases due to data and lack of standardised monitoring, 34 new non-native species were reported, including 28 reported for the first time in French waters during this cycle: 8 new introductions in the English Channel – North Sea, 7 in the Celtic Seas, 7 and 15 in the North and South of the Bay of Biscay respectively and 11 in the Western Mediterranean. Even if many introduced species do not have major impacts at this scale, significant and various impacts by several species have been demonstrated. It is important to quickly progress towards an implementation of measures and monitoring programs, to enable prevention of future new introductions, which is the most (cost-) efficient way to manage this biological pressure. The results of

this new assessment will be published in 2018 and reported to the European Commission in 2019.

The establishment of an operational NIS monitoring program, with a focus on at risk and sensitive areas as a priority, is currently underway. It will be based on sampling and/or analysing different biological communities in areas identified as being high risk, i.e. major ports, marinas and marine aquaculture areas, but also sensitive protected areas. The number of test sampling sites, sampling frequency, and monitoring method retained are currently being chosen. The importance of molecular approaches, and their value in detecting emerging NIS species, was considered during a national workshop (see "Meetings"). This work will be a priority area for national leads in 2018-2020, to prepare the 2020 reporting on MSFD monitoring programme reviews.

The intermediate assessment for the OSPAR Convention on trends in new records of NIS introduced by human activities was published online in June 2017. This assessment should guide and contribute towards the MSFD assessments of European Member States in the North-East Atlantic.

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 approved in March 2017. It aims to prevent the introduction of new invasive species and the management of those that are already established. Its emphasis is on France's largely ultra-peripheral territories, which host over 80% of national biodiversity. IUCN France (Yohann Soubeyran- yohann.soubeyran@uicn.fr) has been tasked by the French Agency for Biodiversity and the French Ministry of Environment with the updating of the inventory of exotic invasive species present in French overseas territories. An updated list should be available end of 2018.

In the French overseas territory of Saint-Pierre and Miquelon (SPM), a monitoring program in collaboration with the AIS committee of DFO Canada (Nathalie Simard) is being strengthened for the early detection of AIS, including the green crab *Carcinus maenas.* The SPM monitoring network is now managed by the "DTAM Service Agriculture, Alimentation, Eau et Biodiversité ».

The Global Register of Introduced and Invasive Species (GRIIS project: Shyama Pagad : s.pagad@auckland.ac.nz) is developed under the framework of the Global Invasive Alien Species Information Partnership convened by the Convention on Biological Diversity. GRIIS presents annotated checklists of terrestrial and aquatic introduced and invasive species for all countries worldwide, and is currently engaging with country experts (editors) to verify species records for accuracy, to identify any significant gaps and to check evidence of impacts (to list if the species invasive or not in your country). Once checklists have been verified they will be published through the Global Biodiversity Information Facility (GBIF), with their own citation and DOI number. The French marine checklist is in the process of being updated. French country editors have drawn attention to the difficulty of characterising a species as being invasive or non-invasive.

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.

A modelling approach, based on an innovative individual-based model integrating the full life cycle (i.e. both the microscopic gametophytic and the macroscopic sporophytic stages) was carried out (Murphy *et al.* 2016b, 2017). This model aimed to examine the role of environmental factors, notably irradiance and temperature limitations, in determining the present-day and putative future range of *Undaria pinnatifida* at the European level (Murphy *et al.* 2017). The model was validated against field data from a real-life population in Brittany (Murphy *et al.* 2016a), and predicted theoretical temperature limits for growth (9.1 - 22.5°C) values which closely match the actual current global range limits for the species (9.5 - 22.4°C) reported in the literature. Under this model, the environmental conditions are predicted to be suitable for the continued spread of the species notably in British Isles, particularly under scenarios of increasing sea water temperatures. However, expansion to waters with a mean annual temperature below 10°C will depend on the seasonal variation in the temperature. The model indeed showed a wider ecological niche in conditions of high seasonality.

3. Summary of Sightings 2016-2018

More detailed information on the introduction events listed below is available via the AquaNIS website.

3.1 Unintentional:

New sightings (2016-2017): new country records or new sub-region records

Taxon	Phylum	References	MSFD sub-region, location	First country record?	Year of observation
Amathia verticillata	Bryozoa	Ulman *et al.* 2017 ; Marchini, Ferrario and Minchin, 2015	W. Med		2015
Aoroides longimerus	Arthropoda	Ulman *et al.*, 2017	W. Med	No – previously in N/S Bay of Biscay	2015
Amphithoe valida	Arthropoda	Gouillieux *et al.* 2016	S. BoB (Arcachon)		
Aurelia solida	Cnidaria	Scorrano *et al.* 2016	W. Med - Cannes	Yes	2002
Boccardia proboscidea	Annelida	Spilmont *et al.*, 2016	EC	No – previously in N/S Bay of Biscay	2014
Celleporaria brunnea	Bryozoa	Ulman *et al.*, 2017	W. Med	No	2015
Chaetozone corona	Annelida	Le Garrec *et al.* 2016	N. BoB	Yes	1996
Dictyota cyanoloma	Ochrophyta	Steen *et al.*, 2017	W. Med – Cannes marina	Yes	1999
Erichthonius cf. pugnax	Arthropoda	Ulman *et al.*, 2017	W. Med	Yes	2015
Ianiropsis serricaudis	Arthropoda	Ulman *et al.*, 2017	W. Med	No – also in Arcachon (Gouillieux *et al. In press)*	2015
Melita nitida	Arthropoda		S. Bay of Biscay (Arcachon)	Yes	2013
Oncorhynchus gorbuscha	Chordata – pink salmon	IBMA newsletter (Unpublished)	EC (Canche estuary)	Yes	2017
Penaeus aztecus	Arthropoda – brown shrimp	Galil *et al.* 2017	W.Med (le Grau du Roi)	Yes	2015
Penaeus japonicus	Arthropoda	Pezy *et al.* 2017a	EC (le Havre port)	No – first for region	2017
Penaeus semisulcatus	Arthropoda	Pezy *et al.* 2017a	EC (le Havre port)	Yes	2017

Perisesarma alberti	Arthropoda – mangrove crab	Pezy *et al*. 2017b	EC (Seine estuary)	Yes	2017
Ptilohyale littoralis	Arthropoda	Spilmont *et al*., 2016	EC - Wimereux	Yes	2014
Rangia cuneata	Mollusca	Kerckhof *et al*., 2017	EC (Canal de Caen)	Yes	2017
Stenothoe georgiana	Arthropoda	Ulman *et al*., 2017	W. Med	Yes	2015

W. Med = Western Mediterranean; EC= English Channel, BoB= Bay of Biscay

Previous sightings: new records within the same sub-region

Taxon	Phylum	References	MSFD sub-region, location	Year of most recent observation	Comments
Carcinus maenas	Arthropoda – green crab	CSRPN report – 16.11.2017	Saint-Pierre et Miquelon	2017	Two individuals caught
Celtodoryx ciocalyptoides	Porifera	Gentric & Sauleau, 2016	N. BoB – ria d'Etel	2015	Well-established population
Grandidierella japonica	Arthropoda	Droual at al., 2017	S. BoB - Noyalo river (Gulf of Morbihan)	2015	ovigerous females, ~90 individuals
Gonionemus vertens	Cnidaria	Marchessaux *et al.* 2017	W. Med – Etang de Berre	2016	Bloom
Paracerceis sculpta	Arthropoda	Marchini, Ferrario & Minchin, 2015	W. Med – la grande Motte	2014	Intertwined in *Amathia verticillata*
Percnon gibbesi	Sally lightfoot crab-Arthropoda	MedObsSub record	W. Med - Antibes	2017	Three individuals

W. Med = Western Mediterranean; EC= English Channel, BoB= Bay of Biscay

Not Seen Species yet:

As part of the MSFD first assessment cycle, a list of NIS present in neighbouring countries which may reach French waters by secondary spread has been drafted. This list will be published in 2018 in Massé & Guérin (2018).

The Indo-Pacifc alga *Avrainvillea amadelpha,* which is considered as invasive in Hawaii, was reported for the first time in the Mediterranean Sea in 2015 along the Tunisian coast (Verlaque *et al*., 2017). Previously, the species had been already sampled in 2012 in Libya (Genbank, as *Avrainvillea* sp., accession number: KY205931, https://www.ncbi.nlm.nih.gov/nuccore/KY205931.1)

General Information:

<u>*Algae*</u>

Caulerpa cylindracea is an invasive seaweed native to south-eastern Australia. Since 1985,

date of its first Mediterranean observation (Fax, Tunisia), it has been found along the coast of 15 Mediterranean countries. Recently, many authors have revealed its negative effect on Mediterranean benthic species as well as its potential to strongly alter indigenous communities. In a study by Bentaalah *et al.* (2017), new evidence data are given concerning the situation of this invasive taxon in Algeria and particularly about a recent spread in the western part of the Algerian coasts, near Oran.

Potentially harmful benthic dinoflagellate blooms, well known in tropical latitudes, are increasing in distribution and frequency in temperate areas. Despite the potential human health, ecological and economic impacts, bHABs (benthic Harmful Algal Blooms) ecology is still poorly understood worldwide. The purpose of a study by Mangialajo *et al.* (2017) was therefore to develop and test a new non-destructive sampling method for quantifying benthic dinoflagellate blooms worldwide the Benthic Dinoflagellates Integra- tor (BEDI). The rationale behind the BEDI method is that mechanical resuspension of cells allows the quantification of cell abundance as cells per surface unit area of seabed by integrating both cells in the biofilm and in the surrounding water. The first application of the BEDI to an *Ostreopsis* cf. *ovata* bloom is presented for three sites in the Ligurian Sea and has been compared with classical estimations of biofilm (macroalgal sample) and surrounding water abundances, in order to test its appropriateness for use for both research and monitoring purposes.

Tunicata

Co-existence, interactions and responses to environmental factors of the invasive ascidian Ciona robusta, compared to its native congeners Ciona intestinalis (NE Atl.) and C. roulei (Med. Sea). *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; Gissi *et al.* 2017). Both are important members of the fouling community of artificial structures (e.g. floating pontoons). As part of the PhD work of Marine Malfant, carried out during the French ANR HySea project (coord. F. Viard), the relative fitness (growth and survival) of juveniles of *C. robusta*, *C. intestinalis* and first generation hybrids were examined through an experimental approach with various salinities and temperatures representative of the conditions found in the English Channel (Malfant *et al.* 2017). The results clearly showed that the first-generation hybrids perform as well as parental species under the different conditions. In addition, the invasive species was shown to perform best under the high temperature conditions. As already suggested by field surveys (Bouchemousse *et al.* 2017), this suggests that the invasive species *C. robusta* may benefit from increased sea surface temperature (i.e. future predicted climate change) in its introduction range. Another experiment coupled with molecular studies and including *Ciona roulei* which co-exists with *C. robusta* in the Mediterranean Sea, showed results similar with those documented in the English Channel for *C. intestinalis*: *C. roulei* is hybridizing with *C. robusta* under laboratory conditions (Malfant *et al.* 2018). Whether these two species are reproductively isolated in the field (as shown for *C. intestinalis* and *C. robusta*) however requires further investigation.

Non-indigenous ascidians of the fouling community (floating pontoons). Artificial coastal structures are expanding. Novel habitats are thus colonized by fouling and mobile assemblages, including numerous non-native species. Previous works show that the proportion of

specimens of non-indigenous ascidians in marinas of the English Channel can be moderate to high (20% and 60% according to marina and season ; Bouchemousse 2015; Bouchemousse *et al.* in prep.). The structure and functioning (e.g. interactions between local and non-native species) in these artificial habitats is however poorly studied. Leclerc & Viard (2017) carried out a manipulative field experiment, using settlement panels, to examine the role of predation, initial artificial structural complexity and biotic complexity – arising from the habitat-forming species that grew on the panels during the trial, on the mobile fauna. A total of 42,391 individuals belonging to 144 species were identified on 72 panels deployed in two marinas. They showed that biotic complexity – created by habitat-forming species and associated epibionts which include NIS- prevails over artificial habitat complexity in determining the distribution of mobile species under low predation pressure. These results suggest that further studies should examine in more detail resistance vs. facilitation processes in marine urban habitats.

Fish

A list of the marine fish species occurring in the EEZ of Metropolitan France was assembled from more than 200 references. It contains 729 species distributed in 185 families and 458 genera (Béarez *et al.* 2017). Among them, 23 marine, non-native species have been listed (including Herculean species and range expansions), plus a further 5 amphidromous/brackish water species.

In the Mediterranean Sea, the concurrent temperature increase and abundance of (sub)tropical non-indigenous species (NIS) is leading to its so-called 'tropicalization', which is dramatically evident in the south-eastern sectors of the basin, but also now in the colder north-western sectors of the basin, as the Gulf of Genoa (Ligurian Sea) (Bianchi *et al.*, 2017). A recent (up to 2015) synthesis of NIS records has been collated to update previous similar inventories. A total of 10 NIS was found, three of which are new records for the Ligurian Sea: the SW Atlantic sponge *Paraleucilla magna*, the Red Sea polychaete *Branchiomma luctuosum*, and the amphi-American and amphi-Atlantic crab *Percnon gibbesi*. In addition, juveniles of the Indo-Pacific bluespotted cornetfish *Fistularia commersonii* have been found for the first time.

Marine Protected Areas

Marine protected areas (MPAs) have proven to be an effective tool to conserve marine biodiversity and restore ecosystem functioning, yet their role in providing resilience to global threats, such as biological invasions, is poorly understood. Assessing the effects of MPAs on invasive species is crucial for effective MPA planning and management. A peer-reviewed literature survey has been conducted by Giakoumi & Pey (2017) to synthesize all available information on the performance of alien/invasive species in MPAs at a global scale. The largest proportion of the available literature provided data on alien molluscs (40%), followed by algae (28%). Information on the effects of protection on alien/invasive species is available for only 11% of the marine biogeographic provinces; principally, for the Mediterranean and Caribbean Seas. Only four studies provided adequate quantitative data to estimate the effect of protection on the density and biomass of 12 alien species. Protection had a significant negative effect on half the species, whereas 33% of the species were positively affected. This review demonstrates the scarcity of data on this crucial topic. More evidence on various species and taxonomic groups across marine regions is necessary to draw robust conclusions.

4. Pathogens

The protozoan parasite *Bonamia ostreae* infects the flat oyster *Ostrea edulis*. A study by Gervais *et al.* (2016) demonstrates that the oyster defends itself against eliminating affected cells through hemocyte apoptosis.

5. Research and Monitoring Programs

5.1. EMODNET Atlantic Checkpoint (2015-2018)

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The purpose of the EMODnet checkpoints is to audit the value of marine data services to solve particular commercial and policy challenges with the development of the Blue Economy. With an increasing number of public marine data sources available, it is timely both to (a) support users in finding the right data products to solve their particular challenges and (b) examine how existing data services should be improved; including the content they offer and the way the service is delivered. The Atlantic Checkpoint considers eleven challenges of importance to the Blue Economy in the North East Atlantic, one of which concerns alien species. This challenge handles the ability to identify & source alien species information in the sea basin, assesses whether the current available marine datasets are readily available and appropriate to the use case, as well as flagging up gaps in the current EU data collection framework. Scientific partners: AZTI (lead), Ifremer, IPMA, CSIC.

5.2. HySea (2012-2016)

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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* (previously 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.

5.3. AQUANIS2.0 (2016-2021)

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Supported by the Foundation TOTAL, the national Aquanis 2.0 project aims to develop new tools based on environmental DNA studies to detect, monitor and study non-indigenous species in marine coastal habitats, with a particular focus on biofouling assemblages in marinas/ports, and secondary spread of NIS in neighbouring MPAs. It has thus a two-fold objective: 1) address important questions regarding biological introduction processes, e.g. processes limiting or enhancing the spread from artificial habitats to natural habitats, and 2) deliver effective tools in support of policies and regulations, incl. MSFD. A PhD student, Marjorie Couton, joined the project last October. Besides tools, this project will continue to support surveys of NIS in marinas from Brittany: quadrats

analyses were carried out in autumn 2017 in 10 marinas located along the coasts of Brittany. It will be repeated in spring 2018 to be compared with data obtained 4 years ago (Bouchemousse 2015).

5.4. Marine communities structuring: harbour ecology and invasion biology as comprehension tools (2017-)

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Supported by the Brittany Region, the Conseil Departemental Finistere and the CNRS (PEPS program), this project focuses on biofouling assemblages in marinas. It specifically aims to examine the response of native vs. non-native species to environmental factors such as temperature and pollutants. Using environmental survey and experimental approaches, this project demonstrates a strong heterogeneity at local scale (within harbors) in the community diversity but also in some functional aspects (respiration, secondary metabolites), in relation with distinct local pollution exposure.

5.5. REGENI (REalisation d'un Guide des Espèces Non Indigènes en Normandie; coord. UMR M2C Caen University) (2016-2018)

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Supported by the Agence de l'Eau Seine-Normandie (AESN), the REGENI project 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 both existing and suggested monitoring and management measures, thus contributing towards biosurveillance objectives of the MSFD.

5.6. EMBIMANOR (ENrichissement de la BIodiversité MArine Littorale en NORmandie) (2017-2021)

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This project, also financed by the AESN, aims to understand the evolution in biodiversity of the Normandy coastline and marinas, encompasses two actions targeting non-native species. The first is a monitoring of the populations of crab of asian origin *Hemigrapsus sanguineus* and *Hemigrapsus takanoi,* which will be jointly carried out by researchers and environmental NGOs. The second action will study the fixed hard-substrate fauna present in marinas and will test the hypothesis that the ports of Normandy with high numbers of cross-Channel and international traffic (Cherbourg, Ouistreham, Le Havre et Dieppe) are the main pathway of introduction of non-native (but rarely invasive) species. The chosen protocol is similar to that develop by the Interreg project Marinexus: 40 alveolated polyethylene plates will be immersed at 1.5m depth in 20 marinas between Granville and Tréport. Plates will be removed and analysed after 3, 6, 9, 12 and 24 months, in order to view the entire colonisation sequence. Colonial species present will be identified to the lowest taxonomic level possible.

5.7. Interreg CleanAtlantic (2017-2020)

Lead partner: Centro Tecnológico del Mar - Fundación CETMAR (Spain)

Marine litter is a severe pollution threat with environmental, human health, safety and socioeconomic impacts and demanding regional collaboration. CleanAtlantic addresses this challenge and aims to protect biodiversity and ecosystem services in the Atlantic Area by improving capabilities to monitor, prevent and remove (macro) marine litter. Ifremer is responsible for the "Monitoring and data management" work package. Within this WP, an action steered by ARDITI will evaluate the role of marine litter as a transport facilitator and available habitat for "nuisance biota" (parasites or non-indigenous species).

5.8. Establishment of a taxonomic and molecular reference collection for the Western Australian Prevention List for Introduced Marine Pests

Lead partner: Curtlin University (Australia)

Under the umbrella and initiative of the Western Australia government, an international initiative coordinated by Joana P. Dias allowed the obtention of vouchers and associated COI barcodes for specimens of 75 introduced marine species (representative of all but four of the species listed in the "Western Australian Prevention List for Introduced Marine Pests"). This species list includes species that are native in France (e.g. the annelid *Sabella spallanzanii)* as well as species introduced in Europe, and France (e.g. the mollusk *Crepidula fornicata*, the ascidian *Didemnum vexillum* etc.; See Table S1 in Dias *et al.* (2017)). European, including French researchers, were associated to this work. The reference collection supports the fast and reliable taxonomic and molecular identification of the 75 species. This work paves the way for similar actions in Europe, for instance in light of the implementation of the MSFD surveillance programme.

5.9. Modelling non-indigenous fish species future range

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Different climate change scenarios predict that, by the end of the 21st century, the Mediterranean will increase in temperature between 2 and 4°C. This could favour the expansion of temperate or tropical fish populations, including non-indigenous species, and lead to the decline of colder water species. The ECOMERS laboratory is developing an ecological niche modelling research axis, starting with the (as yet unpublished) evaluation of the current and future invasion of the lionfish *Pterois volitans* and *Pterois miles.* A PhD on this research topic started in September 2017.

5.10. Awareness-raising/Citizen Science in the Mediterranean

The citizen science project Fish Watch Forum (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. A complimentary program, ECOCIMED was launched in July 2017, 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. At present no information on NIS has been mined.

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 a citizen science initiative where SCUBA divers are asked to report sightings of 36 marine invasive species. Data from this network is shared with the IUCN MedMIS information system. The French Biodiversity Agency and the IUCN have been writing climate change report cards for Corsica. These report cards, as well as summarising the best scientific information available, provide suggestions on the best strategic developments to implement to combat climate change. The ECOMERS laboratory (Patrice Francour and Virginie Raybaud) have been tasked with writing the chapter on non-indigenous species, which should be published in 2018.

During the summer of 2017, a flyer was handed out to owners of mega-yachts in the area of Monaco Principality and in neighbouring marinas of the French Riviera, as a result of collaboration between the ECOMERS laboratory and the AMPN (available from francour@unice.fr). The key message is a plea to not release any plants or animals from aquariums at sea, and to request yacht owners/managers who have on-board aquariums to make sure the water is properly treated (i.e. by ozonation, filtering or UV).

6. Meetings

Past years (2016 & 2017)

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)
- 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
- Island Biology 2016 (Terceira Island, Azores, 18-22 July 2016)

- NEOBIOTA 2016 – 9th International Conference on Biological Invasions (Vianden, Luxembourg, 14-16 September 2016)
- AIS (Aquatic Invasive Species) Monitoring Atlantic Zone meeting. (Ottawa, 22-23 February, 2017)[1]
- eDNA workshop (Paris, France, 18th of October 2017)
  The French National Agency for Biodiversity (AFB) organized a workshop dedicated to environmental DNA: a revolution for the management of aquatic biodiversity? (Paris, 18th October 2017). Although most of the workshop dealt with freshwater and terrestrial environments where considerable progress had been made in the past years, one talk dedicated to marine NIS was provided F. Viard based on two review papers (Viard *et al.* 2016 and Darling *et al.* (2017)) to high-

[1] Participation from Saint-Pierre et Miquelon

light the high potential (and challenges) of such tools for monitoring marine NIS, notably in light of the MSFD.

- National NIS MSFD workshop (Paris, France, 14th of November 2017)
  The main objectives of this workshop were to a) bring together national NIS expertise and, as part of the MSFD assessment cycle b) update national NIS checklists c) further the development of a dedicated NIS monitoring program.

Meetings in 2018

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

- EUROBUS (Towards an EURopean OBservatory of the invasive calanoid copepod *Pseudodiaptomus marinUS)* workshop (Naples, Italy, 29-30 January 2018)
- AIS (Aquatic Invasive Species) Monitoring Atlantic Zone meeting. (Ottawa, Canada, 21-23 February 2018)
- Marine Evolution 2018 – session on evolutionary biology of marine invasions (Strömstad, Sweden, 15-17 May 2018)
- 18th International Conference on Harmful Algae (ICHA2018) (Nantes, France 21-26 October 2018)
- International Conference on Ecological Sciences – session on biological invasions (Rennes, France, 22-25 October 2018)
- National NIS MSFD workshop (Paris, Autumn 2018)

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Germany

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Overview:

Two new taxa were recorded for Germany in 2017 but they cannot be added to AquaNIS yet as they were not identified to species level. One is in the Polychaeta Genus *Laonome* (Lackschewitz pers. comm.). It was found 2016 in the Kiel Canal and 2017 in the Brunsbüttel locks (North Sea side of the canal) as well as in the port of Hamburg in fresh water (Anja Schanz, pers. Comm.). We noted Dutch records of *Laonome calida* in 2009 and in Belgium 2014, but it has to be seen if this German record is the identical species. Other records include Latvia (2012), Estonia (2014) and Sweden (2014) reported as *Laonome* sp..

The second species is a small, round shaped, dark colonial ascidian tunicate found in Büsum (North Sea). The taxonomic analysis is currently on going.

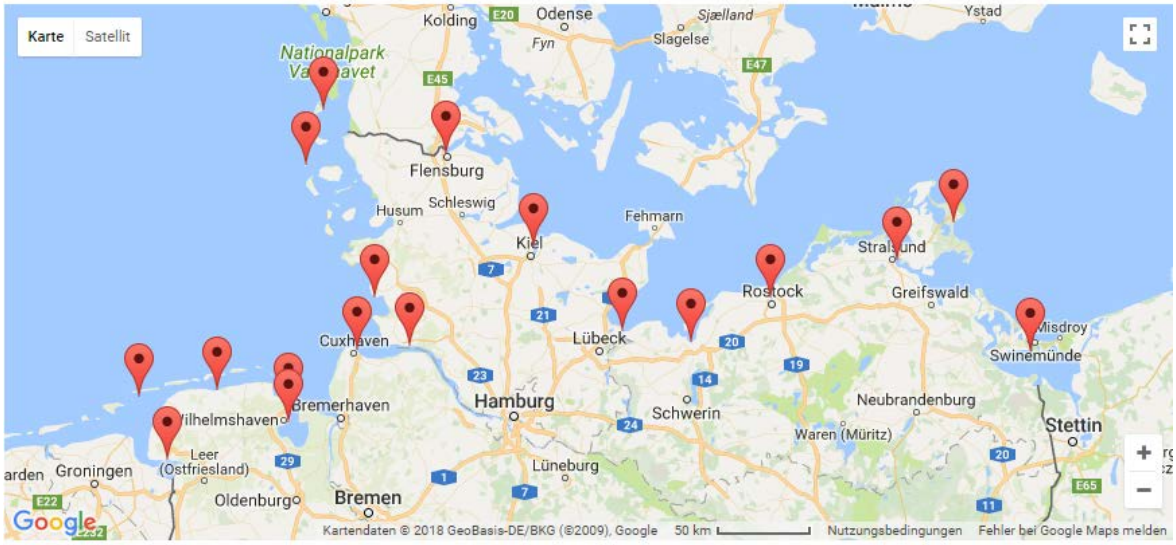

Figure 1. German stations for MSFD NIS monitoring and assessment.

Styela clava specimens were found at two stations during the GEOMAR NIS rapid assessment monitoring in the Port of Kiel in 2017. The salinity is lower than anticipated for their occurrence. The taxonomy was confirmed by Thomas Stach. This is the first record from the German Baltic coast. The closest known occurrence is in Denmark in the Limfjord, but the species was not recorded in the Danish Baltic Sea (Kattegat).

First living individuals of *Ruditapes philippinarum* were found in November 2016 at Langeneß (North Sea), later also near the North Sea islands Föhr and Sylt (both 2017). This was recorded at BeachExplorer, a citizen science instrument, but the records were confirmed by Rainer Borcherding (Schutzstation Wattenmeer e.V., Hafenstrasse 3, 25813 Husum, Germany).

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

Content:

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

No new German legislation has been implemented in 2015/2016. The EU Regulation 1143/2014 on Invasive Alien Species has been implemented in national law in 2017.

As reported in previous years, the **Working group on Neobiota** continues its work with approximately semi-annual meetings to facilitate the information exchange e.g. in the framework of the MSFD Federal States Marine Monitoring Programme and the BWMC. The trend indicators (rate of new introductions) 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. The Neobiota Platform continued its work as expert platform on marine neobiota issues

(www.awi.de/forschung/besondere-gruppen/nordseebuero/neobiota-meldestelle.html). For news regarding newly found NIS, see also www.neobiota-plattform.de/english/news/.

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

www.meeresschutz.info

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

EU Regulation 1143/2014 on Invasive Alien Species

Regulation (EU) 1143/2014 on invasive alien species (the IAS Regulation) entered into force on 1 January 2015, fulfilling Action 16 of Target 5 of the EU 2020 Biodiversity Strategy. It provides for a set of measures to be taken across the EU in relation to invasive alien species included on a list of Invasive Alien Species of Union concern. The first Union list entered into force on 3 August 2016 (no marine species, but see below). The first update of the Union list entered into force on 2 August 2017 with 12 additional species (no marine species).

At the EU IAS committee meeting at 5th December 2017, many members requested a pause before the list of IAS of Union concern is further updated, in order to allow you to focus on the implementation of the Regulation for the species that are already listed. The Commission services reflected on this request and decided to proceed as follows:

- The Scientific Forum on IAS will continue its work towards delivering its opinion on the risk assessments submitted in 2017, and any other risk assessments submitted in 2018 by the deadline of 10 February 2018.
- All risks assessments for which the Scientific Forum delivers a positive opinion will be brought to the IAS Committee for consideration together (both 2017 and 2018 submissions) in the context of a possible update of the Union list in 2019. Therefore, there will be no updating of the list in 2018.
- During 2018, the Commission and the Member States will focus on strengthening the implementation of the Regulation for those species that are already listed and work with economic actors to help prepare for potential listing of more species.

The update originally planned for 2019 includes a marine species, *Plotosus lineatus* (striped eel catfish). It is known to occur in the Red Sea, East Africa to Samoa, north to southern Japan, southern Korea, the Ogasawara Islands, south to Australia and Lord Howe Island. Palau and Yap in Micronesia. It sometimes enters freshwaters of East Africa (Lake Malawi) and Madagascar (www.Fishbase.de, assessed 14 FEB 2018). No publicly available records of this species are found in AquaNIS.

On the list is so far only one marine (catadromous) species, i.e. the Chinese mitten crab. All other species are freshwater or terrestrial. 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. Three distinct types of measures are envisaged, which follow an internationally agreed hierarchical approach to combatting IAS:

- **Prevention**: a number of robust measures aimed at preventing IAS of Union concern from entering the EU, either intentionally or unintentionally.
- **Early detection and rapid eradication**: Member States must put in place a surveillance system to detect the presence of IAS of Union concern as early as possible and take rapid eradication measures to prevent them from establishing.
- **Management**: some IAS of Union concern are already well-established in certain Member States and concerted management action is needed so that they do not spread any further and to minimize the harm they cause.

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 what will be happening when organisms of these species are imported from non-EU Member States? May these parcels be opened for inspection (conflict with postal privacy)? In cases it was confirmed that these species were sent, can the donor be made known to authorities (for procecution)? Nehring (2016) published a report documenting the current distribution in Germany of the 37 species of EU-wide concern of the first list.

Ballast Water Management Convention (IMO-BWMC)

The entry-into-force requirements for this Convention were met, so that ballast water management requirements are 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). In the latest vessel´s ballast water needs to comply with the D-2 standard in 2024. 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.

3. Unintentional:

New Sightings

No new species records for Germany in 2017 were added to AquaNIS because of the unclear taxonomy of the new sightings. One is in the Polychaeta Genus *Laonome* (Lackschewitz pers. comm.). It was found 2016 in the Kiel Canal and 2017 in the Brunsbüttel locks (North Sea side of the canal) as well as in the port of Hamburg in fresh water (Anja Schanz, pers. Comm.). We noted Dutch records of *Laonome calida* in 2009 and in Belgium 2014, but it has to be seen if this German record is the identical species. Other records include Latvia (2012), Estonia (2014) and Sweden (2014) reported as *Laonome* sp.. The second species is a small, round shaped, dark colonial ascidian tunicate found in Büsum (North Sea). The taxonomic analysis is currently on going.

Styela clava specimens were found at two stations during the GEOMAR NIS rapid assessment monitoring in the Port of Kiel in 2017. The salinity is lower than anticipated for their occurrence. The taxonomy was confirmed by Thomas Stach. This is the first record from the German Baltic coast. The closest known occurrence is in Denmark in the Limfjord, but the species was not recorded in the Danish Baltic Sea (Kattegat).

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), and
- in AquaNIS: www.corpi.ku.lt/databases/index.php/aquanis/.

Previous Sightings

The species which were added to last year's report as new findings were also found in 2017. These include the sea squirt *Didemnum vexillum* (found on Sylt Island), the brown algae *Undaria pinnatifida* (Sylt Island), the polychaet *Boccardia proboscidea* (Helgoland Island), the sea squirt *Corella eumyota* (Jade-Weser-Port), and the amphipod *Monocorophium uenoi* (Port of Bensersiel).

Not Yet Seen Species

We searched AquaNIS for new introduction events in our neighboring countries The Netherlands, Denmark and Poland.

Baltic Sea

Nine introduction events are included in AquaNIS along the Danish Baltic coast since 2005 of which four are unknown in Germany.

- The fishes *Acipenser stellatus* and *Huso huso* were found in the Belt Sea in 2010.
- 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.
- The polychate *Tharyx killariensis* was recorded in 2012. This species is known from German North Sea coasts since 1972 and might have spread to now occur also in the Belt Sea.

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),

- *Potamothrix hammoniensis*, not documented anywhere else in northern Europe, was found in Poland in 2010.

North Sea

For Denmark we found 11 new recorded species since 2005 and of those three were not (yet) recognized in German North Sea waters.

- The Asian oyster drill (gastropod) *Ocinebrellus inornatus* found in 2006, it is widely spread in Europe (see records for the Netherlands below),
- The comb jelly *Beroe ovata* found in 2013,
- The Endomyxa (Haplosporidium) *Bonamia ostreae* found in 2014.

When comparing the 20 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 bivalve *Bellamya chinensis* found in 2009, not known anywhere else in Europe,
- The polychaete *Bispira polyomma* was recorded in The Netherlands in 2010, but nowhere else in north-western Europe,
- The hydrozoan *Blackfordia virginica* occurs along continental Europe from Portugal to its (so far) northernmost occurrence in The Netherlands (found here 2014),
- The red algae *Ceramium botryocarpum* and *C. tenuicorne*, both found in 2011 (and not found anywhere else in 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 *Laonome calida* in 2014, in German surveys a *Laonome* species was found, which was not recorded earlier, but it is unclear yet which one,
- The polychaete *Marphysa sanguinea*, found in The Netherlands in 2008, but nowhere else in northern Europe,
- The fish *Neogobius fluviatilis* found in 2009 (since 1997 also in Poland),
- 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 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).

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.

In addition, Germany is actively contributing to non-indigenous species-related meetings at IMO, HELCOM, OSPAR, trilateral Wadden Sea cooperation and other regional and international meetings.

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Greece

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Overview:

In the period 2016-2017, 15 publications and four PhD theses have resulted in the addition of 36 new alien species belonging to Mollusca (10 species), Polychaeta (9 species), Crustacea (6 species), Pisces (5 species), Bryozoa (3 species), Ascidiacea (1 species), Mammalia (1 species), and Porifera (1 species). Another ten species previously overlooked have been added to the list.

A 2018 annotated list of IAS includes 283 species, 217 of which are validated as aliens. Unaided natural dispersal of Lessepsian immigrants (58%) and transport-stowaways (37.1%) are the major pathways of introduction reported for Greek waters. However, with few exceptions (6.4% of species), the confidence level in assigning a pathway was medium to low.

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

European Commission (2014) **Regulation (EU) 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. *Official Journal of the European Union* 317: 35-55 has been adopted and a new project to establish a central SYSTEM in the MINISTRY, and PRIORITISE IAS after Risk assessments is in progress.

Towards implementation of the **Marine Strategy Framework Directive (descriptor D2),** a monitoring scheme has been approved and is planned to start within 2018.

2. **Intentional:**

No intentional introductions were reported.

3. NEW Summary of sighting.

Unintentional:

Thirty-six new NIS species have been reported from Greek waters in the period 2016-17 (Table 1). Crocetta *et al.* (2017) who reviewed the status of molluscs in Greece, added 4 gastropod species based on unpublished material provided by citizen scientists. We refer to: *Cerithidium perparvulum* (Watson, 1886), *Cerithiopsis pulvis* (A. Issel, 1869), *Cerithiopsis tenthrenois* (Melvill, 1896), and *Pyrunculus fourierii* (Audouin, 1826). It is worth mentioning the presence of the bivalve *Isognomon legumen* (Gmelin, 1791) (Micali *et al.* 2017) and

of the gastropod *Viriola* sp. [cf. *corrugata* (Hinds, 1843), both species reported from Karpathos (Micali *et al.*, 2017). The presence of the first is the second Mediterranean record after Israel (2015: Mienis *et al.*, 2016) while the latter constitutes the first Mediterranean record. *Viriola* sp. [cf. *corrugata* was also reported from S. Turkey (Ovalis & Zenetos in Stamouli *et al.*, 2017), and appeared recently in Saronikos Gulf, is considered to be established in the Mediterranean.

Recent studies (Tempesti *et al.* 2016; Ulman *et al.* 2017) have added the decapod *Dyspanopeus sayi* (Smith, 1969) and four isopods to the Greek NIS list, namely, *Paranthura japonica* Richardson, 1909; *Sphaeroma walkeri* Stebbing, 1905; *Mesanthura* cf. *romulea* Poore & Lew-Ton, 1986, and *Cymodoce fuscina* Schotte & Kensley, 2005. The finding of the last species consists its first record in the Mediterranean Sea. The finding of the amphipod *Bemlos leptocheirus* (Walker, 1909) in Heraklion Old Venetian Harbour, Kriti (Ulman *et al.* 2017) is interesting. *Bemlos leptocheirus* is one of the early lessepsian immigrants reported from Egypt as early as 1924 (Schellenberg, 1928).

Nine new polychaetes were added to the list, all based on one or few specimens, that were reported from PhD theses.

The recent study of 3 marinas in Kriti and Rodos Islands has added to the Greek NIS the ascidian *Symplegma brakenhielmi* (Michaelsen, 1904) (Ulman *et al.* 2017) and three bryozoan species namely, *Celleporaria brunnea* (Hincks, 1884), *Celleporaria vermiformis* (Waters, 1909) and *Tricellaria inopinata* d'Hondt & Occhipinti Ambrogi, 1985.

Five new fish species were reported. Three of them (*Oxyurichthys petersi* (Klunzinger, 1871), *carus ghobban* Forsskål in Niebuhr, 1775; *Parupeneus forsskali* (Fourmanoir & Guézé, 1976)) are well known lessepsians, established in the Levantine Sea. *Synchiropus sechellensis* Regan, 1908 is a newcomer in the Mediterranean (Gökoğlu *et al.* 2014) that was reported from Kastellorizo and Rodos (Kondylatos *et al.* 2016) and appears to be established (M. Corsini, pers. commun.). Finally, the Indo-West Pacific fish *Lutjanus sebae* (Cuvier, 1816) reported from the Saronikos Gulf, was seemingly released by an aquarium hobbyist (Zenetos *et al.* 2016).

The latest record is that of a **cetacean,** the Indian Ocean humpback dolphin, *Sousa plumbea* (G. Cuvier, 1829), which was sighted near the port of Heraklion, Kriti, Greece (Frantzis 2018).

Table 1. New records of alien species from Greece reported during 2016-2017.

SPECIES	Taxon	First Sighting	establ	source
Eurythoe complanata (Pallas, 1766)	Annelida	2008	cas	Chatzigeorgiou et al. (2016) PhD
Hydroides brachyacantha Rioja, 1941	Annelida	2015	cas	Ulman et al. (2017)
Leonnates persicus Wesenberg-Lund, 1949	Annelida	2013	cas	Faulwetter et al. (2017)
Lepidonotus tenuisetosus (Gravier, 1902)	Annelida	2008	cas	Chatzigeorgiou et al. (2016) PhD
Linopherus canariensis Langerhans, 1881	Annelida	2007	cas	Chatzigeorgiou et al. (2016) PHD
Lumbrinerides neogesae Miura, 1981	Annelida	2002	cas	Papageorgiou et al. 2006 (unpublished); Faulwetter et al. (2017)
Mediomastus capensis Day, 1961	Annelida	2006	cas	Maidanou et al. (2017) PhD
Neanthes agulhana (Day, 1963)	Annelida	2007	cas	Chatzigeorgiou et al. (2016) PhD
Timarete punctata (Grube, 1859)	Annelida	2006	cas	Maidanou et al. (2017) PhD
Celleporaria brunnea (Hincks, 1884)	Bryozoa	2015	unk	Ulman et al.(2017)
Celleporaria vermiformis (Waters, 1909)	Bryozoa	2015	est	Ulman et al.(2017)
Tricellaria inopinata d'Hondt & Occhipinti Ambrogi, 1985	Bryozoa	2015	unk	Ulman et al. (2017)
Lutjanus sebae (Cuvier, 1816)	Chordata,Pisces	2010	cas	Zenetos et al. (2016)
Oxyurichthys petersi (Klunzinger, 1871)	Chordata,Pisces	2010	cas	Apostolopoulos and Karachle in Karachle et al. (2016)
Parupeneus forsskali (Fourmanoir & Guézé, 1976)	Chordata,Pisces	2017	est	Kondylatos and Corsini-Foka in Stamouli et al. (2017)
Scarus ghobban Forsskål in Niebuhr, 1775	Chordata,Pisces	2014	cas	Apostolopoulos and Karachle in Karachle et al. (2016)
Synchiropus sechellensis Regan, 1908	Chordata,Pisces	2014	est	Kondylatos et al. (2016)
Symplegma brakenhielmi (Michaelsen, 1904)	Chordata,Tunicata	2016	est	Ulman (2016, 2018)
Bemlos leptocheirus (Walker, 1909)	Crustacea, Amphipoda	2015	unk	Ulman et al. (2017)
Cymodoce fuscina Schotte & Kensley, 2005	Crustacea, Isopoda	2015	cas	Ulman et al. (2017)
Mesanthura cf. romulea Poore & Lew-Ton, 1986	Crustacea, Isopoda	2016	unk	Ulman et al. (2017)
Paranthura japonica Richardson, 1909	Crustacea, Isopoda	2012	unk	Tempesti et al. (2016)
Sphaeroma walkeri Stebbing 1905	Crustacea, Isopoda	2015	unk	Ulman et al. (2017)
Dyspanopeus sayi (Smith, 1969)	Crustacea,Decapoda	2015	cas	Ulman et al. (2017)
Sousa plumbea (G. Cuvier, 1829)	Mammalia	2017	cas	Frantzis (2018)
Clementia papyracea (Gmelin, 1791)	Mollusca, Bivalvia	1985	cas	Crocetta et al. (2016)
Isognomon legumen (Gmelin, 1791)	Mollusca, Bivalvia	2016	est	Micali et al. (2017)
Cerithidium perparvulum (Watson, 1886)	Mollusca,Gastropoda	2010	cas	Crocetta et al. (2017)
Cerithiopsis pulvis (A. Issel, 1869)	Mollusca,Gastropoda	2010	cas	Crocetta et al. (2017)
Cerithiopsis tenthrenois (Melvill, 1896)	Mollusca,Gastropoda	1994	cas	Crocetta et al. (2017)
Oscilla galilae Bogi, Karhan & Yokeş, 2012	Mollusca,Gastropoda	2016	cas	Micali et al. (2017)
Pyrunculus fourierii (Audouin, 1826)	Mollusca,Gastropoda	2013	cas	Crocetta et al. (2017)
Rhinoclavis kochi (Philippi, 1848)	Mollusca,Gastropoda	2016	cas	Poursanidis and Zaminos in Lipej et al. (2017)
Sticteulima sp. [cf. lentiginosa] (A. Adams, 1861)	Mollusca,Gastropoda	2015	cas	Ovalis and Zenetos in Gerovasileiou et al. (2017)
Viriola sp. [cf. corrugata] (Hinds, 1843)	Mollusca,Gastropoda	2016	est	Micali et al. (2017)
Paraleucilla magna Klautau, Monteiro & Borojevic, 2004	Porifera	2014	est	Azevedo et al. in Gerovasileiou et al. (2017)

Previous Sightings

The brown alga *Cutleria multifida* (Turner) Greville, a species previously thought to be native to the Mediterranean Sea, is now considered as alien according to molecular work carried out by Kawai *et al.* (2016).

A search in the Ocean Biogeographic Information System (OBIS) revealed an early record (1970's) of the cryptogenic barnacle *Amphibalanus amphitrite* (Darwin, 1854) from Evvoia Island by Koukouras and Matsa (1998).

According to the annotated checklists of Ascidiacea of Greece (Antoniadou *et al.* 2016) and following the recent changes in the alien/cryptogenic status of several ascidian and bryozoan species made by Zenetos *et al.* (2017b) six ascidian species should be added to the Greek list of NIS. These are the alien species *Ascidiella aspersa* (Müller, 1776), *Ciona robusta* Hoshino & Tokioka, 1967 [reported as *Ciona intestinalis* (Linnaeus, 1767)], *Diplo-*

soma listerianum (Milne Edwards, 1841), *Styela plicata* (Lesueur, 1823), and the cryptogenic species *Botryllus schlosseri* (Pallas, 1766) and *Clavelina lepadiformis* (Müller, 1776), all reported in Antoniadou *et al.* (2016).

Similarly, according to the annotated list of Bryozoa (Gerovasileiou & Rosso, 2016) six alien species, previously overlooked, are added to the Greek NIS. These are, the ctenostome *Amathia verticillata* (delle Chiaje, 1822) and the cheilostomes *Crepidacantha poissonii* (Audouin, 1826), *Crisularia serrata* (Lamarck, 1816), *Exechonella antillea* (Osburn, 1927), *Microporella coronata* (Audouin, 1826) and *Scrupocellaria scruposa* (Linnaeus, 1758). However, the alien status of *E. antillea* is debatable while the presence *M. coronata* is considered questionable.

4. Not Seen Species Yet

Although no Horizon scanning has been carried out at National level, in a recent work covering the marine NIS in South-East Europe, Karachle *et al.* (2017) identified more than 45 species as still expected in Greek waters. The groups with the highest numbers of expected species were Ascidiacea (eight species), Decapoda and Annelida (seven species each). The ten most likely species to arrive were (in taxonomic order): *Codium parvulum* (Bory de Saint Vincent ex Audouin) P.C.Silva, *Galaxaura rugosa* (J.Ellis & Solander) J.V.Lamouroux, *Macrorhynchia philippina* Kirchenpauer, 1872, *Leodice antennata* Savigny in Lamarck, 1818, *Metapenaeus stebbingi* Nobili, 1904, *Matuta victor* (Fabricius, 1781), *Ecteinascidia thurstoni* Herdman, 1890, *Decapterus russelli* (Rüppell, 1830), *Jaydia smithi* Kotthaus, 1970 and *Plotosus lineatus* (Thunberg, 1787).

5. **NEW Research and Monitoring Programs**

PROGRAMS

Ongoing

- **MARCONS** is a COST Action aiming to to advance marine conservation in the European and contiguous seas. More than 100 scientists from 28 countries participate in the Action. One of its working groups (WG3) is about marine conservation and biological invasions. The objectives of this WG are (1) to offer methodological approaches and tools for designing networks of MPAs that are more resilient to biological invasions, and (2) to propose management actions to mitigate the impacts of invasive species on biodiversity and ecosystem services. University of the Aegean. **Project duration**: **2016-2020**.
- **ESENIAS-TOOL**S: East and South European Network for Invasive Alien Species – a tool to support the management of alien species in Bulgaria (ESENIAS-TOOLS). Funded by THE Financial Mechanism of the European Economic Area 2009-2014, Programme BG03 Biodiversity and Ecosystem Services. **Project duration: 2015-2017.**
- **RECONNECT (INTERREG V-B)** aims to tackle global threats such as the impact of invasive species and the loss of biodiversity which can be inadequately dealt with only at an international level and under a transnational approach. WP4: A database (TraitBank) with functional traits of selected and invasive species identified during habitat mapping will be created. Institute for Marine Biology, Biotechnology and Aquaculture-Hellenic Centre for Marine Research. **Project duration: 2017-2019**.

- **MOUNT "MOdern UNifying Trends in marine biology**". WP1.1 Population genomics of fish (Task 1.1.1: Invasion genomics of Lessepsian migrants). Institute for Marine Biology, Biotechnology and Aquaculture-Hellenic Centre for Marine Research. 10/2018-9/2020. Greek Operational Programme Competitiveness, Entrepreneurship and Innovation. **Project duration: 2014-2020 (EPAnEK)**.
- **MARISCA/PROTOMEDEA:** These projects do not have specific alien species related objectives, but extensive field surveys were conducted within their frameworks. In these field surveys that covered the entire Aegean Sea, the population density of alien fish and the occupancy of other alien benthic species was estimated. Many new records of alien species were recorded.

Planned

- **MSFD:** Monitoring scheme adopted: 8 monitoring sites every 2 years, including hotspot areas for Lessepsian migration, vessels, and aquaculture as well as MPAs and areas of biogeographic importance. Hellenic Centre for Marine Research and Hellenic Agricultural Organization-DEMETER / Fisheries Research Institute of Kavala. **Starting 2018**.

Planned Research

HCMR/University of Crete: Post Doc

AlienPort : Establishment of a Monitoring Network and a web-based platform of Non-Indigenous Species in Major Ports of Greece. Post Doc Dr Georgios Chatzigeorgiou

AlienPort project aims to create a monitoring network among the major Ports of Greece based on a web platform that includes data, software and network of scientists. The web platform, taking advantage of the LifeWatchGreece Research Infrastrucutre (ESFRI), will include information and data on species lists of NIS and their distribution in the ports studied by the project. In addition, AlienPort will propose a sampling protocol specially focused on NIS species in ports and a management action plan for the Port Authorities to use in order to minimize the impact of the NIS in their ports. The results of the project will be available to the port and management authorities and will be potentially used as a base for developing management tools.

PEIRAIAS, HERAKLION, PATRAS, RHODES

Institute for Marine Biology, Biotechnology & Aquaculture - HCMR. Duration: 36 months - starting 2018.

University of the Aegean: Post Doc

MODIAS: Assessment of the impacts of biological invasions in the Aegean Sea trophic webs using an ecosystem modeling approach. Post Doc Dr Athanasios Evagelopoulos

The core objective of MODIAS is the assessment of how the biological invasions taking place in the South Aegean Sea during the last few decades impact and are influenced by the native food web structure and functioning, fisheries and climate change, using the Ecopath with Ecosim ecosystem modeling tool. It will thus adopt a cumulative impacts assessment framework and follow the ecosystem-based approach that is required by major EU policies related to the management of the marine environment and its resources, like the Marine Strategy Framework Directive and the Common Fisheries Policy.

University of the Aegean, School of Environment, Department of Marine Sciences: Duration: 36 months - starting 2018.

PhD Project: Konstantinos Tsirintanis: Impacts of marine alien species in the Aegean Sea. The aim will be to investigate the under-studied interactions of native and alien species, at priority and vulnerable habitats such as underwater caves and shallow forests of canopy algae. Multiple approaches will be applied for the quantification of these relationships, such as field experiments, large-scale surveys, satellite imaging and remote sensing, species distribution modelling and cumulative impacts assessments. The concluding research aim of this project will be to provide answers to important ecological questions that will assist marine managers in better decisions of actions for marine conservation and halting biodiversity loss in the region.

University of the Aegean, School of Environment, Department of Marine Sciences. Started 2018.

6. **Meetings**

Past year

- 7th ESENIAS Workshop and Scientific conference "Networking and regional cooperation towards Invasive Alien Species Prevention and Management in Europe"
- 28-30 March 2017, Sofia, Bulgaria
- A Joint GFCM-UN Environment/MAP "Sub-Regional Pilot Study for the Eastern Mediterranean on Non-Indigenous Species in Relation to Fisheries", 20-21 September 2017, Athens, Greece.

Upcoming meetings

- Joint GFCM-UNEP/MAP "Sub-Regional Pilot Study for the Eastern Mediterranean on Non-Indigenous Species in Relation to Fisheries", 5-8 March 2018, Chania, Greece
- Marine Evolution 2018 Conference, Session: Evolutionary Biology of Marine Invasions (Session organizers: A. Blakeslee, C. Tepolt, K. Vasileiadou, C. Pavloudi, T. Dailianis, T. Manousaki), 15-17 May 2018, Strömstad, Sweden
- 12th Panhellenic Symposium of Oceanography and Fisheries, Session: Non-Indigenous Species and Aquatic Invasions, 30 May - 3 June 2018, Corfu, Greece

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Israel

Report prepared by:

Bella S. Galil

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

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.* 2018). Of the 17 species recorded between the ICES Working Group on Introduction and Transfers of Marine Organisms (WGITMO) in March 2016 and the present meeting, more than half are considered to have been introduced through the Suez Canal. The major introduced taxa in the Levant- crustaceans and fish – are represented by 4 species each. The extraordinary large number of records (per 180 km long coastline) highlights the role of the southern Levant as a "hotspot", a beachhead and dispersal hub for their secondary spread. The documen-

tation of Erythraean aliens on the upper slope is an ominous development – allowing invasive species to spread into habitats previously inhabited by native species alone.

The implication of a time lag between the first record and subsequent spread is that even were new introductions curtailed, populations of some Erythraean aliens already in the Levant are likely to increase and spread in future. The longer management of the Erythraean invasion is delayed, the larger the "invasion debt" we accrue.

Galil *et al.* 2018. East is east and West is west? Management of marine bioinvasions in the Mediterranean Sea. Estuarine, Coastal and Shelf Science 201:7-16

Content:

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

No regulations, no policies concerning marine NIS. No official list of marine NIS. Though marine nature reserves have been documented to contain large NIS populations, the Nature Reserves Authority has not conducted a census.

2. **Intentional:**

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3. Unintentional:

New Sightings

CHLOROPHYTA

Codium pulvinatum Wynne & Hoffman, 2017 SPECIES NEW TO SCIENCE

Monosporus indicus Børgesen 1931

Hoffman *et al.* 2016 Tetrasporangial plants of *Monosporus indicus* (Ceramiales, Rhodophyta): a new alien in the Mediterranean Sea. European Journal of Phycology

Hoffman *et al.* 2018 *Codium pulvinatum* (Bryopsidales, Chlorophyta), a new species from the Arabian Sea, recently introduced into the Mediterranean Sea. Phycologia, 57(1): 79-89.

BRYOZOA

***Conopeum ponticum* (Hayward, 2001) on tar ball,** not tallied

***Arbopercula tenella* (Hincks, 1880)**

***Drepanophora birbira* (Powell, 1967)**

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

***Mucropetraliella thenardii* (Audouin 1826)**

Sokolover *et al.* 2016 Bryozoa from the Mediterranean coast of Israel. Mediterranean Marine Science 17(2):440-458

SCYPHOZOA

Cotylorhiza erythraea Stiasny, 1920

Galil *et al.* 2017. *Cotylorhiza erythraea* Stiasny, 1920 (Scyphozoa: Rhizostomeae: Cepheidae), yet another erythraean jellyfish from the Mediterranean coast of Israel. Marine Biodiversity 47(1): 220-235

MALACOSTRACA

Arcania brevifrons Chen, 1989

Gonioinfradens giardi (Nobili, 1905)

Grandidierella bonnieroides Stephensen, 1948

Penaeus aztecus Ives, 1891

Galil *et al.* 2016 Foul play? On the rapid spread of the brown shrimp *Penaeus aztecus* Ives, 1891 (Crustacea, Decapoda, Penaeidae) in the Mediterranean, with new records from the Gulf of Lion and the southern Levant. Marine Biodiversity 47(3): 979-985

Galil *et al.* 2017 A record of *Arcania brevifrons* Chen, 1989 (Crustacea; Decapoda; Leucosiidae) from the Mediterranean coast of Israel. BioInvasions Records 6(3): 249-253

Galil *et al.* 2018 The resurrection of *Gonioinfradens giardi* (Nobili, 1905), newly recorded from the SE Mediterranean Sea. Zootaxa 4370(5): 580-590

Lo Brutto *et al.* 2016 *Grandidierella bonnieroides* Stephensen, 1948 (Amphipoda, Aoridae)—first record of an established population in the Mediterranean Sea. Zootaxa. 4092(4):518-528

MOLLUSCA

Isognomon legumen (Gmelin, 1791)

Phidiana militaris (Alder and Hancock, 1864)

Mienis *et al.* 2016 first record of the Indo-Pacific *Isognomon legumen* from the Mediterranean coast of Israel (Mollusca Bivalvia, Isognomonidae). Triton 33:9-11

Rothman *et al.* 2017 Alien facelinid nudibranchs in the Eastern Mediterranean: first report of *Phidiana militaris* (Alder and Hancock, 1864) and report of *Caloria indica* (Bergh, 1896) 30 years after its previous sighting. BioInvasions Records 6(2): 125-128

ACTINOPTERYGII

Arnoglossus nigrofilamentosus Fricke, Golani & Appelbaum-Golani, 2017 SPECIES NEW TO SCIENCE

Encrasicholina gloria Hata & Motomura, 2016 SPECIES NEW TO SCIENCE

Fistularia petimba Lacepède, 1803

Paracanthurus hepatus (Linnaeus, 1766)

Hata H, Motomura H 2016 Two new species of the genus *Encrasicholina* (Clupeiformes: Engraulidae): *E. intermedia* from the western Indian Ocean and *E. gloria* from the Persian Gulf, Red Sea and Mediterranean. Raffles Bulletin of Zoology 64:79-88

Fricke *et al.* 2017 *Arnoglossus nigrofilamentosus* n. sp., a new species of flounder (Teleostei: Bothidae) from off the Mediterranean coast of Israel, probably a new case of Lessepsian migration. Scientia Marina 81(4): 457-465

Marcelli *et al.* 2017 Finding Dory: first record of *Paracanthurus hepatus* (Perciformes: Acanthuridae) in the Mediterranean Sea. Marine Biodiversity 47(2): 599-602

Stern *et al.* 2017 The arrival of a second 'Lessepsian sprinter'? A first record of the red cornetfish *Fistularia petimba* in the Eastern Mediterranean. Mediterranean Marine Science 18(3):524-528

Previous Sightings

Charybdis longicollis Leene, 1938, first recorded in Israel in 1954, dominates mid shelf sandy-mud bottoms at the Levant. **It recently spread to the upper slope off Israel down to 250 m**.

Innocenti *et al.* 2017 Going down together: invasive host, *Charybdis longicollis* (Decapoda: Brachyura: Portunidae) and invasive parasite, *Heterosaccus dollfusi* (Cirripedia: Rhizocephala: Sacculinidae) on the upper slope off the Mediterranean coast of Israel). Marine Biology Research 13(2):229-236

Matuta victor (Fabricius, 1781) was first collected in Haifa Bay in 2012, at the site where a year earlier the Israel Ministry of Environmental Protection authorized a massive beach nourishment scheme depositing 50,000 m^3 of sand. Within 3 years the population underwent explosive growth and spread to Lebanon and Turkey. Undeterred, the ministry authorized deposition in 2016 a total of 100,000 m^3. It is likely that the settlement and rapid population increase of *M. victor* in Haifa Bay formed the "**beach head**" for its subsequent spread to **Lebanon** and **Turkey.**

Innocenti *et al.* 2017 Aggressive, omnivorous, invasive: the Erythraean moon crab *Matuta victor* (Fabricius, 1781) (Crustacea: Decapoda: Matutidae) in the eastern Mediterranean sea. Journal of Natural History 51:2133-2142

The patterns of invasions of **soft-bottom shelled molluscs** have been quantified based on a unique dataset collected between 2005 and 2012 at 13 sites along the coast of Israel. **The number of NIS doubled between 2005 and 2012**. **Disturbance regimes** related to human activities seem to have a critical role in promoting richness and abundance of NIS.

Guarnieri *et al.* 2017 A hazardous place to live: spatial and temporal patterns of species introduction in a hot spot of biological invasions. Biological Invasions 19(8):2277-229

4. **Pathogens**

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5. **Research and Monitoring Programs** (by project- similar to WGBOSV reporting).

No nationally-funded program focused monitoring NIS.

Italy

Report prepared by:

Prepared by Anna Occhipinti-Ambrogi and Agnese Marchini, Department of Earth and Environmental Sciences, University of Pavia, Via S. Epifanio,14 - I-27100 Pavia, Italy, March 2017.

(for a full list of contributors please refer to the end of the report)

Overview:

Eight new introduced species are reported from Italian coasts. These include: three crustaceans, one pycnogonid, one tunicate and three fish species. All of them were recorded in Sicily. Several species reported previously are expanding their range, among which the comb jelly *Mnemiopsis leidyi*, whose blooms in the Adriatic Sea are raising concern. Projects contributing to awareness and information or to involve citizens are increasing.

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

The Council of Ministers has adopted the EU Regulation 1143/2014 on "invasive alien species" in December 15th 2017; it entered in force on February 14th 2018. Italy is planning to adopt a national list of Invasive Alien Species – IAS - of concern, and is considering the inclusion of marine species. The Italian Institute for Environmental Protection and Research (ISPRA), with the collaboration of Scientific Societies such as SIBM (Italian Society of Marine Biology) is currently leading the screening exercise aiming to prioritize the most threatening marine IAS to be potentially included in the national regulation and undergone a risk assessment procedure.

2. Intentional introduction

No new intentional introductions have been reported.

3. Unintentional introduction

New Sightings

Invertebrates

The Western Atlantic amphipod *Stenothoe georgiana* is reported from one harbour and several marinas along the western and southern Italian coast, namely from the Ligurian Sea (Lerici: 44.075°N, 9.905°E) and Sardinia (Porto Torres, coord. 40.842°N, 8.395°E) (Ferrario *et al.*, 2017), and from the Gulf of Naples (Sorrento: 40.629°N, 14.374°E) and Sicily (Palermo: 38.142°N, 13.370°E, Siracusa: 37.073°N, 15.284°E, Licata: 37.097°N13.943°E), as well as from Malta (35.890°N; 14.523°E) (Ulman *et al.*, 2017). The species had been recently reported from Spanish fish farms, but was not known before from elsewhere in the Mediterranean.

Three female specimens of the Penaeid prawn *Trachysalambria palaestinensis* (Steinitz, 1932) were caught by trammel nets off Ragusa, Sicily (36°46.642'N - 14°33.634'E) on Sep-

tember 2016 (Insacco and Zava, 2017). The species has originated from the Red Sea and Persian Gulf and has colonized the eastern and southern rim of the Mediterranean reaching the Tunisian coast.

The Red Sea stomatopod *Erugosquilla massavensis* was detected for the first time in Italian waters, along the eastern coast of Sicily, in the western Ionian Sea. This species coming from the Red Sea is very abundant in the Levantine waters, reaching also Egypt, Lybia and Tunisia. A single specimen was caught by trawlers on May 2017, in an area near the river Simeto mouth, 37.310122ºN; 15.146615ºE (Corsini Foka *et al.*, 2017).

The pantropical pycnogonid *Achelia sawayai* s.l. is reported from the Italian localities of Riposto (37.732°N; 15.208°E) and Siracusa, Sicily (37.063°N; 15.284°E), as well as from Malta (35.890°N; 14.523°E) (Ulman *et al.*, 2017). These represent the first records of this species for the Mediterranean Sea.

The tunicate *Symplegma brakenhielmi*, already known from Israel, Lebanon and Turkey, was reported from Palermo, Sicily (Marina Villa Igiea 38.142°N; 13.370°E) (Ulman *et al.*, 2017). This represents the first record in the Central Mediterranean Sea.

The serpulid *Spirobranchus tetraceros* was reported from the marina of Siracusa, Sicily (37.063°N; 15.284°E) , which represents the first record in the Central Mediterranean Sea (Ulman *et al.*, 2017). Since it represents a complex of species of uncertain origin, it was provisionally not added to the inventory of Italian NIS.

Two different records of the Polychaete *Chaetozone corona* were published (Munari *et al.*, 2017; Grossi *et al.*, 2017). Following Le Garrec *et al.* (2017) we prefer to consider the species as cryptogenic, so we did not add it to the Italian NIS list.

Fishes

A single individual of the lionfish *Pterois miles* was spotted off of the Vendicari coast (Southern Sicily, 36º49′10.36″N; 15º06′28.99″E) in September 2016 (Azzurro *et al.*, 2017). This observation confirms a trend of rapid expansion through the Mediterranean Sea.

The scarid fish *Chlorurus rhakoura* Randall & Anderson, 1997, of eastern Indo-Pacific origin, is recorded for the first time from the Mediterranean Sea. A small school of six individuals of this species was caught off Portopalo, Sicily, 36°36.561'N - 15° 8.456'E, in February 2017 (Insacco *et al.*, 2017).

A third alien fish, namely an adult-sized (about 50 cm long) red emperor snapper *Lutjanus sebae*, was captured in December 2016 off the city of Palermo, Sicily (38.236819° N, 13.294576° E). This is the second finding of the species in the Mediterranean Sea, after the juvenile individual recently catched in Greece. The vector of introduction of this large specimen to the southern Tyrrhenian Sea is very puzzling (Gerovasileiou *et al.*, 2017).

Previous Sightings

Algae & higher plants

The paper by Luglié *et al.* (2017) reports new data on paralytic shellfish toxins (PSTs) from Sardinia and Sicily, where toxic events, mainly caused by *Alexandrium* species (Dinophyceae), have been ascertained in mussel farms since the 2000s. The toxicity of the *A. minutum*, *A. tamarense* and *A. pacificum* strains, established from the isolation of vegetative cells and resting cysts, was determined by high performance liquid chromatography (HPLC).

Alexandrium pseudogonyaulax, together with other non identified species of *Alexandrium*, was recorded with low densities in three sampling dates in the port of Trieste. The non-indigenous diatom *Pseudo-nitzschia multistriata* was found in the plankton of the same port (Cabrini *et al.*, 2016).

An initial scenario of the toxic *Alexandrium minutum* distribution in the Mediterranean Sea, based on the specific sxt A1 gene and STX content, was developed by Penna *et al.* (2016), illustrating the potential risk of PSP occurrences.

A systematic study on toxin profiles and content of Mediterranean *Ostreopsis* cf. *ovata* was performed by Tartaglione *et al.* (2017) with the aim to ascertain the toxic potential of *O.* cf. *ovata* in the Mediterranean Sea, by investigating a significant number of strains collected at 10 Italian coastal sites and cultured under the same conditions. Although the species did not show any variability based on biomolecular results, a significant degree of variation in toxin profiles existed. In 75% of the analyzed strains, toxin content was in the range 4–70 pg/cell with higher levels (up to 238 pg/cell) being found in strains from the Ligurian Sea (Genoa and Villefranche sur Mer) and from the South Adriatic Sea (Giovinazzo, Bari).

Two innovative methods for the automated count of *Ostreopsis* spp. concentration in sea water were described by Vassalli *et al.* (2018). The first is a molecular assay based on RT-qPCR and the second an opto-electronic device implementing automatic recognition algorithms. The proposed approaches were tested on samples coming from different locations along the Mediterranean Sea and compared with the standard counting method based on microscopy observation by a taxonomy expert. The results demonstrate the effectiveness of both automatic approaches. The potential utilization of dissolved organic phosphorus (DOP) by micro-epiphytic mats associated with *Ostreopsis* cf. *ovata*, was investigated throughout a full cycle of a bloom that occurs annually (over the last few decades) during summer along the Adriatic coast – Conero Riviera (Accoroni *et al.*, 2017).

Moderate densities (30 to 63 cells ml^{-1} of the invasive microalga *Chrysophaeum taylorii* were found at Scoglitti (Southern Sicily) (Calabretti *et al.*, 2016).

A manipulative field experiment was carried out in a marine reserve in NE Sardinia, to investigate the effects of the mucilage produced during the bloom of the invasive microalga *Chrysophaeum taylorii* on hard bottom macroalgal communities (Caronni *et al.*, 2016). In the same area, the effect of nutrient enrichment on blooms of *C. taylorii* was investigated (Belloni *et al.*, 2016).

In July 2016 the presence of *C. taylorii* was dectected in the Marine Protected Area of the Isole Tremiti in the Apulian region, although at lower densities in comparison to other areas of the Mediterranean Sea (Calabretti *et al.*, 2017).

Alien seaweeds were investigated in the Phlegraean enclosed coastal lagoons of the Gulf of Naples. The Rhodophyte *Hypnea cornuta* in Lake Fusaro; the green algae *Caulerpa cylindracea* and *Codium fragile fragile* and the red alga *Gigartina* cf. *pistillata* in Lake Miseno (Cecere *et al.*, 2016). As for the latter, should the identification be confirmed, this would be the first Mediterranean record.

A survey to assess the spread of *Caulerpa cylindracea* in the Calabrian Tyrrhenian coasts has been undertaken; the study has considered also the navigation routes as vectors for the dissemination of the alga and the impacts on the native community (Cantasano *et al.*, 2017). An updated overview of invasive *Caulerpa* in Sicily has been produced by Mannino and Balistreri (2017). *Caulerpa cylindracea* was the only alien alga found during a detailed survey on the vermetid reefs in Favignana, one of the Egadi Islands, W Sicily (Balistreri and Mannino, 2017).

The red alga *Ganonema farinosum*, previously known from warm waters of the Mediterranean and from the island of Vulcano (Sicily) has been found in the Ligurian Sea, in the protected area of the small island of Bergeggi (Mussat Sartor *et al.*, 2016). The species was known along the Mediterranean coast of Egypt since 1808 (prior to the opening of the Suez Canal), therefore its alien status is uncertain and it was not included in the Italian list of NIS.

Gracilaria vermiculophylla was the most abundant alga in the area of the navigable canal connecting the centre of Venice to the industrial harbor of Porto Marghera. *Agardhiella subulata* and *Hypnea flexicaulis* (now considered a heterotypic synonym of *H.cervicornis*) were also present in the same area: the alien species represented 40% of total algal biomass (Sfriso *et al.*, 2016). The antibacterial activity of lipidic extracts of the invasive brown alga *Undaria pinnatifida*, sampled in the Lagoon of Venice was determined by Rizzo *et al.* (2016).

The potential of low abundance invaders to alter the resilience of native communities to disturbance has been explored by Bulleri *et al.* (2017) on Mediterranean rocky reefs, by transplanting the non-native seaweed *Caulerpa cylindracea* in small and large plots that were either cleared of the native canopy (formed by the fucoid seaweed *Cystoseira brachycarpa*) or left untouched. The results suggest that some nonnative species may be stronger competitors than natives, despite their low abundance.

Rizzo *et al.* (2017) showed that results show that *C. cylindracea* can influence the quantity and biochemical composition of sedimentary organic matter, and that microbial populations associated with colonized sediments do have specific metabolic patterns and degradation capacities. Samples were taken in 3 localities of the Apulia Region (plus one in Montenegro And one in Greece)

Invertebrates

A geochronological study of sediment cores collected in front of the Po river delta (North Adriatic Sea) has allowed for reconstruction of the molluscs assemblages and has revealed that the first appearance of the introduced bivalve *Anadara trasversa* in the region

was much earlier than previously thought, namely in the 1970s and not in the late 1990s (Albano *et al.*, in press).

The mechanisms of persistence of the hydrozoan *Clytia hummelincki*, as well as its population dynamics both in barren grounds and in species-rich, algae-dominated shallow rocky communities, were investigated *in situ* at four sampling sites in the Northern Ionian Sea (Martell *et al.*, 2017)
The occurrence of the white-spotted Australian jellyfish *Phyllorhiza punctata*, an Indo-Pacific scyphozoan was reported from the Ionian coast of Italy (Taranto), as well as from Maltese waters; it had been previously recorded in Sardinia and western Mediterranean, while it is common in the Levantine basin (Deidun *et al.*, 2017b).

The planktonic ctenophore *Mnemiopsis leidyi* was observed in the offshore, coastal and lagoon systems of the northern Adriatic, at temperatures ranging from 13 °C to 29 °C and salinity from 11 and 38, from July to December 2016. Dense blooms were detected intermittently from mid-August to November 2016 (Malej *et al.*, 2017). Biometric and biomass measurements, laboratory data on egg production and microscopic observations were provided in the paper, along with distribution data.

Del Pasqua *et al.* (2017) have analyzed the genetic structure (on mithocondrial DNA) of the alien polychaete *Branchiomma bairdi* from individuals of five Mediterranean sites and from Mazatlan (Mexico, Pacific Ocean).The different haplotypes cluster in two genetic/geographic divergent groups, thus suggesting the existence of different genetic lineages within the species. Divergence between Mediterranean and East Pacific haplotypes, reflecting their distinct geographic origins, suggests a founder effect in the introduced populations and excludes the Mexican population as a source zone of introduction in the Mediterranean, while the relatedness among Mediterranean haplotypes suggests a degree of connectivity between populations in this basin.

A gastropod previously identified in the Adriatic Sea as *Chrysallida fischei* and subsequently described as a new species under the name *Turbonilla flaianoi*, proved to be conspecific with material from French Polynesia, which likely represents its native range (Mazziotti *et al.*, 2017). Hence, this constitutes a case of pseudo-indigenous species (an introduced species described as new to science from the non-native range).

A single specimen of the heterobranch mollusc *Bursatella leachii* was recorded in the South Adriatic Sea, during bottom trawl surveys carried out from 2011 to 2015 (Casciaro *et al.*, 2017). However, a recent review of the literature regarding *B. leachii* distribution in the Mediterranean Sea (Selfati *et al.*, 2017) suggests that this species may not be a case of lessepsian migration, but rather a case of natural range expansion from Gibraltar. Due to the uncertainty of the "alien" status, the species has therefore been provisionally excluded from the inventory of Italian NIS.

In the Varano Lagoon (Apulia, Central Adriatic coast) non-indigenous species dominated the molluscan assemblage. Four species were present: *Arcuatula senhousia* was the most abundant (89%), *Anadara transversa, A. inaequivalvis* and *Ruditapes philippinarum* (Scirocco *et al.*, 2016).

The copepod *Pseudodiaptomus marinus* was recorded by Cabrini *et al.* (2016) in all the stations sampled in the port of Trieste (N Adriatic).
A single specimen of the non-indigenous crab *Callinectes sapidus* was reported from La Spezia, in the Ligurian Sea, collected by fishermen who then brought it to the attention of professional scientists (Suaria *et al.*, 2017).
Callinectes sapidus was also studied through field samplings in five coastal systems of the Apulia region (SE Italy), three located on the Ionian and two on the Adriatic Sea. Captured blue crabs were weighed and had their $\delta^{13}C$ and $\delta^{15}N$ isotopic signatures measured; their trophic level (TL) was estimated. A considerable spatial and temporal trophic flexibility was found, also in relation with the size of the individuals (Mancinelli *et al.*, 2017a). A literature review of the knowledge about *C. sapidus* in southern Europe has been published by Mancinelli at al. (2017b).

Lezzi *et al.* (2017) report results from a 2-year study on the succession pattern of macrofouling assemblages in the Taranto Sea, where 4 sets of PVC panels were used as collectors. The macrofouling community consisted of 93 sessile invertebrate species, of which 16 were NIS and 5 were cryptogenic. Four introduced species, *Celleporaria brunnea*, *Branchiomma bairdi*, *Perophora multiclathrata*, and *Watersipora subtorquata* were newly recorded for Apulia. *Microcosmus squamiger* was previously erroneously reported in the Taranto basin as *M. exasperatus*. Ascidians (mainly *Polyandrocarpa zorritensis*), serpulids (*Hydroides dirampha* and *H. dianthus*), and bryozoans (*Amathia verticillata*) were structuring components of early communities when favorable conditions exist. Sabellid worms (*Branchiomma bairdi* and *B. luctuosum*) that settled in early and late communities, unlike the other NIS, were are able to persist and become dominant.

The role of commercial harbours as sink and source habitats for non-indigenous species and the role of recreational boating for their secondary spread were investigated by analyzing the fouling community of five Italian harbours and five marinas in the western Mediterranean Sea (Ferrario *et al.*, 2016, 2017). The NIS were observed in all of the sampled localities, ranging from a minimum of three to a maximum of 14 per locality (22 NIS in total). The most common NIS recorded during the sampling campaigns were: *Hydroides elegans*, occurring in all 10 localities investigated, *Celleporaria brunnea* in nine localities and *Paranthura japonica* in eight localities. The hypothesis of a relationship between the NIS assemblages of harbours and neighbouring marinas was not consistently proven by the data, and some small marinas displayed numbers of NIS as high as large commercial harbours.

Fish

Four individuals of *Siganus luridus* have been caught in Rocca San Nicola – Southern Sicily (37.1116083° N, 13.856567° E) (Castriota and Spinelli, 2017).

Orsi Relini (2017) and Lo Brutto (2017) comment on the *Kyphosus* species found in Italy, but there is no agreement about the taxonomic identification and origin of the species (see Orsi-Relini 2017 and references therein).

Species not yet seen

Invertebrates

The Indo-Pacific *Parasmittina egyptiaca*, a cheilostomatid bryozoan found in fouling communities, was reported from Lebanon, Israel, Turkey and Cyprus. It was also recently found from boat hulls moored in Agios Nikolaos (Crete, Greece) and Licata (Sicily, Italy), but not found in the respective marinas (Ulman *et al.*, 2017).

Fish

The first documented record of the Guinea angelfish, *Holacanthus africanus*, for the Mediterranean has been reported, through the capture of two individuals within Maltese coastal waters (Deidun *et al.*, 2017a). Two individuals have been caught, in April 5, 2017 (35.890068ºN; 14.516296ºE) and on May 25, 2017 (35.884880ºN; 14.515246ºE).

Natural range expanding species

Two colonies of the stinging siphonophore *Physalia physalis* were stranded at Capo Peloro (Strait of Messina) in March 2009 and one in March 2014; one more colony was stranded on a beach of Lampedusa Island (Strait of Sicily) in April 2009 (Castriota *et al.*, 2017).

The crab *Percnon gibbesi* is actually rather common in the MPA of Portofino (Genoa); it was also reported near Varazze (Savona) on the western coast of Ligurian sea (G. Relini personal communication). A single specimen was captured by hand by a sport-fisherman in Genoa (Suaria *et al.*, 2017). The possible status of natural range expanding species of this Atlantic crab, previously considered as a NIS, has been discussed by Mannino *et al.* (2017).

Two individuals of the opistobranch mollusc *Aplysia dactylomela* were recorded on a rocky shore near Finale Ligure (Ligurian Sea) (Bernat and Molinari, 2016).

First record of one individual of *Seriola fasciata* in Marettimo - Egadi islands (Lipej *et al.*, 2017).

4. Pathogens

No new information

5. Meetings and research projects

"Benthic Harmful Algal Blooms" (BHAB) was the last Core Research Project (CRP) launched by the Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) program. Although GEOHAB concluded in 2014, an article was published by Berdalet *et al.* (2017) as a global product of its BHAB CRP.

The LIFE Project ASAP, lead by ISPRA (Institute for Environmental Protection and Research), has been launched in October 2016 and will continue until March 2020. It will realize communication, information and training campaigns throughout Italy, targeting the general public and all sectors variously involved in the management of invasive alien species: personnel of public institutions, protected areas, zoos, aquariums and botanic gardens; professionals such as vets, biologists, agronomists, foresters and urban planners; hunters and anglers; pets dealers, plants dealers and the whole horticulture sector; aquarists; scientists.

A two-years long citizen-science project, named "Aliens in the Sea" was launched by the University of Palermo: it is addressed to boaters, divers and fishermen, who are invited to contribute with photos and records of alien species observed in Sicilian waters.

A book chapter on the impact of biological invasions in the Mediterranean has been written by Mannino *et al.* (2017). An updated overview of the marine alien and cryptogenic species recorded in the Egadi Islands Marine Protected Area (Tyrrhenian Sea, Italy), based on relevant publications, grey literature and unpublished data, is presented and discussed by Mannino *et al.* (2016). Altogether, 17 species (14 aliens and 3 cryptogenic), belonging to five taxa are present in the area.

A first large-scale assessment of NIS occurring in Mediterranean marinas was carried out in the framework of an international doctorate project (Ulman *et al.*, 2017); the survey conducted in 2015-16 in 34 marinas located in Spain, France, Italy, Malta, Greece, Cyprus and Turkey, and on the hulls of 600 boats revealed three NIS new for the Mediterranean Sea (the pycnogonid *Achelia sawayai sensu lato*, the amphipod *Aorides longimerus*, and the isopod *Cymodoce* aff. *fuscina*), and increased the distribution of other NIS already known from the basin, totaling 51 new NIS country records: 12 for Malta, 10 for Cyprus, nine for Greece, six for Spain and France, five for Turkey and three for Italy, representing 32 species. These data reveal that Mediterranean marinas indeed act as major hubs for the transfer of marine NIS, and that recreational boats act as effective vectors of spread.

Other projects regarding marine alien species in Italy have been accomplished in 2017:

In the enclosed bay of Mar Piccolo di Taranto (Ionian Sea), the study of *Grateloupia turuturu* has yielded 10 year of data about the biology of this alien alga (RITMARE project).

The Institute for research and protection of the Sea (ISPRA) has performed two projects of alert to warn the public of the risks posed by the alien fishes *Lagocephalus sceleratus* and *Pterois miles* (see Azzurro *et al.*, 2016).

The project BALMAS (Ballast Water Management System for Adriatic Sea Protection) has developed a system of early warning of alien species (Magaletti *et al.*, in press). Moreover with the objective to establish a common crossborder system in the Adriatic Sea, which would link all researchers, experts, and responsible national authorities in order to avoid unwanted risks to the environment from the transfer of harmful aquatic organisms and pathogens (HAOP). Mozetić *et al.* (2017) prepared an inventory of phytoplankton diversity in 12 Adriatic ports. They give a list of 691 taxa; among them 52 were classified as HAB and five as NIS. Records of toxigenic NIS (*Pseudonitzschia multistriata*, *Ostreopsis* species including *O.* cf. *ovata*) indicate that the intrusion of non-native invasive phytoplankton species has already occurred in some Adriatic ports.

Monitoring activities have been initiated by the Regional Environmental Protection Agencies during the years 2015-2017 for the implementation of the EU Marine Strategy Framework Directive and have been funded by the Italian Ministry of the Environment. They have been carried out in Italian major commercial ports and near aquaculture plants, as they are considered as potential hot spot areas for NIS introduction.

Monitoring activities are on-going, as a new programme has just started for detecting and quantifying NIS in hot spot areas in 2018-2020.

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Note: This report is the outcome of a special working group of the Italian Marine Biology Society (SIBM) on a voluntary basis. It does not reflect an official position or knowledge of the relevant Italian Government bodies.

It has been prepared according with the guidelines for ICES WGITMO National Reports; it updates the Italian status up to 2017.

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Overview

No new arrivals were recorded in 2017. All previous introductions since 2000 were first recorded in other Baltic Sea countries and then in Lithuania. The semi-tropical clam, common rangia *Rangia cuneata* continues its spread into the Curonian Lagoon.

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

The IMO BWMC ratification process is not yet finalized.

2. Intentional introductions

No new intentional introductions recorded.

The Fisheries Service under the Ministry of Agriculture of the Republic of Lithuania offers to buy fish suitable for breeding, among them several introduced species the rainbow trout *Oncorhynchus mykiss* and the white amur *Ctenopharyngodon idella* (http://zuv.lt/index.php?2518252435). However, they cannot reproduce under cannot reproduce under the current climatic and hydrological conditions of Lithuania (Rakauskas *et al.*, 2016).

3. Unintentional introductions

The common rangia *Rangia cuneata* (first found in 2013) continues its spread in the Lithuanian waters. A living specimen of (size 27 mm) was found at a monitoring station in the Curonian Lagoon (55°41.8′ N, 21°07.4′ E, depth 9 m). Small specimens were found attached to the spiked watermilfoil *Myriophillum spicatum* (55°33′14″ N, 21°07′44″E, depth 0,4 m), therefore further human-mediated spread with fishing equipment and snagged weed in retrieved anchors is possible.

Soon after the first detection of *R. cuneata* in Vistula Lagoon, a species-specific DNA based marker was developed for early detection of this species in the Lithuanian waters and elsewhere (Ardura *et al.*, 2015). The marker was able to detect the species when its larvae abundance was above 1900 ind./m3 in Vistula Lagoon and the benthic population established in the area with abundance up to 5000 ind./m2. However, the marker did not show presence of R. cuneata in environmental water samples taken during May and September 2014 exactly at the same stations, where in 2013 first individuals of living mollusks and vacant shells were found (abundance of living individuals 10 ind./m2 and vacant shells up to 900 ind./m2). This indicates there is a certain threshold in sensing of the R. cuneata, using this method, when the population is sparse and small at early phase of invasion.

The Ponto-Caspian round goby *Neogobius melanostomus* (first found in 2002) is still abundant in the Lithuanian coastal waters, where it caused significant decline in the blue mussel population. The species is being exploited commercially. In May 2017 the first fishing competition on the round goby (the festival "*Gintarinės grudalinės*") was arranged by the municipality of Palanga maritime resort. One of the aims was to encourage the use of this fish as a local seafood product.

4. Pathogens

None reported.

5. Meetings and projects

Meetings

- Annual ICES Science Conference, Fort Lauderdale, USA. September 18-21, 2017.
- 11th Baltic Sea Science Congress. Rostock, Germany, 12-16. June 2017.
- Non-indigenous species data management under the EU MSFD: available tools, needs and further development, Spanish Oceanographic Institute, September 06, 2017.
- 10th National Conference "Sea and coast"
- National ad hoc meetings on invasive species and ballast water management

Projects:

- 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).
- COMPLETE. An Interreg Baltic Sea Region project "Completing management options in the Baltic Sea Region to reduce risk of invasive species introduction by shipping" (2017-2020).

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Information systems

AquaNIS, 2018. 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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Summary:

During 2017 the Norwegian Alien Species List has been revised (will be published 2018). The revision includes Svalbard (Spitzbergen) (where also several species naturally occurring in mainland Norway have been regarded as alien). IMO BW Convention entered into force as of September 2017. The entering into force also included a revision of the regulation for ballast water exchange along the coast of Norway. During 2017 a proposal for amendments to the regulations relating to alien organisms (pertaining American lobster) were sent on hearing (27th October 2017). No sightings of new NIS, but the red alga *Gracilaria vermiculophylla* and the bryozoan *Schizoporella japonica* were observed in new localities. Two specimens of American lobster (*H. americanus*), and one hybrid (*H. americanus* x *H. homarus*) were recorded. The catches of red king crab (*Paralithodes camtschaticus*) in the quota regulated area (E. of 26 °E) have been reduced, the fishing mortality is above F_{lim} (where a reduction of the stock is expected). The free (culling) fishery W for 26 °E appears to still reduce the S and W spread of the species. The snow crab (*Chionoecetes opilio*) still expands in the Norwegian EEZ. Stray individuals have been caught close to the Svalbard archipelago, and model projections indicate that the species will have colonised the areas around Svalbard by 2025. The combined catches of snow crab in the Barents Sea are however somewhat reduced compared to 2016 and 2015. The pacific cupped oyster (*Magallana gigas* Syn. *Crassostrea gigas*) has been surveyed along the Norwegian

coast from Haugesund (N 59.41, E 5.25) to the Swedish border (N 59.01, E 11.04). A primitive model for presence//distribution was tested. The preliminary results indicates poor spawning success in 2017 for the surveyed area. The propagule pressure for NIS arriving on hull fouling has been high the last 2 years due to a high number of oil service vessels going out of business, arriving from foreign oil fields and anchoring along the Norwegian coast. While many live specimen have been recorded on newly arrived vessels, no live specimen has been observed in the vicinity of the anchorage.

1. **Regulations:**
    a. IMO Ballast water convention entered into force September 2017 https://www.sdir.no/aktuelt/nyheter/ballastvannkonvensjonen-i-kraft-fra-september-2017/
    b. Revision of regulation for ballast water exchange https://www.sdir.no/aktuelt/nyheter/ballastvannkonvensjonen-i-kraft-fra-september-2017/
    c. A revision of the prohibition of import of live American lobster for consumption has been on hearing: https://www.regjeringen.no/contentassets/0a14d54b9f7d439db7028aa87f5210f6/consultation_paper_proposal_for_amendments_to_the_regulations_relating_to_alien_organisms_171027.pdf

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 only in Norwegian only). A new risk evaluation for proposed import of wrasse species caught in Denmark and along the SW Swedish border was initiated in 2017 and will be completed in 2018. Besides the issues related to genetics, the risk for translocations of Round goby will be evaluated.

3. Unintentional:

New sightings

Two new NIS Bryozoans were reported in 2015 *Tricellaria inopinata* and *Schizoporalla japonica*. (Porter *et al.* 2015). For 2017, *Schizoporella japonica* has been recorded at several locations in SW Norway (Vivian.husa@hi.no)

General information:

Two new specimen of *H. americanus* and one hybrid: *H. americanus* x *H. gammarus* have been detected in 2017. Contact: Ann-Lisbet Agnalt, IMR Ann-lisbeth.agnalt@imr.no

The marine oil exploration industry has had significant setbacks the later years, and as a consequence, numerous oil service vessels has returned from worldwide operation to anchorage in Norway. There are two main anchorage areas: one in the Haugesund-Stavanger area (Southern part of the Norwegian west coast) and one in the Ålesund - Kristiansund area (North part of the Norwegian west coast). One of the newly translocated ROV vessels in the southern locality visited early in 2017 carried more than 40 taxonomic groups in the "moon-pool. In a revisit to this vessel some four months later, no

live specimens were found on the hull or in the surroundings. A similar survey to the northern anchorage area will be made in 2018. The results are under publication. Contact: Vivian.husa@hi.no

Previous Sightings.

Range expansions:

Several new observations of range expansion for *Gracilaria vermiculophylla*, *Styela clava* and *C. gigas* have been recorded (Vivian Husa, IMR and A. Jelmert, IMR)

Mnemiopsis leidyi has reappeared along the coast. Higher numbers close to the shore, lower densities offshore.

During 2017, a fairly large mapping survey on the Cupped oyster (*Crassostrea gigas* Syn./ *Magallana gigas*) were undertaken. Some 350 stations from "Karmøy N 59.33, E5.32 to the Swedish border N 59.05, E 11.13 were visited. Additionally some 200 sites were examined for *C.gigas* randomly distributed in the 0-2 m depth stratum) as a validation exercise of a distribution model.

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 (Figure 1). In addition to continued northward and eastward range expansion, several specimen were caught E. of Novaja Zemlja (Kara Sea proper).

C. opilio refer colder water (typ below 3-4 C) than red king crab. S & W distribution, may even retract if the Arctic gets warmer. SSB for Snow crab now > 10 times the SSB for king crab. Stray individuals have been caught close to the Svalbard archipelago, and model projections indicate that the species will have colonized the areas around Svalbard by 2025. The combined catches of snow crab in the Barents Sea are however somewhat reduced compared to 2016 and 2015.

Red King Crab (*Paralithodes camtschaticus*)

Likely due to higher fishing efforts and higher fishing mortality, the stock size of catchable males (CL>130mm) decreased in 2017. Currently the stock net production is BELOW the level for MSY (Maximum Sustainable Yield)

Eradication programmes:

Crassostrea gigas: eradication as part of action plan for one municipality (Oslo and Akershus). An eradication effort has been carried out in the vicinity of the "Raet nasjonalpark" ("Raet, national park"), in the vicinity og Arendal municipality N 58.4, E 8.8. The eventual effects of the effort has not been evaluated.

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, or e.g. public beaches).

Homarus americanus: Not formally established or regularily funded (!), but suspect specimens are collected by fishermen and are still genetically analysed at IMR. Since 2000, 37

specimens of American lobsters have been found in Norway, 24 in Sweden, 1 in Denmark and 3 in Ireland. All have been verified as *H. americanus* 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 (Agder counties (58 59N, 11 4E, to 59 0N, 9 5E). Contact: V. Husa, IMR. Vivian.husa@imr.no

Import and exports:

	Desember 2017 Ureviderte tall			Januar - desember 2017 Ureviderte tall			Januar - desember 2016 Foreløpige tall		
	Mengde	Verdi	Pris pr.kg	Mengde	Verdi	Pris pr.kg	Mengde	Verdi	Pris pr.kg
TOTALT	93	25.424	272,32	958	250.291	261,14	1.169	260.648	222,97
Sør-Korea	40	10.163	255,76	526	130.647	248,26	776	161.370	207,85
U S A	21	5.976	279,46	160	41.478	258,52	161	36.672	228,09
Canada	9	2.544	282,92	102	30.025	294,81	97	27.641	284,50
EU27	11	3.238	291,16	94	25.580	272,54	97	24.158	249,01
Italia	6	1.640	298,00	39	11.291	288,55	38	10.635	278,72
Taiwan	4	1.350	303,56	29	8.951	305,94	18	5.270	290,59
Vietnam	4	1.034	277,62	18	4.942	280,12	0	14	342,80
Storbritannia	2	584	246,21	14	3.432	240,74	16	3.953	242,23
Belgia	1	364	298,20	11	3.226	290,09	10	2.682	264,47
Kina	3	797	277,26	11	3.026	270,20	6	1.257	197,17

Figure 1. Export figures for raw live(!) king crab. Three upper column headers: Left: December, 2017, Non-revised numbers, middle: January- December 2017, non-revised numbers, right: January-december 2016, preliminary numbers. Mengde= Amount (tons), Verdi = value(NOK), Pris pr. Kg= Price per kilogram(NOK). Source: Norwegian fishermens sales organization

http://www.rafisklaget.no/portal/page/portal/RafisklagetDokumenter/Markedstiltak/Norwegian_King_Crab_des2017.pdf

	Desember 2017 Ureviderte tall			Januar - desember 2017 Ureviderte tall			Januar - desember 2016 Foreløpige tall		
	Mengde	Verdi	Pris pr.kg	Mengde	Verdi	Pris pr.kg	Mengde	Verdi	Pris pr.kg
TOTALT	58	19.978	346,64	919	255.157	277,65	1.081	270.706	250,51
EU27	57	19.750	346,29	526	155.359	295,26	429	123.199	286,97
Sør-Korea	.	.	.	170	39.546	232,55	22	5.880	268,77
Nederland	9	3.276	353,80	94	30.572	326,72	99	28.959	293,96
Sverige	9	3.329	380,58	80	27.624	346,28	88	25.437	288,43
Danmark	12	3.929	341,62	91	26.416	291,09	83	21.494	258,77
Frankrike	11	4.248	382,53	99	23.584	239,28	69	20.366	295,96
Japan	.	.	.	70	15.727	224,69	474	109.977	231,94
Spania	1	533	399,81	63	14.813	236,29	12	3.184	267,78
U S A	.	.	.	50	13.943	276,90	68	11.621	171,96

Figure 2. Amount of exported frozen King crab to various markets. Legends and source as in figure 1.

Corresponding numbers for the export of snow crab iis unfortunately not available for the time being.

4. Pathogens

No severe Ostreid Herpes-virus µ-var. reported for *Crassostrea gigas* or other mussels in 2017.

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Poland

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Overview:

Melita nitida (Crustacea, Amphipoda) was reported for the first time in the Polish coastal waters. This species was identified in 2016 in the samples collected in 2014 in the Port of Gdynia (Gulf of Gdańsk, Baltic Sea).

Sinelobus vanhaareni (Crustacea, Tanaidacea) was reported for the first time in the Polish coastal waters. This species was identified in 2017 in the samples collected in 2014 in the Port of Gdynia (Gulf of Gdańsk, Baltic Sea).

In 2017 Poland suspended the ratification of the International Maritime Organization's International Convention for the Control and Management of Ships' Ballast Water and Sediments due to the need of adaptation of some national Acts to requirements of Convention.

Content:

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

In the second half of 2017, Poland suspended the ratification of the International Maritime Organization's International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWMC) after the inter-ministerial as well as public consultations had been completed. The reason was the need to advance works on the amendment of the Act on the Prevention of Pollution from Ships (and some other Acts), the purpose of which is to implement the requirements of the BWMC (national regulations have to be adjusted to requirements of BWMC). The draft of new Act has been agreed and is currently awaiting official submission to inter-ministerial and public consultations, which is expected to be in March 2018. The completion of works on the amendment of the Act is likely in the middle of 2018, then Poland will ratify BWMC.

Poland has fulfilled its obligations related to Regulation (EU) No 1143/2014 of the European Parliament and the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. Activities have been initiated to: (1) analyze the pathways of unintentional introduction and spread of invasive alien species of Union concern in territory of Poland, (2) develop and implement action plans on the prioritized pathways of invasive alien species, (3) establish a central register of invasive alien species and (4) eradicate or control species that are on the list of invasive alien species posing a threat to the Union.

Poland has fulfilled its obligations related to EU Marine Strategy Framework Directive (MSFD) adopted in 2008, which aims to reach the good environmental status of the EU's marine waters by 2020 by preventing the introductions of non-indigenous species and reducing concentrations and effects of contaminants. In 2017 General Inspectorate for Environmental Protection commissioned the updating of the preliminary assessment of

the environmental status of marine waters together with a set of properties for good environmental status. This assessment was submitted to the European Commission in 2014. The preparation of the update of the initial assessment covers years 2011-2016. With reference to descriptor No. 2 "Non-indigenous species" of MSFD, the indicator adopted by HELCOM "trends in arrival of new non-indigenous species in the period 2011-2016" will be applied. The completion of this task is expected for 2019.

2. **Intentional:**

In 2016 deliberate release of salmon *Salmo salar*, sea trout *Salmo trutta trutta*, white fish *Coregonus maraena* and Atlantic sturgeon *Acipenser oxyrinchus* (information from Inland Sea Fisheries Institute in Olsztyn).

In 2016 intentional release of *Piaractus brachypomus* (*Characiformes, Serrasalmidae*) in the Szczecin Lagoon and Lake Dąbie was described by Więcaszek *et al.* (2016). Five specimens of pirapitinga were caught in in 2002-2010 during both, recreational angler and professional fish catch.

In 2017 deliberate releases of salmon *Salmo salar* (ca. 36 thous.), sea trout *Salmo trutta trutta* (ca. 437 thous.), lavaret *Coregonus lavaretus* (ca. 552 thous.), and vimba bream *Vimba vimba* (ca. 110 thous.) were conducted The releases were carried out as part of the "Restocking of Polish sea areas in 2017" task, which included the Vistula river basin, Pomeranian rivers and the Puck Bay basin. However, it should be noted that these are not the only deliberate releases of migratory fish species to the Polish rivers. Restocking resulted from the lease of the use rights of fishing districts, which on average accounted for about 35% of the stocking value in the Polish Marine Areas, should be added to this number (Dr. inż. Tomasz Czerwiński, Inland Sea Fisheries Institute in Olsztyn, pers. comm.).

3. **Summary of sighting:**

Unintentional (new sightings)

Melita nitida (Crustacea, Amphipoda) was reported for the first time in the Polish coastal waters. This species was identified in 2016 in the mobile fauna samples, collected using artificial habitat collectors, in the summer of 2014 in the Port of Gdynia (Gulf of Gdańsk, Baltic Sea). Only 13 specimens, including 3 males, were found (Normant-Saremba *et al.*, 2017). This species is native to the Atlantic coast of the North America and has been already noticed in German part of the Baltic Sea.

Sinelobus vanhaareni (Crustacea, Tanaidacea) was found for the first time in the Polish coastal waters. This species was identified in 2017 in the samples collected in 2014 in the Port of Gdynia (Gulf of Gdańsk, Baltic Sea). Initially, it was misidentified as the native species of the same order. *S. vanhaareni* was found in large numbers during the port survey carried out by Lena Marszewska and Monika Normant-Saremba from University of Gdańsk. Taxonomic identification was performed by specialists of Tanaidacea, prof. Magdalena Błażewicz from the University of Łódź. This species has been already noticed in German and Latvian parts of the Baltic Sea.

Unintentional (accidental escapes)

In August 2017, a massive escape of the Siberian sturgeon *Acipenser baerii* from the aquaculture located in Jeżyczki near Darłowo was observed. Russian sturgeon *Acipenser*

gueldenstaedtii also escaped, but in much smaller numbers. Around 50,000 individuals of the age from 2 till 3-4 years (mean fresh mass 1.2 and 2.0-3.5 kg respectively). The fish farm in located several kilometers from the Baltic coast, so few days after the escape, numerous presence of sturgeons in fishing gears was reported (http://www.hel.ug.edu.pl/aktu/2017/ucieczka_jesiotrow.html, in Polish).

Previous Sightings (range of expansions)

Tubificoides heterochaetus recorded for the first time in the Gulf of Gdansk in 1979 by Legeżyński, was identified in 2016 in samples from 2013 collected in the Port of Gdynia (Marszewska *et al.*, 2017).

Mytilopsis leucophaeata, recorded for the first time in 2010 in the Gulf of Gdansk, was reported in 2016 at additional site in the Vistula Delta (Brzana *et al.*, 2017).

Melita nitida, recorded for the first time in 2014 in the Port of Gdynia was reported at additional site in Gulf of Gdańsk (Radosław Brzana from University of Gdańsk, pers. comm.).

Rangia cuneata found for the first time in 2011 in the Vistula Lagoon (eastern Polish coast) was recorded in 2017 in Kamieński Lagoon (western Polish coast; Dr. Brygida Wawrzyniak-Wydrowska from University of Szczecin, pers. comm.).

4. **Pathogens**

No new findings of pathogens have been reported.

5. **Research and Monitoring Programs**

Developing rules for controlling and eradication invasive alien species along with pilot actions and social education (2017-2018).

This project is coordinated by General Directorate for Environmental Protection and co-funded under the Operational Programme Infrastructure and Environment 2014-2020. It is related to implementation of national obligations related to Regulation (EU) No 1143/2014 of the European Parliament and the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. The main goal of the project is to determine the invasiveness of non-native species in Poland, along with an identification of the species most threatening biological diversity. The aim is also to develop eradication and control methods for these species. In addition to the 49 species on the list of invasive alien species of Union concern, 69 other non-native species will be analyzed. Among them, there are only four marine species: Harris mud crab *Rhithtopanopeus harrisii*, comb jelly *Mnemiopsis leidyi*, Pacific oyster *Crassostrea gigas* and round goby *Neogobius melanostomus*. The last three species are on the ministerial list of species, which in the case of a release to the environment may threaten native species or natural habitats.

Completing management options in the Baltic Sea Region to reduce risk of invasive species introduction by shipping (COMPLETE; 2017-2020).

This project is coordinated by Kotka Maritime Research Association, Finland and co-funded by INTERREG Baltic Sea Region Programme. There are 12 project partners from 7 Baltic Sea states. Poland is represented in the project by the University of Gdańsk. As many as 23 associated organizations from 8 Baltic Sea states representing marine sector

and project target groups are also involved. The project aims at developing a consistent and adaptive management tools and recommendations for the Baltic Sea Region by addressing both major vectors of harmful aquatic organisms and pathogens: ballast water and biofouling. Project activities are arranged in six interrelated work packages. Among the expected project outcomes there are recommendations of improvement of HELCOM monitoring manual of NIS to cover the needs for BWM Convention and EU Marine Strategy Framework Directive, improvement of the risk assessment tool under the HELCOM-OSPAR Joint Harmonised Procedure for granting of exemptions under International Convention for the Control and Management of Ships' Ballast Water and Sediments, Regulation A-4 and the proposal for a regional biofouling management strategy.

National monitoring of the Polish Marine Areas

In 2016 and 2017 biological monitoring of the Polish Marine Areas was carried out. One of the tasks was to detect new non-indigenous species as well as to determine distribution of selected, already introduced ones. Monitoring included marine internal and territorial waters as well as the Polish Exclusive Economic Zone. Samples of phytoplankton, zooplankton were taken 5-6 times in a year while zoobenthos once a year. In 2017 additional samples of ichthyofauna were collected, also in transitional waters. National monitoring is coordinated by Chief Inspectorate for Environmental Protection.

Port survey

In 2016 an artificial habitat collector (providing shelter for small mobile fauna) was recommended for detection of NIS in Baltic and North-East Atlantic ports at the 7th meeting of HELCOM/OSPAR Task Group on Ballast Water Management Convention Exemptions in Brussels. This device could be used to complete two other mobile epifauna sampling methods (baited traps) recommended by 'Survey Protocol of Joint HELCOM/OSPAR Harmonised Procedure' on the Granting of BMW Convention Exemptions.

Unfortunately, in 2017 there was no survey for detecting non-indigenous species in any of four Polish sea ports, Szczecin, Świnoujście, Gdynia and Gdańsk as it was announced in 2016. The survey, based on Joint Harmonised Procedure for the Contracting Parties of HELCOM and OSPAR, was recommended to the ports' authorities by the Polish Ministry of Maritime Economy and Inland Navigation due to the possibility of granting of exemptions under International Convention for the Control and Management of Ships' Ballast Water and Sediments, Regulation A-4. The reasons for the lack of survey were delays in the preparation of guidelines, as well as comments on the method submitted by potential contractors. It is very likely that port surveys will start in spring 2018.

6. **Meetings**

Past meetings

- Harbours Review Spotlight - Ballast Water Management Seminar, EU Transport Week, March 2017.
- National Marine Environment Protection Committee (MEPC) section at the Centre for IMO Affairs meeting, April and October 2017.

- International Conference "Science in the service of nature - conservation genetics and counteracting biological invasions", October 2017.
- 9th international Steering Committee meeting EU Strategy for the Baltic Sea Region, Policy Area on Clean Shipping (PA Ship), November 2017.

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Portugal

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Overview:

A list of 166 aquatic non-indigenous species (NIS) was registered for the Portuguese estuarine and coastal aquatic systems and there were thirteen new additions to the 2017 report. Five new macroalgae (*Acrothamnion preissii, Caulerpa prolifera, Gymnophycus hapsiphorus, Halimeda incrassata* and *Lophocladia trichoclados*) were added to the NIS list for the Azores islands and one (*Grateloupia filicina*) to the mainland (Tagus estuary) list. Two new polychaete species (*Branchiomma luctuosum* and *Ficopomatus enigmaticus*), one amphipod (*Aoroides longimerus*), one bryozoan (*Amathia gracilis*), one sponge (*Mycale* (*Carmia*) sp.), one bivalve (*Ostrea eduli*) and one tunicate (*Styela clava)*) were added to the NIS listed for the Azores islands. The isopods *Paracerceis sculpta* and *Sphaeroma walker* and the tunicate (*Symplegma brakenhielmi)* were new registers in the Madeira islands. The Asian mussel (*Arcuatula senhousia*) and the ctnephora *Mnemiopsis leidyi* were news record for mainland Portugal, registered at the Southwest coast. Cryptogenic species were not included. The International Convention for the Control and Management of Ships' Ballast Water and Sediments has entered into force in Portugal on January 19, 2018. Surveys conducted recently in the aim of ongoing projects that address NIS confirmed the establishment of several species previously recorded, including the blue crab (*Callinectes sapidus*), which was recorded at the Guadiana estuary and Ria Formosa (Algarve), the bryozoan *Bugula neritina* and the tunicate *Styela plicata,* which invaded de Albufeira lagoon during summer 2017. An effort to provide knowledge and new monitoring data on NIS has been made through Interreg, Blue Labs and Mar2020 funded projects, as well as by the monitoring program on invasive species (PIMA) conducted in the Azores, funded by Azores Regional Government.

Content:

1. Regulations

Decree 23/2017, of 31st of July of 2017, approves the accession of Portugal to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) adopted in 2004 by International Maritime Organization Member States. This Convention aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments.

The Convention entered into force on the 8th of September of 2017, requiring all ships to implement a ballast water management Plan, to have a Ballast Water Record Book and to carry out ballast water management procedures to a given standard. In agreement with article 18, number 3, of the Convention, the Convention entered into force in Portugal on January 19, 2018.

In October 5-6, 2017 at the "Our Ocean" meeting in Malta, Portugal expressed the will to have a leadership role in ocean environmental protection and committed to develop new regulations by 2020 addressing the introduction of marine non-indigenous species to ensure the effective implementation of the Ballast Water Convention.

2. Intentional

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

3. Summary of sighting

A list of 166 aquatic non-indigenous species (NIS) is registered for the Portuguese estuarine and coastal aquatic systems. New additions to the 2017 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 and Azores islands and for Ria Formosa, the 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.

Macroalgae (seweeds)

Acrothamnion preissii is an invasive species in the Mediterranean Sea, and is listed among the 100 worst non-indigenous species. In July and August 2009, this non-native red macroalga was found for the first time in the Azores - Santa Maria (Parente *et al.* 2018) being the first record of this species in the Atlantic.

Caulerpa prolifera was found for the first time in 2013 in Faial (Cardigos *et al.*, 2013) and São Miguel (Martins & Neto, com. pess.) and it is established in both locations in intertidal rock pools. *Gymnophycus hapsiphorus* have been found in the Azores, since 2014 and *Halimeda incrassata* has been proliferating in Santa Maria. *Lophocladia trichoclados*, found in 2016 in Santa Maria and São Miguel, was found dominant in Ilhéu da Vila, in Santa Maria.

Undaria pinnatifida has been found in the North and Center coasts of continental Portugal (see location on "MACOI - Portuguese Seaweeds Website" at: www.uc.pt/seaweeds). According to the records of MACOI, this species is present in Ria de Aveiro (Barra), Mondego Cape and Buarcos Bay (Figueira da Foz). According Zahmatkesh (2017), *Sargassum muticum* was present in more than 70% of the northwestern part of the Iberian Peninsula coasts, including Portugal.

Porifera

Mycale (*Carmia*) sp has been found in Ponta Delgada in 2017, fouling hulls of local boats.

Ctenophora

Mnemiopsis leidyi (A. Agassiz 1865) is one of the world's most notorious marine invader and ranked among the 100 most invasive species globally, and their negative impacts on fisheries are of great concern. Three populations of this species were found in Portuguese estuarine ecosystems (Sado, Guadiana and Ria Formosa) during spring 2017 (Cruz *et al.* (*in review*).

Polychaetes

A new polychaete species has been added to the national NIS list (*Branchiomma luctuosum*), since its occurrence was registered at the islands of São Miguel, Santa Maria and

Terceira (Azores). The serpulid *Ficopomatus enigmaticus*, previously recorded at mainland estuarine and lagunar systems, has been found at Terceira island (Azores), where it is established and exhibits an invading behavior in the coastal lagoon of Paúl da Praia.

Bryozoans and Tunicates

Ongoing monitoring surveys conducted in harbors and marinas of the Madeira archipelago have resulted in the detection of the tunicate *Symplegma brakenhielmi* for Madeira island (Gestoso *et al.* 2017).

An invasion of mussel rafts by *Styela plicata* is taking place since May 2017 in the Albufeira lagoon, a semi-enclosed coastal lagoon in SW Portugal. Other non-indigenous bryozoans (e.g. *Bugula neritina*) and bivalves were also observed, but its taxonomic identification is still ongoing. Temporal trends of this *S. plicata* population have been monitored in the Albufeira lagoon since October 2017.

The bryozoan *Amathia gracilis* found in 2013 in São Miguel (Azores) has been seen in two successive years, whereas the tunicate *S. clava* was found in the same island in 2014.

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 (Carvalho, 2016). In 2017 it was also recorded in the Mondego estuary (NW Portugal). A monitoring program of the populations of the Manila clam will be implemented in 2018, as a support for the development of management measures for the sustainable harvesting of this bivalve species. A recent study on contamination by metals and metalloids indicated high accumulation of As by *R. philippinarum* at some areas of the Tagus estuary (Chiesa *et al.*, 2018).

Ostrea edulis

In the Azores, the ongoing monitoring program revealed the presence of the European oyster *Ostrea edulis* has been found in Ponta Delgada harbor since 2013 where it is becoming quite common.

Arcuatula senhousia

The Asian mussel was recorded, for the first time, in Portugal in 2015, during surveys conducted on oyster populations of the Sado estuary (Sá *et al.*, *subm.*). In 2017 *A. senhousia* were collected in the Albufeira lagoon, during a survey conducted on mussell rafts, which had been invaded by tunicates and other fouling species.

Crustaceans

The ongoing monitoring surveys in harbors and marinas of the Madeira archipelago have resulted in the detection of the isopods *Paracerceis sculpta* and *Sphaeroma walkeri* for Madeira island (Ramalhosa *et al.* 2017). *Aoroides longimerus* was found in São Miguel, in 2013.

Callinectes sapidus

The Atlantic blue crab *C. sapidus* Rathbun, 1896 is native in the eastern Atlantic, however it has been collected in several non-indigenous regions along the European coast since 1900 (Mancinelli *et al.*, 2017a; Mancinelli *et al.*, 2017b) and in Portugal since 1978 (Chainho *et al.*, 2015). The capture of this species was reported for first time in the Guadiana estuary and Ria Formosa (SW-Iberian Peninsula, Europe) in july 2017 and january 2018 respectively.

Fishes

The weakfish *Cynoscion regalis* (Bloch & Schneider, 1801) was registered for the first time in 2015 in the Sado estuary but, since then it has been collected at the Guadiana estuary (2016), Ria Formosa and Tagus estuary (2017) (Morais *et al.*, 2017; Morais *et al.*, *in review*).

Table 1. List of new NIS registered in Portuguese waters in 2017-2018.

Taxa	Year of first record	Location of first record	Possible introduction vector	Invasion Status	References
Acrothamnion preissii (Sonder) E.M.Wollaston	2009	Santa Maria (Azores)	Hull Fouling	Established	Parente *et al.* (2018)
Amathia gracilis Leidy, 1855	2013	São Miguel (Azores)	Hull Fouling	Unknown	Micael *et al.* (2017)
Aoroides longimerus Ren & Zheng, 1996	2013	São Miguel (Azores)	Hull Fouling	Unknown	Micael, J *pers com*
Arcuatula senhousia (Benson, 1842)	2015	Sado estuary	Aquaculture	Unknown	Sá *et al.* (*subm.*)
Branchiomma luctuosum (Grube, 1870)	2016	São Miguel, Terceira, Santa Maria (Azores)	Hull Fouling	Established	Costa, AC *pers com*
Caulerpa prolifera (Forsskål) J.V.Lamouroux	2013	Faial, São Miguel (Azores)	Unknown	Established	Cardigos *et al.*, 2013
Ciona intestinalis (Linnaeus, 1767)	1997	Arrábida (Mailand Portugal)	Unknown	Unkown	Saldanha, 1997
Ficopomatus enigmaticus (Fauvel, 1923)	2016	Terceira (Azores)	Phorensy	Established	Costa *et al.* (subm.)
Grateloupia filicina (J.V. Lamouroux) C. Agarh	1804	Tagus estuary (mainland)	Unknown	Unkown	Ardré, 1970
Gymnophycus hapsiphorus Huisman & Kraft	2014	São Miguel (Azores)	Hull Fouling	Unknown	Parente, MI *pers com*
Halimeda incrassata (J.Ellis) J.V.Lamouroux	2016	Santa Maria (Azores)	Hull Fouling	Established	Parente, MI *pers com*
Lophocladia trichoclados (C.Agardh) F.Schmitz	2016	São Miguel, Santa Maria (Azores)	Hull Fouling	Established	Parente, MI *pers com*
Mnemiopsis leidyi A. Agassiz, 1865	2017	Guadiana estuary, Ria Formosa, Sado estuary	Ballast water	Unknown	Cruz *et al.*, *in review*
Mycale (Carmia) sp. Gray, 1867	2017	São Miguel (Azores)	Hull Fouling	Unknown	Costa, AC. *pers com*
Ostrea edulis Linnaeus, 1758	2013	São Miguel (Azores)	Hull Fouling	Established	Costa, AC. *pers com*

Paracerceis sculpta (Holmes, 1904)	2015	Madeira	Hull fouling	Unknown	Ramalhosa *et al.* (2017)
Sphaeroma walkeri (Stebbing, 1905)	2015	Madeira	Hull fouling	Unknown	Ramalhosa *et al.* (2017)
Styela clava (Herdman, 1882)	2014	São Miguel (Azores)	Hull Fouling	Unknown	Micael, J *pers com*
Symplegma brakenhielmi (Michaelsen, 1904)	2015	Madeira	Hull Fouling	Unknown	Gestoso *et al.*, 2017

4. Research and Monitoring Programs

Planned Research:

- 2017-2020 - NIPOGES Current status of the Manila clam populations of the Ria de Aveiro, Óbidos lagoon and the Tagus and Sado estuaries - scientific bases for a sustainable resource management. MARE – Marine and Environmental Sciences Centre. Program Mar 2020 (PI: Paula Chainho).
- 2018 – 2020 - RESTAURA2020 - Evaluation and Restoration of salt marsh communities affected by plant invasive species: management and conservation actions for the revitalization of the ecosystem services and function while fish nursery. MARE – Marine and Environmental Sciences Centre. Program Mar 2020 (PI: Bernardo Duarte).
- 2017-2019 - AMALIA. Algae-to-MArket Lab IdeAs adding value to invasive seaweeds of the Iberian northwest. Blue Labs, Co-funded by the European Union.
- 2017- 2018 - Development of a new methodology to evaluate the interactive effects of marine urbanization and bioinvasions on coastal communities: experimental tests across insular and continental systems. MARE mini grant project (PI: Ignacio Gestoso).
- 2017 – 2018 - NIAS - Native versus Introduced Atlantic settlers. Joint research initiative of CIIMAR (UP) together with MARE-FCUL, MARE-Madeira and IBBV/cE3c (University of Azores) (PI: Francisco Arenas).
- 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) (Bases for the Sustainable Planning of marine areas in Macaronesia). 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) (Monitoring, control and mitigation of proliferation of marine organisms associated with human disturbances and climate change in the Macaronesian Region). Programa INTERREG MAC 2014-2020.
- 2015 - 2017 - "Elaboração do programa de implementação da Diretiva-Quadro Estratégia Marinha - Programa invasoras marinhas nos Açores (Development of the Marine Strategy Framework Directive implementation program – Marine invasions in the Azores) (PIMA)". 3/DRAM/2015.
- 2018 – 2020 MONISPOR – Monitoring marine non-indigenous species in Portugal. Project submitted to the Blue Fund ("Fundo Azul"), a financial mechanism

established by the Government of Portugal to promote the protection and monitoring of the marine environment, among other priority investment areas.

Research Needs:

There is the need to have a closer interaction between the scientific community, port authorities, fisheries and aquaculture competent authorities, nature conservations institutions to be able to have an overall risk assessment of NIS introduction vectors. A strong investment is also needed on raising awareness of different stakeholders on the risks of introduction of NIS posed by different activities, prevention and mitigation procedures and possible impacts of invasive species. It would be helpful to have a national focal point to foster research on ballast water and biofouling as a source of NIS and on the economic impact of these introductions. This would contribute to support decision making and implementation of management strategies.

5. Meetings

Canning-Clode J (2017). The role of biological invasions in shaping global diversity patterns in the sea. GAME project 15th Anniversary Symposium. 19-21 September 2017. GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany. (Invited speaker).

Canning-Clode J (2017). The Macaronesia islands in the context of global diversity patterns. EcoAqua Third Summer school, Marine/Maritime Spatial Planning, 4-8 September 2017, Madeira, Portugal. (Invited speaker).

Chainho, P., P. Anastácio & F. Ribeiro. 2017. 1st Meeting on Non-indigenous aquatic species in the Tagus river basin. Organized by MARE, 22th March, Alcochete, Portugal.

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*CCMAR - Centre of Marine Sciences

CESAM - Centre for Environmental and Marine Studies

CIBIO - Research Centre in Biodiversity and Genetic Resources

CIIMAR - Interdisciplinary Centre of Marine and Environmental Research

DGPM - Directorate General for Maritime Policy

ICNF – Institute of Nature Conservations and Forests

IPMA - Portuguese Institute for Sea and Atmosphere

MARE-UC - Marine and Environmental Sciences Centre, University of Coimbra

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Overview:
There has been no report showing new species in Sweden since January 2017. The round goby *Neogobius melanostomus* is continuing to expand its range in the Baltic Sea. Pink salmon *Oncorhynchus gorbusch* have been abundant in catches at the Swedish west coast in 2017. Pacific oyster *Magallana gigas* is expanding its distribution southwards. Two new observations of American lobsters *Homarus americanus* were made in the Skagerrak in 2017. Alien crabs including the Japanese shore crab *Hemigrapsus sanguineus* and the brush-clawed shore *H. takanoi* have been frequently reported in Swedish waters during 2017. Other crab spices such as the North American mud crab *Rhithropanopeus harrisii* and the Chinese mitten crab *Eriocheir sinensis* were also observed in Sweden.

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.
- National and regional information meetings and workshops on alien species
- New communication activity – a national status report on alien species to be subscribed by e-mail – published by SwAM and the Swedish Environmental Protection Agency.
- Development of management plan for round goby (published by SwAM in 2018).

- Development of a risk assessment of pink salmon including potential management measures (published by the Swedish University of Agricultural Sciences – SLU, in 2018).
- Information campaign – to report and send in live American lobster for genetic and diseases analysis.
- The citizen science project Rappen has continued for the third year with the aim to facilitate and encourage to reports of alien and threatened aquatic species by the public. It also aims to increase awareness of alien species. The web-based smartphone/tablet was developed further, essential to enable a direct connection to the Swedish Species Observation System, more species to report and increased performance. The project is run by SwAM, University of Gothenburg and the Swedish Species Information Centre at SLU (www.havochvatten.se/Rappen).
- Generic Ecological Impact Assessment of Alien Species Risk – development of a national risk list of invasive alien species, using the method developed by Norwegian Biodiversity Information Centre. The assessment includes door-knocker species as well as national established species (a summary report will be published by the Swedish Species Information Centre, SLU, in November 2018).
- Cost-benefit analysis on the invasive alien species SwAM (under review, will be published in March 2018 by SwAM and the Swedish Environmental Protection Agency – SEPA).
- SwAM has continued to develop the methodology for monitoring according to MSFD descriptor D2 Non-indigenous species, by testing a more efficient methodology – Extended Rapid Assessment Surveys (eRAS). It is a result of previous year's work of development of monitoring for HELCOM and OSPAR's joint harmonized procedure for ballast water management exemptions. In 2017 ports as well as marinas were investigated in the North Sea and the Baltic Sea. A report will be published in 2018, presenting how the eRAS concept could be conducted to monitor pathway hotspots in the Swedish marine environment. In addition, traditional methods are also compared with novel genomic approaches of conducting fauna and flora surveys in port areas. The report will be published on by SwAM (https://www.havochvatten.se/) with an English summary in March 2018 (Sundberg *et al.* in press). SwAM further evaluate the methodology of DNA barcoding and metabarcoding for monitoring for the purpose to early detection and rapid eradication. However, the barcoding technics still develops at a fast rate and the DNA based methods for monitoring has not yet been standardized. Knowledge, technology, and infrastructure exist to take this step forward. However, a clear commitment from the relevant authorities, a clear stated goal, and discussions for long-term goals between authorities as well as scientist within bioinformatics, taxonomist and molecular geneticist are needed.
- Pathway analysis according to article 9, in the EU regulation (1143/2014) on invasive alien species: As a part, to prevent unintentional introduction and spread of invasive alien species into or within the Union, comprehensive analyses of the species priority pathways are needed for risk assessments and action plans. The Swedish Biodiversity Centre have delivered a thorough analysis of pathways of the IAS listed by the EU commission, plus a few species of national concern. The report will be published in 2018. Based on the results SwAM will be crucial for the best practice management of

the pathways for more effectively conduct monitoring and minimize unintentional introduction in marine environment.

2. Intentional:

No information

3. Unintentional:

New Sightings
There has been no report showing new species in Sweden since January 2017.

Range expansions

Pacific oyster *M. gigas* is expanding its distribution southwards. Under a school project (see below) the following numbers of Pacific oyster were collected from Västra Götaland County during May-June 2017: 71 from Ellös strand, 75 from Maj Svanvik, 79 from Getskär, 97 from Näs badplats, 25 from Stenungsunds municipal house. 123 from Marstrand, 54 from Tjuvkil, 39 from Stenungsund, 129 from Jörlanda, and 38 from Svanesund. In addition, a total of 88 individuals of *M. gigas,* were collected from Söskär (Ödsmål) on the 24 August 2017. Pacific oysters were also found in Helsingborg but not between Helsingborg and Falsterbo (Åsa Strand, pers. com.).

The round goby *N. melanostomus* is continuing to expand 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. The round goby was the most common species during test fishing in Muskö in 2017 (Florin & Tärnlund 2017). According to this test fishing, the number of round goby caught by gill nets in Muskö has increased from 297 in 2016 to 1835 in 2017. In addition, under the student project, eight round goby was captured by angling in Nya Varvet (Västra Götaland County) on the 14th of May 2017. Reports from commercial fishermen revealed a high number of round goby in their fishing gear in Öland indicating an increase in the abundance of this species also in Kalmar County (Karl-Johan Persson, pers. com.; see also Nilson 2016). They have also been found in two freshwater systems (in the Counties of Gotland and Kalmar) at the Swedish east coast. A pilot study in Blekinge County, however, revealed that round gobies are the common prey in the diet of cod, perch and cormorant (Karl Lundström pers. com).

Pink salmon *O. gorbuscha* was observed for the first time in river Ljusnan (Hälsingland) in 1974. Since then, stray individuals of this species have occasionally been found in Sweden. They have been abundant in catches at the Swedish west coast in 2017 (Sofia Brockmark, pers. com.). The fish is probably originating from stocking in Arctic Ocean. It was observed in river Göta älv (one 20+ individual), Örekilsälven (two individuals caught on the 26th of August 2017), the bay Ljungskileviken (one individual caught on the 30th of June 2017) and Halland County during 2017 (Beatrice Alenius, pers. com.; Degerman & Peterson 2017).

Two new observations of American lobsters, *H. americanus* were made in 2017, one on the 20th of October (117 mm carapace length, N 58.0430, E 11.2230) and the other on the 7th of

November (98 mm carapace length, N 58.2706, E 11.4521) in the Skagerrak (verified only morphologically). Hence, a total of 38 American lobsters have been observed in Sweden until 2017 if the two new lobster are verified genetically.

One Japanese shore crab *H. sanguineus* was found during the fyke net test fishing near the outlet of cooling water from Ringhals nuclear power plant. At this location, one new species of red algae *Dasysiphonia japonica* along with one species of previously reported red algae *Dasya baillouviana*, and one species of brown algae *Sargassum muticum* were also found during this year diving survey. Another species of previously reported red algae *Bonnemaisonia hamifera* were found at two other sites during the survey. Besides the algae, Japanese oysters, *M. gigas* were found in large numbers near the outlet of cooling water from this nuclear plant and in smaller numbers at the two other sites (Frida Sundqvist, pers. com.). *Dasya baillouviana* was discovered in Strömmarna (Bohuslän) near the Kristineberg Marine Research station in 1953 and gradually infested Kattegar and Skagerrak areas. Recently, they have significantly increased in abundance and occurrence along the Bohuslän coast and in the Gothenburg archipelago.

Alien crabs have been frequently reported in Swedish waters during 2017. One individual of the North American mud crab *R. harrisii* and one individual of the Chinese mitten crab *E. sinensis* were found in Karlskrona (Blekinge County) (Matz Berggren & Ulf Lindahl, pers. com) and Österfjärden (Umeå manucipality) (Kristin Dahlgren, pers. com.), respectively.

The Japanese shore crab *H. sanguineus* and the brush-clawed shore *H. takanoi* have been frequently reported in Swedish waters during 2017 (Table 1, Matz Berggren, pers. com. see also Berggren & Karlsson 2017).

4. Pathogens

In 2017, the Swedish glass eel imported for restocking purposes were found to be infected with Eel Virus European X (EVEX). Due to clinical disease and mortality associated with the virus in the quarantined eels close to restocking, all glass eels (about 3 million eels) were euthanized and thus the national eel management plan suffered a great loss both in loss of restocking fish and economically (Håkan Wick & Axén Charlotte, pers. com.).

Table 1. Occurrence of Japanese shore crab *Hemigrapsus sanguineus* and brush-clawed shore crab *Hemigrapsus takanoi* in Swedish waters during 2017.

Date	Species	Sex	Size (mm)	Latitude	longitude	Location
1 June	*H. cf takanoi*	female	9	11,81250	58,06240	Nösnäsbadet, Stenungssund
17 June	*H. sanguineus*	male	30	11,63497	57,72733	Öckerö - St. Rävholmen
20 June	*H. sanguineus*	male	-	11,48522	57,35509	Donsö
24 June	*H. sanguineus*	male	25	11,66761	57,69383	Hönö - Heden

05 July	*H. takanoi*	female	20	11,41778	58,13856	Kattevik, stocken Orust
14 July	*H. sanguineus*	female	25	11,48814	58,28757	Fiskebäck, Lysekil
15 July	*H. sanguineus*	female	20	11,63541	57,69176	Lappesandsbadet Hönö
16 July	*H. sanguineus*	female	20	11,58804	57,88706	Koön, Marsstrand
17 July	*H. sanguineus*	female	20	11,36956	58,24007	Bredholmen, Gullmarsfjord
21 July	*H. sanguineus*	female	20	11,64741	58,05984	Röra strand, Tjörn
23 July	*H. sanguineus*	female	25	11,59021	57,86356	Utkäften, Klåveön, Marstrand
25 July	*H. sanguineus*	female	20	11,77635	57,97377	Timmervik, SV Jörlanda
26 July	*H. sanguineus*	female	14	11,43211	58,20390	Skallhavet, Grundsund
26 July	*H. takanoi*	male	15	11,65458	57,90373	Instön, Marstrand
26 July	*H. sanguineus*	male	35	12,09138	57,24797	Bua, close to Ringhals
02 Aug	*H. sanguineus*	male	15	11,01810	58,90410	Familjeviken at Vettnet, Nordkoster
07 Aug	*H. sanguineus*	female	10	11,31715	58,46736	bovallstrand
08 Aug	*H. takanoi*	male	20	11,74509	58,00234	Tjörn
10 Aug	*H. sanguineus*	male	38	12,05312	57,15121	Ringhals
14 Aug	*H. sanguineus*	male	25	11,42632	58,22852	Munkevik, Grundsund, Skaftö
14 Aug	*H. sanguineus*	female	25	11,42632	58,22852	Munkevik, Grundsund, Skaftö
20 Aug	*H. sanguineus*	female	35	12,09138	57,24797	Close to Ringhals power plant
20 Aug	*H. sanguineus*	female	35	12,09138	57,24797	Close to Ringhals power plant

5. Research and Monitoring Programs

1) Aquabiota will map round goby distribution along the eastern coast of Sweden (including Lake Mälaren) through eDNA metabarcoding method during 2018.

2) "Projekt Nya arter" is financed by County of Västra Götaland involving schools along the west coast of Sweden. 11 schools, 40 teachers 1300 students. Following alien species are in focus (and investigated with different methods: *Ficopomatus enigmaticus, Austromin-*

ius modestus, Watersipora subtorquata, Caprella mutica (panels) *H. takanoi, H. sanguineus* (cages) *M. gigas* (collection) *and N. melanostomus* (fishing with cage and angling).

3) Culture of Pacific oysters evaluation of submerged culture systems – can new species and new production techniques contribute to the diversification and expansion of the Swedish mariculture sector?

This project will test and evaluate culture methods that can allow cultivation of the Pacific oysters in Swedish waters and facilitate expansion of the existing bivalve culture industry. The proposed methods involve technology for fully submerged culture, a technique that enables both biologically and societally sustainable development of the Swedish aquaculture sector in parallel with an economic development of rural communities and Swedish tourism. This would increase the availability of organic, locally produced and healthy mussels and oysters, as well as having positive environmental effects through an increase of extractive culture. More specifically the project will: 1) develop a model for evaluation of maturation of cultured Pacific oysters in relation to temperature, and test different techniques to prevent reproduction of the cultivated oysters, 2) evaluate the biological culture potential of native bivalves (blue mussels and flat oysters) in submerged culture systems, and determine whether the technology can contribute to reduced fouling on the cultured organisms and equipment, and 3) create a knowledge platform regarding different types of submerged culture systems and highlight appropriate model systems based on Swedish conditions.

4) Knowledgebase for a uniform management of OSPAR listed bivalve beds, Financed by EHFF 2018-2021 (granted 2017). Including evaluation of competition between *M. gigas* and native bivalves?

Although we keep getting reports about declining blue mussel and flat oyster populations along the Swedish west coast, there is no monitoring of these biotopes. This project will quantify the demographic development of the blue mussel and flat oyster populations over the coming 4 years (also based on some historical data). In order to evaluate the threats to these biotopes, this project will conduct a threat analysis identifying the major threats (which is not fisheries in Sweden as dredging is not allowed in shallow areas), and potential knowledge gaps in this respect, and try to fill some of these gaps (focusing mainly on interactions between the non-native Pacific oysters and the two native species) by comparing feed preferences, niche requirements and doing field studies to detect signs of potential competition. To facilitate management, population genetics and dispersal will be investigated using oceanographic trajectory modelling. Two field studies will also be performed to evaluate a) the effects of blue mussel and flat oyster population demographics on clearing these biotopes from Pacific oysters, and b) the effects of stock enhancement/restoration on the blue mussel and flat oyster population development.

5) The extensive transatlantic trade of live American lobster *H. americanus* is a transport pathway for introductions of the alien species to European waters. A project to determine if the *H. americanus* should be regarded as an alien or invasive alien species has been initiated in Sweden and Norway. In addition, to be able to predict what effects *H. americanus* will have on the native European lobster *H. gammarus*. The current status of *H. gammarus* stock is at a record low, which potentially could make it less resilient to impact

from a competitive alien lobster species. There are only two species within the lobster genus *Homarus* and they have been geographically separated by the Atlantic Ocean, but yet still have many similar morphological, genetic, ecological and physiological traits. It is not yet shown if the *H. americanus* has established a reproducing population and thereby should be classified as invasive, but the occurrence of ovigerous females with both American and hybrid eggs are enough to raise concern. This projects aim to answer these questions, through a series of laboratory studies.

Until now the main results are:

- Female American lobsters and male European lobsters mate in the wild.
- Their hybrid offspring can develop and hatch in European water conditions.
- A small proportion of the larvae are deformed, but the majority are not and survive the first larval stage comparably well to the European larvae.
- In general, hybrid larvae behaviour and tolerance are not different from the European larvae.
- In conclusion, hybrid *Homarus* larvae are likely to survive and develop in Europe and thereby pose a threat to the local ecosystem and lobster population.

The results of the projects will improve the Swedish risk assessment of American lobster.

6. Meetings

A workshop on current status and management initiatives through commercialization of pacific oysters was held in Ribe, Danish Wadden sea, 2-3/10 2017. The workshop was hosted by the Scandinavian oyster network (SNOK II), and was attended by approximately 50 representatives from the oyster industry, governmental authorities, and scientists from Sweden, Norway, Denmark and Finland.

7. Other (relevant publications)

Articles

Anglès d'Auriac, M.B., Rinde, E., Norling, P., Lapègue, S., Staalstrøm, A., Hjermann, D.Ø. Thaulow, J. (2017) Rapid expansion of the invasive oyster *Crassostrea gigas* at its northern distribution limit in Europe: Naturally dispersed or introduced? PLoS ONE 12, e0177481. https://doi.org/10.1371/journal.pone.0177481

Faust, E., André C., Meurling, S., Kochmann, J., Christiansen, H., Fast Jensen, L., Charrier, G., Laugen, A.T., Strand, Å. (2017) Origin and route of establishment of the invasive Pacific oyster (*Crassostrea gigas*) in Scandinavia. Marine Ecology Progress Series 575, 95-105.

Leppänen, J.J., Kotta, J., Daneliya, M., Salo, E. (2017) First record of *Chelicorophium curvispinum* (G.O. Sars, 1895) from Lake Mälaren, SE Sweden (2017). BioInvasions Records 6, 345–349.

Mortensen, S., Bodvin, T., Strand, Å., Holm, M.W., Dolmer, P. (2017) Effects of a bioinvasion of the Pacific oyster, *Crassostrea gigas* (Thunberg, 1793) in five shallow water habitats in Scandinavia. Management of Biological Invasions. Vol 8. http://www.reabic.net/journals/mbi/2017/Accepted/MBI_2017_Mortensen_etal_corrected proof.pdf

Øresland, V., Ulmestrand, M., Agnalt A-L, Oxby, G. (2017) Recorded captures of American lobster (*Homarus americanus*) in Swedish waters and an observation of predation on the European lobster (*Homarus gammarus*). Canadian Journal of Fisheries and Aquatic Sciences, 2017, 74, 1503-1506, https://doi.org/10.1139/cjfas-2016-0532

Samson, E., Philipp, E., Hirsch, P.E., Palmer, S.C.F., Behrens, J.W., Brodin, T., Travis, J.M.J (2017) Early engagement of stakeholders with Individual-Based Modeling can inform research for improving invasive species management: the round goby as a case study. Frontiers in Ecology and Evolution, 5(149). https://doi.org/10.3389/fevo.2017.00149

Reports

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8. References and bibliography

Berggren, M., Karlsson, R. (2017) Invasiva, asiatiska krabbor längs Västkusten, Fauna & Flora. 112, 23-26.

Degerman, E., Petersson, E (2017). Översikt, riskbedömning och förslag på åtgärder för puckellax (*Oncorhynchus gorbuscha*). SLU ID: SLU. aqua.2017.5.2-275 Overview, risk analysis and suggested management actions for pink salmon.

Florin, A-B, Tärnlund, S. (2017) Explosive increase of invasive fish species in the Stockholm archipelago. SLU Aqua News.
https://www.slu.se/ew-nyheter/2017/10/explosionsartad-okning-av-invasiv-fiskart-i-stockholms-skargard/

Nilsson, J. (2016) Inventering av det strandnära yngel och småfisksamhället, samt utbredning av svartmunnad smörbult längs Kalmar läns kust, Linnéuniversitetet, Rapport 2016:5 I.

Sundberg P., Obst M., Bourlat S.J., Bergkvist J. & Magnusson M. (in press). Utvärdering av ny övervakning av främmande arter. Metodjämförelse mellan traditionell och DNA-baserad identifiering (English summary). Havs- och vattenmyndighetens rapport 2018:12.

United Kingdom

Report prepared by:

Compiled by Lyndsay Brown (Marine Scotland), Gordon H. Copp (Cefas), Paul Stebbing (Cefas) and Hannah Tidbury (Cefas), with contributions from Jenni Kakkonen (Orkney Islands Council Marine Services), Jan MacLennan (Natural England), Iveta Matejusova (Marine Scotland), John Bishop (Marine Biological Association), Keith J. Wesley (Bedwell Fisheries Services), Ian G. Cowx (Hull International Fisheries Institute) and Gabe Wynn (Natural Resources Wales).

Highlights:

Priority marine NNS monitoring and surveillance lists have been published by Cefas. Lists include high priority species currently present and those that are considered likely to arrive in the near future. Species on these lists have been included in regular marine biodiversity monitoring programmes since 2016. Further developments to the monitoring programme will be made in 2018.

Further work has been completed on the UK integrated assessments for D2 under the MSFD. This involved comparing assessment results to characteristics and targets laid out in Part 1 of the Marine Strategy. Cefas is in the process of reviewing the MSFD D2 Programme of measures. The review will be used to inform policy on what gaps/complexities still exist, what additional actions may be required to fill those gaps and contribute to the 2018 assessment of POMS required by the MSFD.

The annual Marine Pathways Group face-to-face meeting has taken place. Key points were an update of the MSFD monitoring and surveillance lists, refinement of the INNS monitoring programme to include high risk locations of introduction and development of new action plans, for example for *Didemnum vexillum*.

Monitoring and surveillance work continues on a Scottish west coast oyster farm following an outbreak of the carpet sea squirt, *Didemnum vexillum* in 2016. 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 out with the farm. A new establishment of *D. vexillum* is also being monitored at a Scottish west coast marina and a second west coast oyster farm; however, it is thought that it has been established at this farm for quite some time.

Annual INNS surveys continued in marinas in Orkney by Orkney Isles Council and in rivers and estuaries throughout the south coast of England by the Marine Biological Association. Surveys of a protected serpulid reef on the west coast of Scotland were undertaken by Scottish Natural Heritage and surveys of dredge disposal sites were undertaken in Wales by Natural Resources Wales. Natural England continues with removal of Pacific oysters from various locations in the south of England.

Range expansions include the carpet sea squirt in additional sites on the west coast of Scotland, the red alga *Gracillaria verminculophylla* in west Wales, American lobster sight-

ings off the Welsh coast and various locations on the east and south coasts of England, the Asian shore crab on the southeast coast of England and Atlantic sturgeon in the River Thames.

As in several other countries bordering the North Sea, the UK experienced an invasion of several of its water courses by pink salmon *Oncorhynchus gorbuscha* in July and August of 2017, especially in Scotland and northern England. The most remarkable were the evidence of successful reproduction in the River Ness (Scotland) and broad geographical spread of pink salmon reports for rivers around the UK, including two rivers in Southern England. Non-native fishes captured in the River Thames (England) in January 2017 include a large European catfish *Silurus glanis* and a large Atlantic sturgeon *Acipenser oxyrhynchus* just above the tidal zone.

Regulations

The Ballast Water Management Convention entered into force on 8 September 2017.

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

Ruditapes philippinarum (Manila clam) – The UK Department of Environment, Food & Rural Affairs (Defra) has confirmed that non-native *R. philippinarum* has been 'naturalised' in England and they consider it to be an 'ordinary resident' in Great Britain. This species is not present yet in Wales and the Welsh Government is considering its position on this issue. Reviewed evidence seems to suggest that the species is not particularly invasive in nature in current climatic conditions but, given the current lack of information about potential impacts on biodiversity, any decisions to introduce or naturalise populations of *R. philippinarum* in Wales should be approached with caution.

Natural Resources Wales (NRW) and the Welsh Government had an enquiry regarding the introduction of the giant keyhole limpet *Megathura crenulata* for hemocyanin extraction but so far this has not been progressed.

Unintentional introductions

New sightings –

The first sighting for Wales of the invasive red alga *Gracillaria vermiculophylla* was recorded in the summer of 2017 in the Dwyryd Estuary in West Wales. We do not currently know the pathway of introduction. The nearest records are in Ireland and on the South Coast of England.

Invertebrates

Fish
None reported.

Previous sightings –
Invertebrates

The carpet sea squirt *Didemnum vexillum* was observed at a new marina on the west coast of Scotland in July 2017 and at an active oyster farm in the Clyde in October 2017, both confirmed by molecular analysis. It is likely that *D. vexillum* has been present here since at least September 2016 when original samples were collected and stored before analysis the following year. The oyster farm in the Clyde is in close proximity to previously known established *D. vexillum* colonies. Similarly it is likely that this new establishment has been around for a number of years.

American lobster *Homarus americanus* records – following on from the *H. americanus* record in Tremadog Bay in 2016 another single specimen was found by a fisherman off the North Wales coast. There is still no proof that *H. americanus* is now resident in Wales, and more work still needs to be done on the source of these isolated records. Single *H. americanus* specimens have been captured at five locations within English waters in 2017: Whitby, Torquay, Great Yarmouth, Sunderland and Christchurch. These ports are in closest proximity to the location where *H. americanus* were being caught. It is difficult to determine the source of these animals, and more work is required to identify the route of introduction, although specimens caught from the south coast, especially Great Yarmouth and Christchurch, may be associated with the mass release of American lobsters in 2015 near Brighton.

A review of the bryozoan *Schizoporella japonica*, which was first recorded in European waters in 2010, was published in 2017, detailing the link between this species and human activities, especially marinas and harbours (Loxton *et al.* 2017). The species inhabits a few sites in England, Wales and Ireland, only but is frequently found in Scottish marinas and harbours. This southward-spreading invasive species is expected to spread into suitable coastal areas of England, Wales and Ireland as well as further within Europe (Loxton *et al.* 2017).

An update on the spread of the brush-clawed shore crab *Hemigrapsus takanoi* provides new data on the species' occurrence at six additional locations in the English counties of Kent (n = 5) and Suffolk (n = 1), with apparent establishment of a large reproducing population at the latter location (Ashelby *et al.* 2017).

Fish
In January 2017, a large specimen of Atlantic sturgeon *Acipenser oxyrinchus* was captured in the River Thames just above the tidal zone. Also captured in the Thames that month was a large European catfish *Silurus glanis*. Exact locations, lengths and weights not available (K.J. Wesley, pers. comm.). During July and August 2017, similar to several other North Sea countries, the U.K. experienced an invasion of some of its rivers by pink salmon *Oncorhynchus gorbuscha*, with particularly high numbers in Scotland (the River Ness) and less abundant but still remarkable numbers in some rivers of northern England (Copp 2017). Successful spawning, egg incubation and hatching were documented for the River Ness, and specimens displaying pre-spawning behaviour were observed in water

courses as far south as the rivers Frome (Dorset) and the River Avon (Hampshire).

Species not yet reported or observed
With the arrival in past years of Ponto-Caspian invertebrate species, the UK remains on the lookout for Ponto-Caspian fish species, most notably gobies, but none have yet to be reported anywhere in the UK.

Pathogens –

Sightings/records

None reported.

General information
Cefas
The MSFD NNS priority lists, and species ID guides, whose development was led by Cefas, are now published and can be accessed via the GBNNSS website: www.nonnativespecies.org/index.cfm?pageid=597

Further work has been completed on the UK integrated assessments for D2 under the MSFD. This involved comparing assessment results to characteristics and targets laid out in Part 1 of the Marine Strategy.

A review of the MSFD D2 Programme of measures is currently being undertaken at Cefas. The original programme of measures, finalised in 2015, was compiled of existing and planned biosecurity related actions. Various gaps in this programme have been identified since it's development, along with complexities with implementation to meet MSFD D2 requirements. In addition, since 2015 there have been a number of initiatives from across the UK relating to marine biosecurity. This review attempts to highlight the gaps in the initial programme, understand the issues with implementation, and incorporate activities undertaken since 2015. The review will be used to inform policy on what gaps/complexities still exist, what additional actions may be required to fill those gaps and contribute to the 2018 assessment of POMS required by the MSFD.

Molecular analysis has been undertaken at Cefas of a number of water samples from the Thanet MPA for the presence of *Didemnum vexillum*. While this work is not yet completed, initial outputs highlight the presence of *Didemnum vexillum* in some of the samples.

Cefas has also contributed to the work being undertaken to develop pathway action plans under the Alien Species Regulation, including those for the recreational boating and angling pathways. Cefas is in the early stages of refinement of the marine pathways risk assessment to include the use of particle tracking models to facilitate understanding of risk of introduction of INNS by natural dispersal into coastal areas around GB and Ireland.

A workshop, funded by IEG, has been organised and held at Cefas to discuss how to further enhance the existing NNS monitoring initiative; inclusion of additional monitor-

ing programmes, and additional activities under taken that could assist in the monitoring for NNS. The workshop was held on the 29th November 2018 and was attended by representatives from across the UK from NGO, government and agencies, including the Inshore Fisheries Committees. Collation and assessment of the large amount of information received during and following the workshop is ongoing. In addition to the workshop, IEG has also funded further development of primer sets for priority INNS. Primer set development and validation against a range of native species and positive controls is currently being undertaken. In combination with scrape sample collection methods previously developed by Cefas, these primer sets will be used for monitoring of high risk locations for INNS.

Advice on a number of species has been provided by Cefas. More Specially, Cefas have provided a short review, building on that conducted by GBNNSS in 2010, discussing environmental impact of Pacific oysters. This review has highlighted knowledge gaps which is it proposed are addressed through subsequent R and D. Advice has also been provided in relation to mitten crabs, American lobsters and Crayfish.

Research and development at Cefas continues on the application of molecular tools, such as environmental DNA (eDNA) analysis and substratum scrapes, in the detection of non-native species. An eDNA application published in 2017 to assess the efficacy of topmouth gudgeon *Pseudorasbora parva* eradication from an angling pond in southeastern England (Davison *et al.* 2017) has been extended through the development and trial of a more sensitive analytical approach, which will be published in 2018. 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) and Phil Davidson (phil.davison@cefas.co.uk). During 2017, the results of a genetic study (Jeffries *et al.* 2017) provided evidence that the freshwater fish, crucian *Carassius carassius*, which was believed by many to be native to England, is most likely a non-native species introduced about 800 years ago, at around the same time as common carp *Cyprinus carpio*. An application of the Aquatic Species Invasiveness Screening Kit (AS-ISK) undertaken in China was published this year (Li *et al.* 2017), which is to be followed by a global trial, led by WGITMO delegates, of this decision-support tool's applications on marine, brackish and freshwater species. Results are expected to be published in 2019 or early 2020. For further information contact Gordon H. Copp (gordon.copp@cefas.co.uk) and Lorenzo Vilizzi (Lorenzo.vilizzi@gmail.com).

Natural Resources Wales

PhD at School of Ocean Sciences Harry Goudge (Bangor University, Wales) – This PhD research is investigating if and why sub-tidal fouling organisms, including non-native species (NNS), more readily establish populations on floating marine structures, such as marina pontoons, compared to non-floating artificial fixed structures exposed to similar environmental conditions. It asks if different construction materials determine the fouling communities present and also if small-scale differences in environmental factors such as light, water flow rates and depth, dissolved oxygen and salinity affect species composition on floating structures at scales of individual marina pontoons and also at scales of individual marinas.

To answer these questions the research combines environmental monitoring of key physicochemical variables, observational studies using SCUBA dive surveys and camera surveys and manipulative ecological succession studies using settlement panels. The research is currently focused in Holyhead Marina and Port area for logistical ease of access. The water within Holyhead is fully marine and flushed twice a day by the tide. In contrast, the second study area, Milford Haven Marina, having lock gates and a significant freshwater input, means the salinity within the marina fluctuates daily depending on rainfall and the state of the lock gates.

During the first year of this PhD, the focus was on gathering baseline environmental data and developing robust quantitative sampling methods for surveying the undersides of marina pontoons. The PhD is now in the second year of this three and a half year project and the focus this year, is to survey floating and fixed structures to determine if any differences in the fouling communities are detectable on structures of different materials and structures exposed to gradients of environmental factors such as dissolved oxygen, salinity, flow rates and light.

The Wales Invasive Non-Native Species (WINNS) Programme – The WINNS (October 2016 – December 2017) was established to support the delivery of new legislation and government policy objectives in relation to tackling INNS within Wales (e.g. Invasive Alien Species Regulation 2014 (IAS Reg) and the Infrastructure Act 2015). The Programme supported the implementation of actions associated with the GB INNS Strategy (2015) to minimise the risk posed by INNS and reduce their negative impacts by adopting the three-stage hierarchical approach of: (1) prevention; (2) early detection and rapid-response; and (3) long-term management and control. For example, the WINNS Programme has supported the development of GB NNS surveillance work, produced Wales level contingency plans (rapid-response) and has contributed to the production of UK management plans for widely spread NNS and Priority Species for Acton in Wales. The work of the WINNS Programme has also built capacity to assist in delivering future INNS actions within Wales and undertook some action to understand biosecurity within the organisation and made clear recommendations on how this could be improved within NRW.

Welsh Monitoring and Surveillance Lists – Welsh Government have now published their (bilingual Welsh and English) Welsh Monitoring and Surveillance List for Marine INNS. The list is now available on the Welsh Government website:

http://gov.wales/topics/environmentcountryside/marineandfisheries/marine-conservation-and-biodiversity/species-and-habitats/?lang=en

Dredge disposal site surveys – To enable NRW to advise its marine licensing team and dredge disposal companies on the risks dredge disposal poses in terms of spreading INNS (particularly Schedule 9 species) we have been undertaking baseline surveys of dredge disposal sites around Wales for marine INNS. So far, NRW has only surveyed Holyhead Deep, but plans to survey the outer Milford Haven sites and the Severn disposal sites in 2018. Swansea's outer disposal site was surveyed as part of a Masters Pro-

ject (Chloe Jenkins), which is examining the survival of *Crepidula fornicata* in dredge arisings at disposal sites.

General approach to Biosecurity on Dredging activities in Wales – the NRW Advisory have been working closely with NRW Marine Licencing and various dredging operators in Wales to produce some effective biosecurity management measures in relation to dredging activities in Wales. The measures are being implemented thought the Marine Licensing process in relation to the need for developers and operators to produce and agree an appropriate 'Biosecurity Risk Assessment' with NRW prior to undertaking any relevant works.

Measures include:

- Adherence to relevant existing legislation and guidance i.e. ballast water and hull fouling
- Additional measures associated to the uptake, exchange and deposition of hopper water in relation to dredging activities
- Recognition and adoption of specific 'biogeographic areas' in relation to minimising the risk of introduction and spread of marine INNS through specific biosecurity measures due to dredging activities in Wales. This discussion is on-going and is in the process of being finalised internally within NRW. However, these areas will likely be derived from the WFD water bodies model and include combining several water bodies to constitute a single 'biogeographic area' where appropriate.
- Requirement for all biosecurity management measures to be documented, logged and submitted with the next update review of the biosecurity risk assessment. Currently on an annual basis.

Evidence Gaps - NRW have recently published our Marine Biodiversity Evidence Gaps report. This includes evidence gaps for marine INNS. www.naturalresources.wales/evidence-and-data/research-and-reports/marine-biodiversity-collaborative-research-priorities/?lang=en

On-going work on the disinfection berth in Holyhead Marina – Prof. Stuart Jenkins and Dr Ronan Roach are continuing to trial the disinfection berth for recreational vessels at Holyhead Marina. They are also undertaking further stakeholder surveys to understand the level of appetite for biosecurity measures at Holyhead.

Natural England

The RAPID LIFE project (Reducing and Preventing Invasive Alien Species Dispersal) will pilot an innovative approach to Invasive Non Native Species (INNS) management in freshwater, riparian and coastal environments across England supporting local action and putting people at the heart of the environment. The project started in July 2017 and will run for for three years. It is led by the Animal and Plant Health Agency (APHA) with Natural England and Bristol Zoo as partners. www.nonnativespecies.org/index.cfm?sectionid=139. The preparatory phase will mobilise regional stakeholders to produce five Regional Invasive Species Management Plans (NW, NE, SW, SE and Midlands) using templates and guidance produced by national

experts. These plans will assist stakeholders in any given region to work together more holistically to manage INNS. A national toolkit is being prepared, along with revised and more effective materials to improve uptake of biosecurity practices. This will include biosecurity planning toolkits targeted at managers of coastal operations such as ports, harbours and marinas and new awareness raising materials to promote Check Clean Dry messages in the coastal environment. The delivery phase of the project will involve local stakeholders utilising the materials produced in the preparatory phase to deliver consistent (and regionally tailored) prevention, early warning, rapid response, eradication and control of INNS throughout England. Actions across the region will:

- Focus on minimising pathways of introduction and spread of INNS by working with specific priority stakeholder groups, promoting GB-level campaigns (such as "Check, Clean, Dry") through a range of activities (training workshops, events, posters etc.);
- Increase stakeholder capacity to detect and report novel INNS early and support rapid responses;
- Improve local practitioners' knowledge of best practice methodologies for the management of INNS

Contact Dave Parrot Dave.Parrott@apha.gsi.gov.uk

English Biosecurity planning project

Natural England funded further biosecurity planning work in 2017 to continue to promote and provide support for organisations to take forward biosecurity planning as a tool to help manage pathways of spread of INNS in the marine environment. The project was delivered by independent consultants Sarah Brown and Robin Payne working with Chris Wood at the Marine Biological Association and Anna Yunnie and Tom Vance at Plymouth Marine Lab. The project delivered the following objectives:

- Worked directly with 5 marina companies/port authorities across England and Wales to write biosecurity plans specifically for their operations – with the aim to roll these out across their sites.
- Undertook an estuary wide biosecurity plan training workshop with a range of stakeholders from the local area to draft a biosecurity plan for use across the estuary in Plymouth and also developed estuary wide plans for South Devon AONB.
- Developed further biosecurity plan templates– individually tailored to one off events, specific operations and general site activity.

All the outputs from this project including templates, plans and a project report are available here: www.nonnativespecies.org/index.cfm?pageid=597. Contact Jan.Maclennan@naturalengland.org.uk for more information.

Pacific oyster control - Kent

A team of volunteers coordinated by Natural England works in the North East Kent European Marine site to target and control the spread of the Pacific Oysters by regularly manually killing and removing individual animals in order to manage the impact of this species on the protected chalk reef and mussel bed habitats. This is a long term control project which continued in 2017 and since starting in 2010 has removed more than 200 000 oysters from the site. In 2017, further successful work was carried out to remove oysters from artificial structures in Ramsgate Harbour thereby potentially removing a significant source of future spat – this aspect of the project will now also be sustained in future years. The project is based on containment rather than eradication and is support-

ed by continuous monitoring in order to target volunteer effort most effectively. Contact Nadine.Atchison-Balmond@naturalengland.org.uk for more information

Pacific oyster control - Southwest
A new project working with local community groups in a number of estuaries in the South West to monitor and control Pacific oysters has been established in 2017. Pacific oysters are impacting the favourable condition of protected features in designated estuaries and it is hoped that this project will secure funding to be continued and expanded in following years. Contact Carolyn.Waddell@naturalengland.org.uk for more information

Marine Biological Association
Surveys of the rivers Itchen and Hamble around Southampton were conducted to look at the extent of marine non-native species in their estuaries. Collected material is still being processed but *Ficopomatus enigmaticus* was present in nuisance proportions in parts of the Itchen, and *Diadumene lineata* very abundant there also. *Watersipora subatra* has become frequent on natural rocky shores in parts of south Devon, and *Perophora japonica* continues to spread in natural habitats, notable occurrences being in north Devon at Woolacombe and Lee Bay (information from D. Fenwick), a substantial distance from known populations in Cornwall. A survey in collaboration with Seasearch divers confirmed the continued presence of *Didemnum vexillum* in the Dart Estuary, Devon. *Hemigrapsus takanoi* is confirmed as established in GB (see Ashelby *et al.* 2017), but there do not seem to have been any recent reports of *H. sanguineus*. For further information, contact John Bishop (jbis@MBA.ac.uk).

Marine Scotland
Work continues understanding and managing the outbreak of *Didemnum vexillum* on a shellfish farm in Loch Creran. The occurrence of *D. vexillum* at other sites within Scotland (all within the Clyde Sea area) is being further investigated and management measures put in place (e.g. Species Control Agreements under the Wildlife and Natural Environment (Scotland) Act). The Scottish INNS Working Group is developing strategic approaches in INNS monitoring in Scotland to: (1) Revised and finalised list of species for monitoring and monitoring frequency; (2) Pathways analysis and risk assessments (revised and finalised list of monitoring sites); (3) Outreach and education (e.g. field guides, guidance, information leaflets, citizen science); and (4) Regional biosecurity plans. For further information contact Lyndsay Brown (Lyndsay.brown@gov.scot).

Marine Scotland completed validations of compulsory *D. vexillum* treatment trials, which are currently required prior to any shipment of Pacific oysters from a *D. vexillum* positive aquaculture site to other sites for on-growing. Efficacy of a combined 24 hour freshwater bath followed by a 48 hour air exposure in an intertidal zone was trialled both in-situ and under laboratory conditions. Clear differences in colour and general appearance of *D. vexillum* fouling on oyster shells were observed between treated and control groups. There were signs of new growth of *D. vexillum* on the majority of untreated oyster shells while treated *D. vexillum* appeared darkened and necrotic with entire patches detaching from shell surfaces. The Laboratory phase of the experiment was carried out over 25 days and for 74 days in the field. Following treatment no signs of *D. vexillum* growth was observed on the treated oyster shells. This study demonstrates an effective treatment for *D.*

vexillum fouling of an economically important shellfish species. This work will be submitted for peer-review. For further information contact Iveta Matejusova (iveta.matejusova@gov.scot) and Lyndsay Brown (lyndsay.brown@gov.scot).

A research project is continuing in Marine Scotland on the development of DNA-based methods for monitoring marine invasive species using water and hard surface scrape samples. The first year of the project focused on validation of specificity and sensitivity of a single species detection technique by real time PCR for *D. vexillum* and *Styella clava*. Preliminary results obtained from water samples collected from *D. vexillum* positive marinas and an oyster farm demonstrated the feasibility for monitoring of invasive species using this technique. Detection probabilities for *D. vexillum* real time PCR assay were calculated taking into account the level of current surveillance effort and range of environmental factors. The second year of the project will look at the feasibility of using multispecies detection techniques such as metabarcoding, and sequencing platforms such as Illumina and Nanopore MinION are being trialled. The metabarcoding approach will be assessed on a range of samples including water, scrapes and settlement panels. The ultimate goal of this project is to design sensitive tools for routine monitoring of marine invasive species in Scotland. For further information contact Iveta Matejusova (iveta.matejusova@gov.scot) and Lyndsay Brown (Lyndsay.brown@gov.scot).

A PhD student supervised by Prof. Stuart Piertney and Dr. Alex Douglas from the University of Aberdeen and Dr. Iveta Matejusova from Marine Scotland started in October 2017. This project aims to assemble the complete genome for *D. vexillum* and characterise additional population markers to investigate the origins of *D. vexillum* introductions. For further information contact Iveta Matejusova (iveta.matejusova@gov.scot).

An invasive species DNA technical group was established in the UK – this brings together regulators and representatives from academic institutes to create an interactive platform to share experiences and knowledge of novel DNA approaches for monitoring of invasive species. The first meeting took place in November 2017 in Preston. If you want to be involve in this initiative or just want further information, then contact Iveta Matejusova (iveta.matejusova@gov.scot).

Orkney Islands Council

Orkney Islands Council is continuing with their annual marine non-native species monitoring programme, now on its 6th year. A total of eleven non-native species were recorded during the 2017 monitoring season, all eleven species have been previously recorded in Orkney. To date no invasive marine non-native species have been recorded in the Orkney Islands. For further information, contact Jenni Kakkonen (jenni.kakkonen@orkney.gov.uk).

Marine Pathways Group

The Marine Pathways Group, chaired by Dr Paul Stebbing, comprising experts from all relevant government organisations across the UK, has continued to provide technical support and guidance on INNS to HBDSEG, discuss and coordinate work on INNS and disseminate information to stakeholders where appropriate. In addition to regular meetings via teleconference, the annual Marine Pathways Group face to face meeting was held

at Defra in London on 17 and 18 January 2018. Key points discussed at this meeting, included the review and update of the MSFD target species list, refinement of the UK marine INNS monitoring programme to include high risk areas of introduction, the development of new action plans for species such as *Didemnum vexillum* and methods and approaches for the assessment of NNS risk management. For further information contact Hannah Tidbury (hannah.tidbury@cefas.co.uk) or Paul Stebbing (paul.stebbing@cefas.co.uk).

Meetings

At one of the workshops at the CEDA Dredging Days Conference (9–10 May 2017; see below), NRW delivered a presentation of Marine INNS issues in relation to dredging activities in Wales. The concept of the risks associated to 'hopper water' were introduced (potential loophole in the Ballast water convention in relation to dredging) and potential biosecurity management measures were highlighted i.e. hopper water exchange/circulation at sea in between biogeographic areas. This workshop marked the start of current discussion surrounding biosecurity and dredging activities in Wales.

A series of workshops held at the Freshwater Invasives (FINS-II) conference (11–14 July 2016; see here below) resulted in a collective paper (Piria *et al.* 2017) in which recommendations are provided on the opportunities and threats associated with the new EU Regulation on Alien Invasive Species.

The EU Cost Action (TD1209) "European Information System for Alien Species (ALIEN Challenge)", led by Dr Helen Roy of the Centre for Ecology and Hydrology and involving some members of WGITMO, has held a series of meetings in recent years to develop minimum standards for risk assessments for the listing of non-native species in the annexes of the new EU Regulation on the management of invasive alien species. In November 2017, these minimum standards were published online in a peer-reviewed article (Roy *et al.* 2017).

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

Past year (2017)

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

CEDA 2017 – Central Dredging Association, CEDA Dredging Days Conference (Rotterdam, The Netherlands; 9–10 May 2017 (https://dredging.org/news/news/ceda-dredging-days-2017---programme-announced/detail_news=0048_000327_000000)

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

SEFS-10 – Symposium for European Freshwater Sciences (Olomouc, Czech Republic; 2–7 July 2017) (www.sefs10.cz/how-register)

Island Invasives 2017 – Scaling up to Meet the Challenge (University of Dundee, UK; 10–14 July 2017) (www.islandinvasives2017.com/)

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

BES Symposium 2017: The Macroecology of Alien Species: Patterns, Drivers and Consequences of Global Biotic Exchange (Durham University; 24–26 July 2017) (www.britishecologicalsociety.org/events/bes-symposium-2017-macroecology-alien-species-patterns-drivers-consequences-global-biotic-exchange/)

EUROMAL 2017 – 8th European Congress of Malacological Societies (Krakow, Poland; 10–14 September 2017) (www.euromal.pl./)

II. Workshop on Invasive Species – Global meeting on invasion ecology (Bodrum, Turkey; 27–29 September 2017) (https://istilaciturlercalistayi.ecovasion.org/workshop-announcement/)

ICES-PICES-CIESM session 2017: Bioinvasion trajectories and impacts in contrasting marine environments (Fort Lauderdale, Florida, USA; 18–21 September 2017) (http://ices.dk/news-and-events/asc/ASC2017/Pages/Theme-session-B.aspx)

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

ICBI 2017 – 3rd International Congress on Biological Invasions (Hangzhou, China; 19 November 2017) (www.icbi2017.org/dct/page/70066)

Meetings in 2018

Canadian Conference for Fisheries Research (Edmonton, Alberta, Canada; 4–7 January 2018) (http://www1.uwindsor.ca/glier/ccffr/)

15th International Symposium on Aquatic Plants (Queenstown, New Zealand; 18–23 February 2018) (www.aquaticplants2018.co.nz/)

CWNH 2018 – 20th International Conference on Conservation of Wildlife and Natural Habitats (London, England; 15–16 March 2018) (https://waset.org/conference/2018/03/london/ICWNH/home)

SIBIC2018 – Where rivers meet the ocean (Faro, Portugal; 2–15 June 2018) (www.sibic2018.org/welcome)

MFIS 2018 – Marine and Freshwater Invasive Species: Solutions for water security (Beijing, China; 27–29 August 2018) (http://conferences.aehms.org/mfis-china/)

NEOBIOTA 2018 – 10th International Conference on Biological Invasions: New Directions in Invasion Biology (Dun Laoghaire, Dublin, Ireland; 4–7 September 2018) (www.neobiota2018.org/ehome/index.php?eventid=166837&)

WRW2018 – 4th International Conference Water Resources and Wetlands (Tulcea, Romania; 5–9 September 2018) (www.limnology.ro/wrw2018/abstract.html)

ASC 2018 – ICES Annual Science Conference (Hamburg, Germany; 24 September 2018) (http://ices.dk/news-and-events/asc/ASC2018/Pages/default.aspx)

ICMB-X – 10th International Conference on Marine Bioinvasions (Puerto Madryn, Patagonia Argentina; 16–18 October 2018).

MarFresh2018 – 1st International Marine & Freshwater Sciences Symposium (Kemer/Antalya, Turkey; 18–21 October 2018) (http://marfresh2018.com/)

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United States

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Overview

The United States reports no new national regulations; however, the US Environmental Protection Agency continues to work toward reissuance of the Vessel General Permit regulating ballast water discharges into US waters, expected to be finalized in December of 2018. In addition, the State of California has issued new biofouling management regulations taking effect in October 2017. We report a dozen new introductions, including one significant range expansion. At least one of these new introductions (the reed mealybug *Nipponaclerda biwakoensis*) is already causing significant ecological damage with potential for negative impacts on important ecosystem services in its invaded US range. Five additional taxa are noted as having been observed in US waters but are suspected not yet to have established. No new pathogens are reported. Major research efforts in the US include a large multi-national project to catalog biodiversity associated with Japanese tsunami debris transported to North America and Hawaii after the 2011 earthquake, as well as an aggressive research program to understand the ecology and invasion dynamics of lionfish (*Pterois* sp.).

1. Regulations

There are no new national regulations to report. However, there are several important developments worthy of note.

Although the Pacific state of California lies outside the geographic purview of ICES, the issuance of new biofouling management regulations in that state is indicative of the increasing presence of this vector on the international regulatory agenda, and may provide a preview of future attempts to mitigate invasion risk associated with biofouling. California's regulation, "Biofouling management to minimize the transfer of nonindigenous species from vessels arriving at California ports," became effective 1 October 2017. It applies primarily to commercial vessels and requires preventative planning using a Biofouling Management Plan and Record Book, management of niche areas like rudders and sea chests, and submission of a reporting form for risk-based inspection prioritization. Text of the regulation is available at https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I7B8BB9028E8D46DFB63FBC7410E45356&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)

The US EPA continues to work toward reissuance of the Vessel General Permit in 2018. The national permit regulating ballast water discharges into US waters (among other things) is expected to undergo revision largely in response to the October 2015 US Court of Appeals decision that found various faults with the EPA's ballast water management requirements, including:

- EPA should not have adhered to the USCG/IMO Standard without better explanation as the court concluded there are shipboard technologies capable of surpassing that standard.
- EPA prevented the EPA Science Advisory Board from expanding its ballast water treatment analysis to include an assessment of the feasibility of onshore treatment approaches.
- EPA's exemption of pre-2009 "Lakers" (ships that remain within the Great Lakes) from the numeric ballast water treatment standards was arbitrary and capricious, because a "lack of a supply" of systems does not render them unavailable and, as discussed above, EPA had erred in not giving greater consideration to the availability of onshore treatment approaches.
- EPA's VGP was too vague to "ensure compliance" with water quality standards stating that the narrative standard is (1) insufficient to give a shipowner guidance as to what is expected, and (2) allows for water quality exceedances in limited instances for which the permittee does not have to address until after identification of such exceedances
- EPA erred in not including monitoring to assess compliance with the water quality standards.

These issues will be addressed in the 2018 reissuance. A draft is expected by June of 2018.

In the meantime, Senator Roger Wicker (R-Miss.) is attempting to breathe new life into the Vessel Incidental Discharges Act. He is attempting to work with Republicans in the House of Representatives to get the measure rolled into the March omnibus spending bill. However, there is still considerable opposition to the bill, particularly from the Great Lakes States, the National Governors Association, and groups representing state environmental officials. VIDA would strip EPA's authority to regulate ballast water under the Clean Water Act, and would unify regulations under the US Coast Guard.

Although they are not regulations, Presidential Executive Orders may give direction to US federal agencies and help to define their responses to the threat of invasive species. For example, Executive Order 13112, signed 8 February 1999 by President Clinton, mandated the formation of the National Invasive Species Council, which continues to provide advice to US federal agencies and to guide US activities. On December 8, 2016, President Obama signed Executive Order 13751 "Safeguarding the Nation from the Impacts of Invasive Species." This EO amends EO 13112 and addresses 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 EO confirms previous orders and retains and expands 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 emphasizes 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; however, it is noteworthy that EO 13751 has thus far been maintained by the Trump administration. Text of the EO is available at https://www.federalregister.gov/documents/2016/12/08/2016-29519/safeguarding-the-nation-from-the-impacts-of-invasive-species

2. Intentional introductions

There are no new intentional introductions to report. The United States continues to import (and export) large amounts of marine organisms. These data are difficult to summarize and even more difficult to capture for the Northeast region of the US. Information on this trade can be obtained at

http://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/, current through December 2017.

3. New sightings

3.1. New introductions and notable range expansions

Chlorophyta: Ulvales *Ulva ohnoi* M. Hiraoka & S. Shimada, 2004

Described from Japan, also found in Hawaii and Australia. In the Western Atlantic, first found from Yucatan in 1999.1st US Atlantic Record- Surfside Beach/TX/Freeport Harbor Channel (2/26/2013, Melton *et al.* 2016, 28°56'12.5"N 95°17'41.5"W). Found from Freeport/TX/Gulf of Mexico (28°56'12.5"N 95°17'41.5"W) to Cocoa/FL/Indian River Lagoon (8/10/2013, Melton *et al.* 2016, 28°21'20.3"N 80°43'14.8"W).

This alga is known for 'green tides' in Japan, and has created large mats on mudflats, seagrass beds, and mangroves in estuaries from Florida to Texas (Melton *et al.* 2016). This alga has a high affinity for anthropogenic nutrients. It has been detected in ships' ballast water in the Mediterranean, but has not become established there (Flagella *et al.* 2007).

Arthropoda: Insecta: Hemiptera *Nipponaclerda biwakoensis* Kuwana.

This insect is known as the Phragmites scale or Reed Mealybug. It is native to Japan, where it infests the circumtropical form of *Phragmites australis*, Common Reed (Haplotype I of Saltonstall 2002= *P. a. ssp, berlandieri* (Saltonstall and Hauber 2007). The insect feeds on the xylem and phloem of the reeds' stems, usually 0.5-1 m above the water (Kaneko 2002). The adult insect is ~12 mm long and is immobile within the stem, but the nymphs are a few mm long and can be dispersed by birds or other natural vectors. Floating debris and reeds moved on boats, or by hunters building blinds, are all likely vectors. In 2016, and 2017, extensive (~40,000 hectares) mortalities of reeds, known locally as 'Roseau Cane', were observed in Plaquemines Parish, Louisiana, in the Mississippi Delta Extensive areas of *Phragmites* marshes have been converted to mudflats and open marshes, leading to fears of accelerated erosion in the Mississippi Delta (Baurik 4/13/2017, 2017; Fears 5/3/2017; Mississippi Sea Grant 2017). The area of the dieback has been estimated at 40,000 hectares. Before the discovery of the insect pest, *Phragmites* marshes were already stressed by the digging of channels for shipping and oil exploration, rising sea level and increasing salinity (USGS 2017). By January 1, 2018, the insect had been found in 13 Louisiana parishes, much of the eastern tidewater portion of the states (Lincoln 1/1/2018).

Several genotypes of *P. australis* are present on the Gulf Coast of North America, including Haplotype I (mostly nontidal, and cryptogenic in the Delta) and 5 introduced lineages, which were probably introduced from Europe and the Mediterranean region more than 90 years ago (Kettenring *et al.* 2012). One of these genotypes (Haplotype M, native to Europe) has extensively invaded wetlands in the eastern United States, and more localized areas in the West (Saltonstall 2003; Kettenring *et al.* 2012). Initially, Haplotype M

was thought to be less susceptible to the insect, but it now appears to be equally vulnerable (Lincoln 1/1/2018).

Potential impacts of this invasion are large because of the importance of the Delta to Gulf of Mexico fisheries, wildlife and shipping, and protection from floods and hurricanes. The remarkable aspect of this invasion has been its speed, scale and severity. The information above on the Delta invasion comes from newspaper, public radio, and agency websites. An article is in preparation for *Biological Invasions* (James Carlton, personal communication). Research on biocontrol of the insect, by a parasitic wasp (Neastymachus japonicus) is being studied (Baurick 4/27/2017). This insect was probably brought to the Delta in ships' cargo. It represents a threat to *Phragmites* wetlands on the Atlantic and Mediterranean coasts of Europe.

Arthropoda: Insecta: Diptera *Thambemyia borealis* Takagi, 1965.

This insect is a long-legged fly (Dolichopodidae) native to Japan. This fly is associated with shorelines and lays its eggs on the empty shells of barnacles. The predatory larvae develop in the shells, in the intertidal zone and feed on small benthic invertebrates. It was collected in California and Mobile Bay, Alabama. in 1993 (Masanuga *et al.* 1999). In 2015, 30 specimens of this fly were collected in Spring Lake, New Jersey (40.15°N 74.020°W), its first Atlantic record outside the Gulf of Mexico. Photographs sent by Twitter to other entomologists contributed to rapid identification of this insect. (Jackson *et al.* 2017). This insect was probably transported by shipping to ports in New Jersey.

Mollusca: Gastropoda *Thylacodes vandyensis* Bieler, Rawlings & Collins 2017 *Thylacodes vandyensis* is a worm-shell (Vermitidae). Worm-shells are sessile gastropods, whose shells are long, coiling tubes attached to hard surfaces, often growing in colonies, this species is known from only one shipwreck off the Florida Keys, but genetics indicates that it is native to the Indo-Pacific. In 2014, it was discovered attached to oysters on a sunken ship at 29 meters depth. At that point, it appeared to be scattered and rare, but recent dives (January 2016) have shown large increases in its abundance. It is expected to spread to other shipwrecks, many of which have been deliberately sunk to create habitat for marine life and attractions for divers (Bieler *et al.* 2017). Given its recent discovery and limited range, ecological and economic impacts of this species are unknown. Location: Wreck of USNS General Hoyt S. Vandenberg, between Western Sambo Reef and Sand Key, about 11 km off Key West/FL/Atlantic Ocean (May 2014, 24◦ 27.0270 N, 081◦ 43.9910W).

Chordata: Osteichthyes: Pomacentridae *Neopomacentrus cyanomos* Bleeker 1856. (Regal Demoiselle).

This fish has a broad native range in the Indo-Pacific from the Red Sea and Japan, to Madagascar, and New Caledonia. Its habitats include coral reefs and reef slopes, and harbors (Froese and Pauly 2018). In 2013, 15 specimens were captured on coral reefs south of Veracruz, Mexico (González-Gándara *et al.* 2014). In 2015, *N. cyanomos* was seen at 6 reefs in Veracruz and the Madagascar Reef, off the Yucatan Peninsula (Robertson *et al.* 2016). A modeling study predicted that the probability of colonizing the northern Gulf of Mexico was low, due to unfavorable current (Johnston and Akins 2016). However, in 2017, specimens of this fish were collected and/or photographed in the northern Gulf of Mexico at sites off Florida, Alabama, Mississippi, Lousiana, and Texas. Identifications were verified by D. Ross Robertson (USGS 2018). This fish seems to be strictly marine,

and is largely planctivorous. It reaches about 100 mm in length (Froese and Pauly 2018). It is a popular aquarium fish, and this appears to be the likeliest vector of introduction.

Mollusca: Gastropoda *Pyrgophorus parvulus* Guilding 1828

The native range of *Pyrgophorus parvulus* is the Caribbean rim and coastal South America – including Cuba, the Lesser Antilles, Venezuela, and Mexico (Harrison 1984). Populations inhabiting coastal regions of southern Florida were described as *Pyrgophorus platyrachis* by Thompson (1968). The single population of which we are aware in our study area, inhabiting a brackish system of ditches and drainage ponds on Hilton Head Island (SC) has probably originated from an artificial introduction (reported by R. Dillon; http://fwgna.blogspot.com/2015/12/the-many-invasions-of-hilton-head.html). The snail has not yet been observed in open waters, but flourishing at salinities of up to 17.9 ppt.

Cnidaria: Anthozoa: Alcyonacea *Hedera caerulescens* Conti-Jerpe and Freshwater 2017

An introduced soft coral, easily recognized by its brilliant blue polyps, is newly reported from North Carolina by Conti-Jerpe and Freshwater (2017), who describe it as a new genus and species, *Hedera caerulescens*. Molecular analyses reveal it is related to alyconiid clades largely rooted in the Eastern and South Atlantic Oceans and the Western and Indo-West Pacific Oceans. Conti-Jerpe and Freshwater (2017) provide robust evidence for its prior absence in the Western Atlantic Ocean, where it was first detected circa 2002-2004.

Polychaeta *Chaetozone corona* Berkeley & Berkeley, 1941

The southern California polychaete worm *Chaetozone corona* Berkeley & Berkeley, 1941, has been introduced to the Mediterranean and western Europe (Le Garrec *et al.*, 2017). In the same paper it is reported, in passing, from Florida, by James Blake; it was collected there in 2010 (J. Blake pers. comm. to J. T. Carlton, December 2017).

Decapoda: Caridea *Palaemon elegans* Rathke 1837

The British prawn *Palaemon elegans*, first reported to WG-ITMO in 2011 based upon a discovery in 2010 in Massachusetts, and since recorded from Maine to Rhode Island, was found in September 2017 on the eastern edge of Long Island Sound, at Stonington Point (intertidal rock pools, 21°C and 21.8 ppt), in Stonington Connecticut, establishing a new southern (and new state) record. It is expected to continue to move into Long Island Sound, if not further south. A paper is in preparation documenting the introduction and ranges of both *P. elegans* and the Asian *Palaemon macrodactylus* in the Northeast Atlantic.

Bryozoa *Amathia verticillata* delle Chiaje 1822

The "spaghetti weed" bryozoan, *Amathia verticillata*, whose common names now include "zoobotryon," reappeared in southern New England in the summer and fall of 2017. Populations were detected again at a large marina in New Bedford, Massachusetts. *A. verticillata*, a widespread fouling species likely representing a species complex, dies back in the freezing winters of New England, but has re-appeared, presumably re-introduced via hull fouling on pleasure craft coming from southern waters, regularly over the past few years. The 2017 populations were monitored and documented by Cristina Kennedy, Niels-Viggo Hobbs, Adrienne Pappal, and J. T. Carlton.

3.2. Overlooked invasions (previous sightings)

Mollusca: Gastropoda *Amathina pacei* Petuch 1987

A small limpet-like marine gastropod, which lives as an ectosymbiont on bivalves such as scallops and thorny oysters, and rarely moves. It was first collected, and described in 1979 from Biscayne Bay, Florida. It was described as *Cyclothyca pacei* by Petuch 1987, cited by Lee 2011; Petuch and Myers 2014, Bieler *et al.* 2017). Initially, it was regarded as native, and classified in the family Capulidae, which are mostly suspension-feeders or kleptoparasites. It was re-examined, and found to be nearly identical to the Indo-Pacific gastropod *Amathina tricarinata* (Lee 2011; Hardy 2017). It has been found attached to the shells of the native bivalves, *Caribachlamys imbricatus* (Little Knobby Scallop) and *Spondylus americanus* (American Thorny Oyster) (Lee 2011, Petuch and Myers 2014; Bieler *et al.* 2017). It has been collected on the Florida Coast from Boca Raton south to the wreck of the USNS General Hoyt S. Vandenberg, about 11 km off Key West at 24.7 to 26.6°N Latitude (Lee 2011; Bieler *et al.* 2017). This mollusk was found to be abundant on sunken shipwrecks off the Florida Keys. It may live on bivalves as an ectocommensal, feeding on attached sponges, or as an ectoparasite, sucking body fluids from its host. It typically positions itself near the exhalent opening of its hosts' shell (Bieler *et al.* 2017). Few details are known about its life history and potential impacts.

Rhodophyta: *Pyropia koreana* Hwang, Choi & Lee 2011

This is a leafy red algae native to the Northwest Pacific. It was first found in the Northwest Atlantic in 2003 in Long Island Sound. It's been found from Long Island Sound to Brunswick Maine. Likely vectors include boat fouling and ballast water. At least 4 species of Pacific *Pyropia*, listed below, recently separated from the genus Porphyra, have been introduced to the Northwest Atlantic. *Pyropia koreana* was also synonymized with *P. olivii*, described from the Mediterranean. The Mediterranean populations are now recognized as introductions. The species was collected in 2003, but not recognized as an introduced species when described as *P. olivii* by from the US and Italy by Brodie *et al.* in 2007. It was later found to be synonymous with *P. koreana*, and considered to be an introduction from the NW Pacific (Verges *et al.* 2013

The definitely introduced Pyropias are:

Pyropia katadae (2005), Sandwich MA to Charleston RI

Pyropia koreana (2003) Brunswick ME to Stamford CT

Pyropia suborbiculata (1947) Florida to Falmouth MA

Pyropia yezoensis (1965) Falmouth MA to Texas

Mathieson and Dawes' table of introduced species (p.23) includes these 4 plus 4 additional species marked with question marks, *P. collinsi*, *P. novae-angliae*, *P. spatulata*, and *P. stamfordensis*, Genetic analysis suggests that these species also have Asian affinities. One form of *P. yezoensis* was cultivated for food ('nori') in Cobscook Bay, Maine, but is not established there. So shipping is the likeliest vector for these species. Mathieson and Dawes (2017) massive new seaweed compendium provides an updated review of 32 species of introduced marine macroalgae from the Eastern Canadian Arctic to Maryland. The introduced marina flora of the Northwest Atlantic is dominated by 23 species of red algae (Rhodophyta), followed by 4 green algae (Chlorophyta) and 5 species of non-native brown algae (Chromista).

3.3. Sightings of species not yet known to have established in US waters

Mollusca: Gastropoda *Fissurella nimbosa*

Fissurella nimbosa is commonly known as the Rayed Keyhole Limpet. Its native range extends from Mexico and Puerto Rico to northern Brazil, where it is typically found on tropical rocky intertidal shores (Abbott 1974). In 2017, two shells of this limpet were recorded in Coral Cove Park, Palm Beach County, Florida. No live specimens were found so the establishment status of this species is unknown. Coral Cove Park is about 2000 km from the nearest known established population (Jacksonville Shell Club 2017).

Chordata: Osteichthyes *Acanthochromis polyacanthus*, Spiny Chromis

Indo-Pacific, 1 specimen in Biscayne Bay, 6/20/17, aquarium release. USGS Nonindigenous Aquatic Species Database 1-12-2018. https://nas.er.usgs.gov/queries/SpecimenViewer.aspx?SpecimenID=1407678

Chordata: Osteichthyes *Siganus unimaculatus*, Blotched Foxface

Indo-Pacific, 1 specimen in Biscayne Bay, 6/25/2016, aquarium release. USGS Nonindigenous Aquatic Species Database 1-12-2018 https://nas.er.usgs.gov/queries/SpecimenViewer.aspx?SpecimenID=1322322

Chordata: Osteichthyes *Protemblemaria punctate*, Warthead Blenny

Tropical West Atlantic. 1 specimen in Tampa Bay, 4-1-2017. Probably ballast water. USGS Nonindigenous Aquatic Species Database 1-12-2018 https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=3162

(West Coast)

Mollusca: Gastropoda *Dendronotus orientalis* Baba 1932

Dendronotus orientalis is a nudibranch which was first described from Japan. It is native to the Western Pacific where its range spans from Russia to the Philippines. In March 2016, one individual *D. orientalis* was found by Robin Agarwal, diving in the harbor of Redwood City, California, on South San Francisco Bay. She posted the pictures on iNaturalist (Robin Agarwal 3/29/2016), and it was quickly identified by Alison Young, Citizen Science Engagement Coordinator at the California Academy of Sciences (CAS) and confirmed by Rebecca Johnson, CAS Citizen Science Research Coordinator, Gary McDonald of the Long Marine Laboratory of the University of California Santa Cruz, and Jeffrey Goddard of the University of California, Santa Barbara (Marisa Agarwal 2017). Twenty-two specimens, and probable egg masses, were found in April 2016. No specimens have been seen since April 2016, so establishment of this population is somewhat uncertain (Marisa Agarwal 2017). Ballast water and hull fouling are likely vectors for the introduction of this nudibranch.

4. Pathogens

No reports of new pathogen sightings

5. Research and Monitoring Programs

Researchers from a number of US institutions participated in a broad international collaborative effort to catalog the diversity associated with Japanese tsunami debris resulting from the 2011 earthquake. This effort has now resulted in a large number of final products, including a publication in *Science* (Carlton *et al.* 2017) and more than a dozen papers published in a special issue of the journal *Aquatic Invasions* ("Transoceanic dispersal of marine life from Japan to North America and the Hawaiian Islands as a result of the Japanese Earthquake and Tsunami of 2011," Volume 13, Issue 1, February 2018, edited by James Carlton and Amy Fowler). Although these introductions have occurred outside of the ICES geographic boundaries, this research effort has contributed considerably to our understanding of the importance of ocean rafting on anthropogenic marine debris as a general vector of introduction with potentially broad global significance.

The National Oceanic and Atmospheric Administration continues to support a comprehensive research effort aimed at better understanding and addressing the invasion of Pacific lionfish (*Pterois* sp.) in the US Southeast and Caribbean coastal waters. The NOAA Office of National Marine Sanctuaries recently released a guide to lionfish traps that use unbaited fish attraction devices (FADs) centered in open frames to attract and concentrate lionfish from nearby habitats. Trap jaws close over the FADs during retrieval to capture the lionfish. In trials, traps have produced no bycatch, and the open design would preclude ghost fishing. Recent field tests demonstrated high attraction and capture efficiency for these traps. A second phase of testing will evaluate potential habitat disturbance by the traps, conditions that cause trap movement, and the entanglement risk of different gear configurations. Testing will require collaboration with volunteers and commercial fishermen to improve designs, and to determine optimal soak times and preferred fishing techniques in different situations and locales. In addition, a "Fish Trap Extension Kit" that can be added to commercial traps (initially planned for lobster traps) is currently being developed to make the traps selective for lionfish. The "smart trap" has cameras and software that recognize lionfish, which triggers the opening of an entry to the trap. The trap stays closed when no lionfish are present, eliminating bycatch. Prototyping testing will be in 2018 and commercial scale up with start in 2019. Several meetings were held with the NOAA Southeast Regional Fisheries Office to determine steps that could result in the certification of certain designs for use in areas with existing trap bans, to establish limits on the number of traps fished, and consider appropriate temporal or spatial restrictions. These research activities are carried out as part of the NOAA National Marine Sanctuaries Lionfish Response Plan (https://sanctuaries.noaa.gov/science/conservation/lionfish15.html).

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 Academies of Sciences, Engineering, and Medicine (NASEM) recently published a report, "Gene Drives on the Horizon" that outlines technical, social, and ethical issues related to these technologies (https://www.gene-drives.com/gene-drives.pdf). In July 2017 NASEM and the ILSI Research Foundation held a symposium on Gene Drive Modified Organisms and Practical Considerations for Environmental Risk Assessments (http://ilsirf.org/event/genedrives_july2017/). 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 marine systems will almost certainly also be investigated (Momose & Concordet 2016, Darling *et al.* 2017). 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

6. Meetings

6.1. Past year's meetings

Several national and international meetings/events were held in 2017 that are noteworthy. First, the annual National Invasive Species Awareness Week was held from 26 February to 2 March in a number of locations across the US, with primary events held in Washington D.C. NISAW is intended to raise awareness and identify solutions to invasive species issues at local, state, tribal, regional, international and national scales. Issues addressed included early detection and rapid response, climate change and invasive species, legal issues associated with management, and others. NISAW events were also held in New York, Nebraska, Washington, and Florida.

The North American Invasive Species Forum met May 9-11 in Savannah, Georgia. The NAISF is a biennial conference encompassing the interests of professionals and organizations involved in invasive species management, research, and regulation in North America, and aims to build cooperation across borders. Although the meeting focuses primarily on terrestrial and freshwater systems, marine systems were addressed as important components of national invasive species programs.

The US hosted the 20th International Conference on Aquatic Invasive Species, 22-26 October 2017 in Fort Lauderdale, Florida. ICAIS is billed as the most comprehensive international forum to address new and emerging issues related to aquatic invasive species in freshwater, marine and estuarine environments. ICAIS provides an international platform for the presentation of aquatic invasive species research that pertains to species biology, risk assessment, prevention, management and control methods, ecological and ecosystem impacts and restoration, outreach and policy. Conference proceedings will be published as special 2018 issues of Management of Biological Invasions and Aquatic Invasions. Publicly available presentations from the meeting are available at http://www.icais.org/html/previous20.html

6.2. Future meetings

International Institute of Fisheries Economics & Trade, 16-20 July 2018 in Seattle, WA. IIFET 2018 will feature a special session titled Northern Fisheries: Adapting to a Changing World that will provide venue in which to examine fisheries activities with the purposeful and climate change related introductions of marine invasive species in several geographic settings. Marine invasive species have in fact become formal commercial fisheries and it is relevant to examine the ramifications of these fisheries.

2018 International Invasive Sea Squirt Conference, 2-4 May at the Woods Hole Oceanographic Institution, Massachusetts. The aim of this conference is to bring together marine biologists and people concerned with invasive ascidians, to explore the biology, ecology, impacts, management options for control and other relevant topics. The format of the three-day conference includes oral presentations and posters on current research. The conference audience is expected to include marine biologists, shellfishery scientists, representatives of the shellfishery industry, members of local, state, and federal agencies concerned with coastal resources, representatives from sponsoring organizations and the media. This conference is sponsored by the Woods Hole Sea Grant, MIT Sea Grant, and Oak Bluffs Shellfish Department. Papers from the conference proceedings are published in special issues of the REABIC journal Management of Biological Invasions (at a reduced rate) under the guidance of guest co-editors.

The 19th International Congress on Marine Corrosion and Fouling will be held 24-29 June at the Florida Institute of Technology in Melbourne, FL. The conference will include a session on fouling as a vector for invasive species as well as multiple sessions on technological advances related to fouling with potential relevance to the management of vessel-borne introductions.

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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)

Special Session on Molecular tools for detection and monitoring NIS

Molecular tools for NIS detection and monitoring: promises and challenges- with an illustration of the context of the European Uion MSFD requirements

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The objectives of the Marine Strategy Framework Directive (2008/56/CE of 17 june 2018) are to achieving or maintaining good environmental status in the marine environment. Eleven descriptors had been set-up to monitor progresses towards these objectives, including D2 dedicated to non-indigenous species. Three criteria have been proposed to support D2, namely D2C1, the number of newly introduced NIS per assessment period (6 years), D2C2 relying on abundance and spatial distribution of established NIS and D2C3 about impacts (e.g. proportion of species altered due to NIS). A report from the Commission assessing Member States' monitoring programmes under the MSFD pointed out in 2017 a lack of monitoring data and knowledge for some descriptors, notably D2, and the need for a clear acceleration. However, addressing the MSFD requirements is a challenging task with traditional methods (e.g. decline in taxonomic expertise, numerous cryptic species, issues with the habitat accessibility etc.). Molecular tools, notably using barcoding and metabarcoding are in this context promising tools.

This is illustrated with one study which reported a new tunicate species in the Western English Channel in both France and UK (thus in support to D2C1). The barcodes developed were used in other distant regions (e.g. Chile where the species was identified on ship hulls; thus in support to other regulations like the BWMC). Then, the use of bulk DNAs retrieved from zooplankton sampling was also shown to efficiently identify 10 non-indigenous species in one bay of the Western Channel and able to monitor variation of their abundance over time (seasons). Importantly, this metabarcoding approach was applied to a closed list of targeted species, as global taxonomic assignment can hardly be done to the species level because of lack of reference data. With this closed list of species, the method was shown to be sensitive, and the results obtained similar to those found with traditional methods.

There are thus potentially several benefits of (meta)barcoding approaches in support of surveillance programmes, notably because i) they are standardized procedures with no need for taxonomic expertise (once reliable reference data have been made available) ii) they are particularly useful when morphological traits are tricky to use (e.g. early stages, e.g., larvae, spores) and iii) for metabarcoding, they allow to process a large number of specimens and samples (required for D2C2 & D2C3). It does not mean that such approaches are free from limitations and biases. Some examples of important issues were provided, notably regarding unreliable reference database in public database as well as

problems with false negative (species that are present but not recovered by the technique used). Although further improvements are needed, these DNA-based approaches are promising, and already effective for active surveillance of specific/targeted species for which the above mentioned limitations had been overcome.

Main references (examples and review papers) used in support of the presentation

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eDNA as a surveillance tool and how this compares with standard NIS monitoring methods in the Canadian Arctic

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Given the significant global changes currently underway in the Arctic, creating a large-scale standardized biodiversity database for Arctic marine biodiversity is crucial. Although standard approaches (e.g., netting, trawling, grabs) can be effective at sampling marine diversity, more sensitive methods like environmental DNA (eDNA) can enhance detection of more difficult to sample organisms including benthic and fouling taxa, and provide robust baseline genetic information as a reference point for current native biodiversity prior to significant change. In this study our goals are to: a) evaluate the potential of eDNA as a cost-effective biodiversity monitoring tool to assist in detecting large-scale coastal biodiversity shifts (species loss, non-indigenous species detection and community structure change) in sensitive Arctic areas; 2) characterize spatial distribution of eDNA (depth, proximity from shore, season, tidal & estuarine effects); and 3) evaluate eDNA sources through comparison of water and sediment samples versus classical port survey methods. Based on preliminary results in two Arctic ports (Churchill and Iqaluit) with two COI primer pairs, we demonstrate that eDNA metabarcoding can successfully be used to document coastal metazoan species diversity (140 and 87 species detected in these two ports, respectively). We found that eDNA is spatially and temporally heterogeneous within ports and that the efficiency of the eDNA recovery is improved when sampling under-ice cover. Comparisons among different sampling approaches demonstrated that eDNA detects a wide range of taxa from the water column that includes not only holo- and meso-plankton, but also benthic species that lack pelagic larvae and may not be detected with methods such as plankton nets tows. By allowing rapid sample collection by inexperienced or novice individuals and reducing the cost associated with data collection/shipping and reducing manipulation of organisms, the analysis of eDNA from water or sediment samples could increase the power of species detection, improve spatial coverage and frequency of sampling, thus improving detection of biodiversity shifts in large coastal Arctic ecosystems.

Implementating DNA metabarcoding as a cost-effective tool to provide biological data for port baseline surveys

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The international Convention for the Control and Management of Ships' Ballast Water and Sediments, entered into force in 2017, has been developed to prevent the introduction of aquatic non-indigenous species via discharged ballast water. Under the Convention's, ships are required to manage their ballast water; but they can also ask to be exempted to comply with ballast water management requirements by providing a risk assessment, ensuring that the threat of transferring harmful organisms between specified ports is limited. Biological data are essential components of such risk assessment, and robust port biological baseline surveys are needed to provide inventories of native and non-native biodiversity. Yet, these detailed biological baseline surveys are complex, as they imply exhaustive sampling followed by species identification, which usually relies on time-consuming and expertise-dependent morphological taxonomy. To ease port baseline surveys, we developed and applied a protocol that relies on metabarcoding, a method that allows the simultaneous taxonomic characterization of hundreds of complex samples (water, sediment) based on sequencing a conserved DNA fragment. To this

aim, we sampled the commercial port of Bilbao (Spain) during the four seasons to collect fouling organisms attached on port structures, benthic macroinvertebrates living on sediment and filtered water containing zooplankton, phytoplankton and expelled material such as feces, cells, and tissues released from larger organisms. Our analysis is the first thorough metabarcoding-based biodiversity assessment applied to port baseline survey. We show that metabarcoding enhances detection sensitivity, provides a time saving and cost-efficient alternative to visual identification and is easily standardizable and reproducible. In sum, we provide early insights into the advantages and drawbacks of implementing such genetic-based species identification to depict port communities for biological risk assessments.

Other Presentations ToR a

Some northward expanding non-indigenous species in Europe
Dan Minchin

The circum-Antarctic ascidian, the orange-tipped tunicate Corella *eumyota*, was first recorded in Brittany, France in 2002 (Lambert (2004*) JMBA* **84**:239-241). Since then it has spread to the Atlantic coast of the Iberian Peninsula and to Britain in 2004 and Ireland in 2005. It has rapidly spread about the coast of Ireland extensively fouling some leisure craft at marina berths. It has been found stranded ashore on debris in a remote area on the west coast of Ireland. Despite its short larval duration it has had an ability to spread rapidly. Its current most northerly distribution is the north of Scotland and in Orkney (Nall *et al.*, (2015) *Aquat. Inv*. **10**(1): 107-121). *Corella eumyota* is capable of cross- and self-fertilisation and can form dominant 'carpets'. In Ireland those found on boat hulls had extended and unretractable orange siphons, whilst those on the lower shore and immediately sub-tidally had shorter siphons, without any orange colouration and lay fixed on their right side. This tunicate may be expected to extend its range further northwards along Atlantic coastal waters to Shetland, Iceland and Norway and may enter the Barents Sea. In time, it may be spread to the New England States of North America and Atlantic coasts of Canada.

The phaeophyte *Undaria pinnatifida* may also extend its range northwards and may be expected to appear on the Atlantic coast of Scotland and its western and northern Isles. It is currently expanding its range and abundance in Northern Ireland.

ToR b) Evaluate the impact climate change may have on the introduction and spread of non-indigenous marine organisms, including the Arctic environments. This ToR also includes the 2017 Request from WGHABD concerning the role of shipping as a vector for the introduction of HAB organisms to the Arctic. Also refer to ToR e) Alien Species Alert for Harmful Algae in Arctic regions

Joint Special Session on Arctic Environments

Current knowledge on HABs in the Arctic
Kimberly Howland, Christine Michel, Kaven Dionne, Jesica Goldsmit, Chris McKindsey, Cynthia McKenzie, Nathalie Simard, Fatma Dhifallah, Frederic Laget, André Rochon

There is an interest in better understanding prevalence and risks of harmful algae in the Canadian Arctic given warming ocean conditions and growing potential for transport of organisms with increased levels of shipping in this region. This presentation provided an overview of ongoing research efforts in Canada. These include a literature review of recent studies focussed on toxin-producing algae in the Arctic. Although there are no published studies in the Canadian Arctic, preliminary findings noted 12 studies for the wider Arctic (the majority in Greenland waters) and three more general studies on species composition of algae in the Canadian Arctic which contained data on toxin producing algae. Efforts are currently underway to develop a comprehensive Arctic phytoplankton database of species from 50 publications together with raw data sets from key phytoplankton researchers in Canada. Species are being categorized by Marine Ecoregion (Spalding 2007) and information on toxicity and invasion status are being noted if available. Approximately 25% of the species reviewed to date are potentially harmful, but many are considered rare or only occasionally occur in the Arctic. Other ongoing research include surveys of phytoplankton communities in the highest activity ports of the Canadian Arctic to provide baseline data and detect the arrival of potential nonindigenous species as well as ballast surveys to characterize diversity and relative abundance of phytoplankton communities in ballast waters of vessels arriving at Canadian Arctic ports. Results of port surveys generally show a decrease in diversity and abundance of dinoflagellate taxa and more specifically of harmful taxa with increasing latitude. Interestingly surveys indicate a substantial increase in the proportion of harmful taxa in the port of Churchill since 2007. Ballast surveys of vessels transiting from temperate to northern Canada have identified up to 15 non-indigenous species with potential to survive in colder waters, seven of which are potential toxin producers, confirming that shipping provides a pathway for transport of harmful taxa to the Arctic. A subset of five of these harmful species were modelled to predict the potential spatial distributions at Arctic and global scales using the Maximum Entropy (MaxENT) habitat model. Modelling was conducted under present environmental conditions and under two future global warming scenarios (2050 and 2100), representing intermediate greenhouse emissions (temperature anomaly of 2.4 °C by 2100). Results showed that predicted suitable habitat under current conditions was much greater and, in most cases, extended more poleward than documented occurrences. Overall a global loss of habitat is predicted for modelled species (mainly in tropical regions), but a slight increase in suitable habitat is expected in the Arctic under future climate scenarios.

Climate change opens new frontiers for marine species in the Arctic: current trends and future invasion risks

Farrah Chan, Keara Stanislawczyk, Andrea C. Sneekes, Alexander Dvoretsky, Stephan Gollasch, Dan Minchin, Matej David, Anders Jelmert, Jon Albretsen, Sarah Bailey

Nonindigenous species (NIS) are increasingly threatening the Arctic environment due to the effects of climate change. The general warming in this region is promoting human-mediated introductions and natural spread of NIS. Additionally, the Arctic is becoming more suitable for temperate species, allowing for increased probability of successful establishment once introduced. In this review, we examined information on 47 introduction events of 31 NIS in the marine Arctic to better understand temporal and spatial patterns and to identify important source and introduced regions. We also studied single- and

multi-pathway introductions. The rate of introduction ranged from 0-3 new NIS per year during the studied period. The Norwegian Sea, Barents Sea, and Iceland Shelf had the greatest number of introductions. Many NIS originated from the Northwest Pacific, Northeast Atlantic, and unknown sources. Shipping has introduced the greatest number of NIS to the Arctic, including phyla Ochrophyta and Arthropoda. We found that a lack of baseline taxonomic data compromises the identification of new NIS. Therefore, further inventory of Arctic biodiversity is needed, particularly as climate change is creating a more hospitable environment for new species. Finally, we reviewed management techniques that may be effective in mitigating NIS in the marine Arctic when implemented promptly. The Arctic ecosystem is expected to undergo rapid changes that may facilitate the establishment of invasive NIS, thus further study and management of the area is crucial.

Special Session on Marine Invasive Species Screening Tools

Preliminary results of the WGITMO-led global trial of the Aquatic Invasiveness Screening Kit (AS-ISK)

Gordon H. Copp[1], Lorenzo Vilizzi[2], and 50+ contributors, including WGITMOers

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ABSTRACT

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. Following the global applications of the Fish Invasiveness Screening Kit (FISK), Cefas, WGITMO and the University of Łódź led in the development of FISK's transformation into a decision-support tool, 'AS-ISK' (www.cefas.co.uk/nns/tools/), which is generic for screening aquatic species regardless of their taxonomic status and the climate type of the risk assessment area. AS-ISK was developed to be compliant with the 'minimum standards' for use with the new EU Regulation on invasive alien species of EU concern, including questions on socio-economic and ecosystem services impacts as well as six additional questions through which the assessor evaluates the potential impact of predicted future climate conditions on the AS-ISK assessment. The initial applications of AS-ISK summarised here cover broad taxonomic, geographic and climatic ranges of non-native species and aquatic RA areas. An overview of current and anticipated applications will be presented, and the completion of AS-ISK assessments that involve WGITMOers will be discussed.

Risk assessment protocol towards implementation of the EU regulation (1143/2014)

Argyro Zenetos, Marika Galanidi, Gordon Copp

The EU Regulation (1143/204) concerning the management of invasive alien species (IAS) entered into force on 1 January 2015 to establish "rules to prevent, minimise and mitigate the adverse impact on biodiversity of the intentional and unintentional introduction and spread within the EU of IAS". It introduced a priority list of IAS of Union concern ("Union list"), selected on the basis of specified inclusion criteria (outlined in Article 4), compliance with which is ascertained by a detailed Risk Assessment according to provisions made in Article 5. Species considered for inclusion can be proposed by Member States or by the Commission itself. This implies that, as a first step, a prioritization process (e.g. Horizon Scanning approach and risk screening protocol) has identified species likely to pose the highest risks and therefore warrant a full risk assessment. Thus, rapid risk assessment protocols are the first tool at our disposal for the implementation of the regulation.

Full risk assessments may employ any non-native species (NNS) risk analysis scheme, but the chosen scheme must comply with a number of 'minimum standards', which were established during an EC-funded study (ENV.B.2/ETU/2014/0016). A few existing European schemes, in particular the GB NNS scheme, were modified to comply with these minimum standards. At the same time, the Aquatic Species Risk Screening Kit (AS-ISK) was being created and these minimum standards were integrated into AS-ISK during its development. During 2017, in the framework of an EC-funded study (ENV.B2.ETU/2016/0013), ten species were evaluated, including three fishes, the Lessepsian fish *Plotosus lineatus* (risk assessed by M. Galanidi and A. Zenetos) and collectively the freshwater mosquitofishes *Gambusia affinis* and *G. holbrooki* (risk assessed by G.H. Copp and H. Verreycken). Drawing from our experience with these species, we showcase how the application of the adapted EU Risk Assessment scheme can help Member States in implementing the EU IAS regulation.

The scheme comprises different sections, presenting basic organism information, describing the distribution of the organism, current and potential (under current and future climate conditions) and addressing the four main aspects of the invasion process (Introduction, Establishment, Spread and Impacts). Additionally, a Management Annex describes and evaluates a suite of possible management measures, ranging from pre-invasion stage (i.e. prevention) measures to population control and mitigation of impacts for already widely established species, including information on their feasibility, cost and cost-effectiveness.

First and foremost, the risk assessment presents the evidence that determines whether or not the proposed species fulfils the basic criteria for listing in the Regulation's annex, i.e. it is: (i) alien to the EU, (ii) capable of establishing and spreading under current and foreseeable climate change conditions (in one biogeographical region shared by more than two MSs or one marine sub-region); and (iii) likely to have adverse impacts on biodiversity and ecosystem services. Regarding *P. lineatus*, after thorough examination of the abiotic requirements and conditions encountered, the biology of the species, its reported and potential impacts and existing management in the EU, we concluded that it can be regarded as a species of EU concern as it: a) is very likely to establish and spread throughout the whole Mediterranean marine sub-region and along the Bay of Biscay (albeit at a

moderate rate of spread); and b) has demonstrated moderate environmental impacts in neighbouring countries but may potentially have major impacts in the area of establishment. *Gambusia* spp. on the other hand is (are?) already present and/or likely to establish in most European countries; and c) threaten(s) endangered native species with potentially major impacts on ecosystem services.

Secondly, it assists the Member States in fulfilling their obligation (under Article 13) to conduct a comprehensive analysis of all pathways of introduction relevant to the Union list species and establish action plans for the priority pathways. The "Risk of Introduction' section identifies and prioritises pathways, e.g. unaided followed by release and escape from aquaria for *P. lineatus* and Stowaway/ Contaminant of fish imports, followed by Escape from aquaria/garden ponds and release in nature for *Gambusia* spp. Specific prevention measures are discussed in the Management Annex, offering a starting point for Member states to formulate action plans. For aquarium trade related species, these can include increased security measures in public aquaria, awareness campaigns with aquarium suppliers and better tracking of the intra-EU trade, where a few countries act as main importers and distributors.

Additional information in the Management Annex (and throughout the RA sections) address early detection/surveillance (articles 14–16), management for already widely established species (article 19) and eradication measures (articles 17–18). It was concluded that, for *P. lineatus*, eradication campaigns with intensive targeted fishery would most likely be ineffective, impractical and damaging to native species and habitats, however interceptions at stepping stone areas are possible, commercial fisheries for human consumption a viable option and mitigation of human health impacts highly feasible. In contrast, eradication of *Gambusia* spp. is possible in ponds, reservoirs or small water courses, while in order to prevent further spread and new introductions, a prohibition on the keeping (as an aquarium fish), release (for mosquito control) and use of the species as live bait should be enforced.

CMIST the Canadian Marine Invasive Screening Tool

David Drolet, Claudio DiBacco, Andrea Locke, **Cynthia H. McKenzie**, Christopher W. McKindsey, Andrea M. Moore, Janis Webb, **Thomas W. Therriault,** Fisheries and Oceans Canada

Screening-level risk assessment tools for non-indigenous species are important for informing and prioritizing management and policy decisions. Most existing tools target freshwater or terrestrial environments and are not typically calibrated or evaluated. Here, we present the Canadian Marine Invasive Screening Tool (CMIST), a new tool for assessing risk of invasion by nonindigenous invertebrate species in the marine environment that aims to simplify and improve the assessment process. CMIST has 17 questions based on the sequence of events in the invasion process: arrival, survival, establishment and spread as well as the species' potential impacts in
the assessment area. To evaluate CMIST, we scored 60 species/ecoregion combinations of nonindigenous marine invertebrates known to have been introduced to three Canadian marine ecoregions and compared the results to scores from MI-ISK (Marine Invertebrate Invasiveness Scoring Kit), the only other available tool for marine invertebrates. Assess-

ment scores from both tools were then compared to the results of an expert opinion survey about the level of ecological risk posed by these species. The scores returned by the two tools were generally similar, had comparable levels of inter-assessor variability, and correlated well with the results of the expert opinion survey for two of the three ecoregions. For all ecoregions, CMIST scores were more
strongly correlated with expert opinion scores than were MI-ISK scores. Further, CMIST easily distinguishes both elements of invasion risk (likelihood and impact), has fewer questions to score (17 compared to 49 for MI-ISK), and could easily be adapted for other taxa. The tool is now available publicly at http://www.bio.gc.ca/science/monitoring-monitorage/cmist/index-en.php.

Drolet, D., DiBacco, C., Locke, A., McKenzie, C.H., McKindsey, C.W., Moore, A.M., Webb, J.L., Therriault, T.W. 2015. Evaluation of a new screening-level risk assessment tool applied to non-indigenous marine invertebrates in Canadian coastal waters. Biological Invasions 18:279-294. DOI 10.1007/s10530-015-1008-y

Drolet, D., DiBacco, C., Locke, A., McKenzie, C.H., McKindsey, C., Therriualt, T. 2017. Optimizing screening protocols for non-indigenous species: are currently used tools over-parameterized?" Management of Biological Invasions 8(2) 171-179.

Which regions of the Arctic are most vulnerable to marine invasive species introductions? Insights from habitat suitability modelling under current and projected climate change scenarios

Kimberly Howland, Jesica Goldsmit, Chris McKindsey, Fisheries and Oceans Canada, Bruce Stewart, Arctic Biological Consultants, Philippe Archambault, Laval Université, Guillem Chust, Ernesto Villarino, AZTI-Tecnalia, Marine Research Division, Spain, George Liu, Jennifer Lukovich, Dave Barber, CEOS, University of Manitoba, Canada

The risk of aquatic invasive species (AIS) introductions in the Arctic is expected to increase with ongoing trends of greater shipping activity, resource exploitation, and climate warming in the region. We identified a suite of AIS (benthos, zooplankton, macroalgae) with the greatest likelihood of introduction and impact in the Canadian Arctic using the Canadian Marine Invasive Screening Tool (CMIST). This is a rapid screening tool that uses available literature to score the relative risk of species by answering 17 questions related to various stages in the invasion process. Phytoplankton species were also assessed, but they were chosen according to species that are known to produce harmful toxins and that have been found in ballast water of ships transiting to the Canadian Arctic since insufficient information was available to apply CMIST. Using these two screening systems, the top twenty three riskiest species were then modelled to predict the potential spatial distributions at Arctic and global scales using the Maximum Entropy (MaxENT) habitat model. Modelling was conducted under present environmental conditions and under two future global warming scenarios (2050 and 2100), representing intermediate greenhouse emissions (temperature anomaly of 2.4 °C by 2100). Results show that hotspots or regions where suitable habitat was present for the greatest number of modelled AIS are in the Hudson Complex, Northern Labrador, Chukchi/Eastern Bering Sea, and Barents/White Sea. For the complete suite of AIS assessed, the future overall

predicted distribution change at an Arctic scale was a habitat gain of +5.8% for 2050 and +14.1% for 2100. However, when separated by taxa, benthic invertebrates and macro algae showed a higher percentage of habitat gain than planktonic species under future climate scenarios. When the same analysis was done at a global scale, the projections showed that by 2050 and 2100, there will be an overall habitat loss (-4% and -4.2% respectively). These results suggest that most of the modelled species will find better environmental conditions in colder regions, with a trend towards a positive pole-ward shift in future distributions. This approach will aid in the identification of present and future high-risk areas for AIS in response to global warming.

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

Joint Special Session on Vessel Biofouling with WGBOSV

GEF-UNDP-IMO GloFouling Partnerships Project Concept
Antoine Blonce, John Alonso (presented by **Teo Karayannis**)

The GloFouling Partnerships project – a collaboration between the Global Environment Facility (GEF), the United Nations Development Programme (UNDP) and the International Maritime Organization (IMO) – will address the transfer of invasive aquatic species through biofouling on ships' underwater hull and structures. The new project will build capacity in developing countries, developing and harmonizing best practices and focusing on the implementation of the IMO *Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species* (Biofouling Guidelines), with a view to minimize the impacts of marine biofouling.

Overview of biofouling work in U.S.

Lisa Drake

Hull fouling management efforts continue in the United States, notably with California's biofouling management regulations ("Biofouling Management Regulations to Minimize the Transfer of Nonindigenous Species from Vessels Arriving at California Ports") entering into effect in October 2017. In other state and regional efforts, Washington State commissioned a six-year strategic plan for biofouling Management, which is based on programs in New Zealand, Australia, and California. Finally, the Western Regional Panel on Aquatic Nuisance Species will undertake a series of actions outlined in a white paper. Regarding recent research developments, in early 2018, a project to quantify the efficacy of in-water cleaning and capture (IWCC) of ship-cleaning technologies was begun.

ICES Biofouling Viewpoint
Composed by **Bella Galil and Cynthia McKenzie**, with contributions from Sarah Bailey, Marnie Campbell, Ian Davidson, Lisa Drake, Chad Hewitt, Anna Occhipinti-Ambrogi, and Richard Piola**.**

Evaluating and mitigating introduction of non-native species via vessel fouling

The recent robust increase in the merchant fleet and recreational boating has transformed vessels into a significant "vectors of change" in marine ecosystems. Vessel biofouling affects the environment as well as the economics of vessel management. Biofouled vessels support ecological communities characterized by great abundances of opportunistic and non-native species. If established in new regions, these vessel-transported species can affect the native species, community structure, and, ultimately, ecosystem functions. Biofouling compromises the operational effectiveness of vessels, their effective range and maneuverability, and even safety procedures when these rely on seawater uptake systems. Further, biofouling can accelerate corrosion, and it increases hull roughness and frictional resistance that increase power and fuel requirements. Indeed, even minor levels of biofouling, such as biofilm formation, can add considerable drag, resulting in elevated fuel consumption, emissions, and costs for fleet operations and maintenance. It is likely the risk of introduction of invasive species via vessel fouling will increase in the next 20 years driven by (1) trends in maritime shipping and boating (increase in vessel number and size, changes in routes, transit speeds and port stays) and (2) the alteration of propagule pools and conditions in recipient destinations arising from climate change.

What actions can be recommended to prevent/minimize biofouling on vessels to control this vector of introduction and spread?

Recognize that vessel biofouling has been shown to be the vector responsible for the **highest number of marine NIS** (primary and secondary introductions), representing 30% in the North Sea, 69% in New Zealand, 70% in the continental USA, and 74% in Hawaii, advise the **highest urgency** in dealing with **mitigating introductions via vessel fouling.**

Recognize that biofouled **recreational vessels** pose a significant risk, advise they should be part of the control and management to minimize the transfer of invasive aquatic species**.**

Recognize the need for information on the **currently employed** vessel biofouling management regimens, advise **monitoring assessment and performance evaluation of the voluntary guidelines**.

Aware that the current antifouling tool box is limited, advise to concentrate effort on **active management.**

Special Session on Biofouling in Marinas and Harbours

Abiotic factors related to high NIS richness in Mediterranean marinas

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4Department of Marine Sciences and Applied Biology, University of Alicante, Spain

The Mediterranean Sea is both a global hotspot for marine bioinvasions and for recreational boating traffic, the latter representing a vector for non-indigenous species (NIS) introductions and their spreading via biofouling. Here, a large-scale analysis was completed on NIS across Mediterranean recreational marinas to examine the drivers for NIS success and similarities between marinas. In total, 50 Mediterranean marinas spanning 7 countries from Spain to Turkey were investigated for NIS macroinvertebrate fauna. Then, total NIS richness of each marina was tested against several abiotic factors using multivariate statistics to determine which factors are significant in contributing to both higher NIS success and similar NIS assemblages between marinas. The marinas with the highest NIS richness were Heraklion, Crete, Greece (27), Villa Igiea, Sicily, Italy (20) and Port Camargue, France (18). The following factors were significant in shaping NIS richness in marinas: sea surface temperature, number of berths, proximity to Suez Canal, proximity to aquaculture sites, proximity to commercial harbours, absence of pontoons, biogeographic sector and climate type. Instead, the factors found to shape similarities of NIS assemblages across marinas mostly related to environmental factors; here a combination of temperature, primary productivity, biogeographic region, climate type and additionally proximity to the Suez Canal were found to be significant influences. These results can help prioritize monitoring and management efforts for controlling the introduction and spread of marine NIS in the Mediterranean Sea.

Biofouling prevention and AIS control – A Harbour Case Study

Cynthia McKenzie

The vase tunicate, *Ciona intestinalis*, was first confirmed in Newfoundland and Labrador (NL) waters in September 2012. The Department of Fisheries and Oceans (DFO) Aquatic Invasive Species (AIS) monitoring program, in collaboration with the Department of Ocean Sciences at Memorial University of Newfoundland (MUN), detected an isolated infestation of vase tunicate in Burin, Placentia Bay. The solitary tunicate was attached to wharf structures, and some vessels in the area. Early detection of AIS is one of the primary goals of the DFO AIS monitoring program. This early detection, with the species currently confined to a small area of Placentia Bay, provided a unique opportunity for mitigation activities. Pre-invasion planning and the response plan include key phases of communication, detection and demarcation, containment and risk assessment, mitigation implementation and evaluation. Mitigation trials in Burin, Placentia Bay (2015-2017) have included floating dock and permanent structure cleaning/scraping, and recreational and

commercial vessel cleaning with application of antifouling paint. Close partnerships with the Harbour Authorities and the vessel owners have been key to these control activities. Mitigated harbours have been monitored to evaluate the effectiveness of the control efforts. A rapid response plan based on experience, good communication, strong partnerships, and common goals has allowed NL to respond to a high impact AIS tunicate in an effective manner. The new Aquatic Invasive Species Regulations in the Canadian *Fisheries Act* will provide authority for response, but monitoring, vigilance, prior planning, collaboration between stakeholders and rapid action are the real tools for an effective control plan.

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

ICES ASC 2017 Bioinvasion Theme Session Review and Summary

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

Conveners: Cynthia McKenzie (ICES-Canada), Thomas Therriault (PICES-Canada), Henn Ojaveer (CIESM-Estonia)

The session hosted ten oral and seven poster presentations, with presenters provided the opportunity to give a short introduction of their posters during the session. A general discussion on bioinvasion trajectories, impacts and other topics relavant to the subject was held at the end of the session. The contributed presentations covered Atlantic and Pacific Oceans, Arctic and the Mediterranean Sea. Presentations included introduction vectors, population structure and dynamics, environmental impact, application of genetic methods, and several applied aspects (incl. risk assessment and marine conservation) of marine bioinvasions.

The discussion session was focussed on identifying broad future research needs in the field of marine bioinvasions, of potential interest of ICES, PICES and CIESM, including Arctic. The outcome of the discussion which emphasized collaboration and strength of joint ICES-PICES-CIESM activities can be summarised as follows:

- ✓ Invasion trajectories and vectors are a common theme between regions and collaborative studies to investigate specific routes and vector risk would benefit from multi-region studies, particularly with regard to the Arctic.
- ✓ A joint effort to obtain critical data on shipping (vessels/routes/hot spots) from relevant authorities and make them available to bioinvasion scientists , particularly for risk assessment studies.
- ✓ Sharing of data and making at least key information on recent introduction events freely available. ICES is using online platform for reporting (AquaNIS), which already accommodates data from non-ICES areas. Sharing information on mitigation activities success and failure would be very productive between regions and would provide information for response options.
- ✓ Prioritize investigation on one the most important non-native species transfer pathway – hull fouling and niche areas, both on commercial ships and recreational vessels, and through this contribute to IMO request for scientific information on use and effectiveness of IMO Biofouling guidelines globally.

- ✓ Coordinate and facilitate the study of the impact of non-native species on environments and particularly on vulnerable habitats (Arctic and Marine Protected Areas). Update ICES Code of Practice and potentially develop new ones for affected industries (Aquaculture, live fish trade). Some concern was expressed on the ethics of introducing non-native species which may still be occuring in some regions.
- ✓ Investigations on adaptive capabiltity and differences between non-native populations should also be a priority as it has been shown to be relavant to impact and climate change. Explore NIS adaptability between different invaded locations in the ICES-PICES-CIESM domain to detect ecosystem level changes for specific invaders which would help to characterize impact.
- ✓ Devleop applications of molecular methods (incl. e-DNA), including the study of genetical structure of non-indigenous species populations (e.g. early warning). Further, we need to determine how these results should/will be used by management agencies. This is especially true for 'shared waters' where integration is critical for success (and not wasting limited funding)
- ✓ Investing more effort in stakeholder communication and try 'standardising' messages to them. Communicate/educate managers and influence them to ask right questions. A good example is Clean, Drain, Dry that now has relatively standard messaging/signage in North America.
  ICES, PICES and CIESM are invited to consider the list above and first identify their priorities, to be later able to identify research issues of joint interest between the three organisations.

HELCOM Baltic Review and Monitoring Guidelines
Sergeu Olenin and Maiju Lehtiniemi

Non-indigenous species (NIS) monitoring is to address all biotic components as NIS may belong to any trophic level and be found in various man-made as well as natural habitats. There is currently no coordinated monitoring specifically targeting NIS in the Baltic Sea. Some observations (e.g. plankton and soft bottom macrofauna species) are obtained through the HELCOM biological monitoring programme. In addition to joint monitoring programme, HELCOM coastal fish gill-net monitoring and BITS surveys provide information on NIS presence-absence, spread and abundance/biomass. The only targeted method to monitor NIS is the HELCOM/OSPAR Port survey protocol, which provides information on NIS found in ports to support decisions on granting exemptions from the IMO BWMC. In addition, a variety of targeted approaches and methods has been and are being developed, which may be used for NIS monitoring. These include rapid assessment surveys, monitoring of Marine Protected Areas, molecular methods, automated image analysis, public involvement (citizen science) and environmental impact assessments. However, as none of these covers all groups of organisms or habitats these approaches should be considered as additional parts of the NIS monitoring. A centralized database is the key element of the integrated NIS monitoring system. Thus, AquaNIS (the Information system on Aquatic Non-Indigenous and Cryptogenic Species) database comple-

mented by data from coordinated monitoring has been agreed to be the data source for the assessments.

Project COMPLETE
Sergej Olenin

Summary

The project COMPLETE (Completing management options in the Baltic Sea Region to reduce risk of invasive species introduction by shipping) is an INTERREG Baltic Sea Region (BSR). The project supports the BSR programme priority 3. 'Sustainable Transport' in its specific objective 3.4 'Environmentally friendly shipping'. The main objective of the project is to minimize introduction of harmful aquatic organisms and pathogens (HAOPs) by shipping through the development of a consistent and adaptive management system for the Baltic Sea region. The overall goals are: 1) Harmonized implementation of the Ballast Water Management Convention; 2) Proposal (roadmap) for a regional biofouling management strategy; and 3) Consistent regional monitoring of non-indigenous species. There are 12 full partners in the project, including nine research institutes and universities (Finland, Estonia, Latvia, Lithuania, Poland and Sweden), a Federal agency (Germany), an NGO (Finland) and an intergovernmental environmental organization (HELCOM). The Lead Partner is the Kotka Maritime Research Association, Finland. Eight people representing full project partners are members of the ICES/IOC/IMO WG BOSV and/or ICES WGITMO. The associated project partners include 22 organizations, representing nine Baltic Sea riparian countries, including environmental ministries and agencies, transport agencies, ship owner associations, port authorities and maritime academies. The project duration is 36 months (10/2017 – 09/2020) and total budget 3,2 million euros. More information on project tasks and deliverables may be found at www.balticcomplete.com (to be opened 06/2018).

Project details

COMPLETE aims at developing a consistent and adaptive management system proposal for the Baltic Sea region, addressing two major vectors of harmful aquatic organisms and pathogens introductions by shipping: ballast water and ship hulls. It is highly relevant to the Priority 'Sustainable Transport' and directly addresses a management objective "No introductions of alien species from ships" of the HELCOM Baltic Sea Action Plan. Project partners have expertise and know-how in innovative solutions for shipping, risk assessment and management systems, surveillance and monitoring. Participation of HELCOM as a partner ensures involvement of relevant institutions from HELCOM countries, contributing to harmonized implementation of exemptions under Ballast Water Management Convention (BWMC) and elaboration of the BSR biofouling management strategy proposal.

The management of both ballast water and biofouling of ships is a complex task. COMPLETE is tackling several gaps: the need to take into account rights and obligations of involved stakeholders; approaches for non-indigenous species (NIS) monitoring and surveillance for Marine Strategy Framework Directive (MSFD) and BWMC; risk assessment based exemptions from ballast water management requirements; legal aspects; regional cooperation and information exchange. The technical aspects of that complex problem include yet limited knowledge on antifouling practices and procedures (and

resulting level of biofouling); the lack of common cleaning procedures and facilities, their cost-efficiency analysis; quantities of biofouling waste and its handling procedures; the role of leisure boats and their trailers in primary introductions and secondary spread of NIS.

The main target groups are: shipping industry (getting advice on best practices to ensure safe, efficient and environmentally friendly transport, e.g. resulting in saving fuel); shipyards (by promoting the use of new technologies for hull cleaning services); marinas and boating associations (by providing knowledge on best practices and environmentally friendly small boat management); national competent ministries of transport and environment (by fulfilling the EU Regulation No 1143/2014, reaching Good Environmental Satus (GES) of the MSFD Descriptors 2 and 8, harmonized implementation of the IMO BWMC and Biofouling Guidelines); Baltic Sea ports and coastal municipalities (by increasing competitive equality, exchange knowledge and experience); power plant and other large industrial establishments using cooling waters from the sea (by advise on mitigation of species introductions at "warm water islands").

The project includes 6 interrelated work packages (Fig. 1)

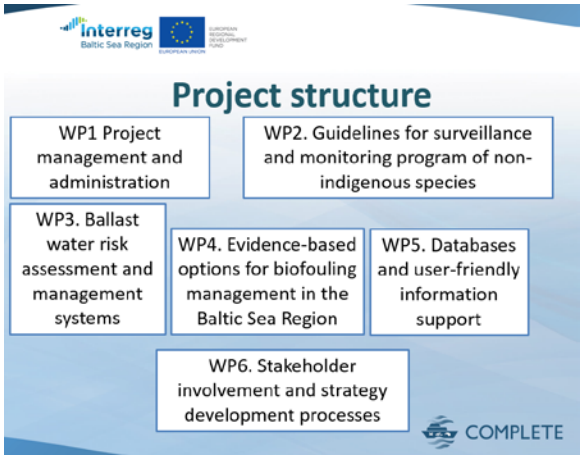

Figure 1. Work package structure of the INTERREG Baltic Sea Region project COMPLETE (Completing management options in the Baltic Sea Region to reduce risk of invasive species introduction by shipping).

The overall aim of WP 2 is to develop a system to permanently monitor the effectiveness of ballast water and hull biofouling management measures and to evaluate the progress towards the ecological objective '*No introductions of alien species from ships*'. WP3 is aimed to develop a fully operational and regionally harmonised structure for the ships' ballast water management in the BSR. WP4 aims for collecting and assessing legal and national regulation aspects, and current knowledge and practices for direct use by target groups. WP5 is aimed at developing information products, which will be maintained after the end of the project. These products will be used for collecting, summarizing and assessing data on harmful aquatic organisms and pathogens (AquaNIS), and for decision-making on choosing optimal antifouling system and cleaning options. WP5 will use data gathered in WP2, WP3 and WP4, providing information support for development of roadmap

for biofouling management (WP6). WP6 is oriented on active communication and involvement all project target groups with aim to develop a proposal of a roadmap for harmonized biofouling management for Baltic Sea Region.

Other Business

Update on PICES NIS Activities in 2017
Tom Therriault (A/Chair PICES AP-NIS)

PICES and ICES have a long history of collaborating on many important marine issues, including non-indigenous marine species. Initial collaborations between the two organizations were centred on PICES WG-21 and more recently the PICES ADRIFT project that was looking at the impacts of debris generated by the tsunami resulting from the 2011 Great East Japan earthquake. However, PICES now has a longer-term expert group (an Advisory Panel in PICES lingo) related to non-indigenous marine species. This group met for the first time at PICES-2017 in Vladivostok and has a Term of Reference specifically dedicated to working with ICES and other international organizations to better understand and share information related to marine invasions.

In 2017, PICES, ICES, and CIESM hosted a joint theme session at the 2017 ICES Annual Science Conference in Fort Lauderdale, FL entitled "Bioinvasion trajectories and impacts in contrasting marine environments" co-convened by Cynthia McKenzie, Canada-ICES; Thomas Therriault, Canada-PICES; and Henn Ojaveer, Estonia. In addition to highlighting the need to work together on marine invasive species issues, a specific product that arose at the ASC was the desire to develop a viewpoint on biofouling. For PICES, 2017 also marked the end of its special 3 year project "Assessing the Debris-Related Impact of Tsunami (ADRIFT)" funded by the Ministry of the Environment of Japan. Two special issues, one in Aquatic Invasions and the other in Marine Pollution Bulletin, both available via open access, make project results available to the scientific community while highlights will be presented at a special session at the 6th International Marine Debris Conference in San Diego, CA in March 2018. In conjunction with ICES, PICES is also supporting the Marine and Freshwater Invasive Species Conference to be convened in Beijing in August 2018. In October 2018 PICES will be supporting the 10th International Conference on Marine Bioinvasions in Argentina and PICES and ICES will host a joint theme session at the 4th Climate Change Conference in Washington, DC in June 2018. With respect to scientific publications, PICES contributed to the ICES COOPERATIVE RESEARCH REPORT/RAPPORT DES RECHERCHES COLLECTIVES NO. 335: Alien Species Alert: *Didemnum vexillum* Kott, 2002: Invasion, impact, and control led by WGITMO with two additional collaborative papers in development – one on global invasion vectors led by WGBOSV and another applying the AI-ISK risk assessment tool led by WGITMO.

Understanding marine invasions is complex but PICES and ICES have worked well together (and with other organizations) in the past and there are many avenues for continued collaboration on this topic. Many joint theme sessions have been orga-

nized/are planned and there is ongoing dialogue and participation in each other's meetings. One specific action item following discussions at the ICES WG meetings in Portugal is using AquaNIS as a global marine invasive species database and information exchange portal. PICES will work to get existing data into a format that would be uploaded to AquaNIS that would enhance information exchange.

Global Approach to Marine Invasive Organism Management

Thomas Landry

A discussion on the need to assess the merits of a global approach to issue advice on Marine Invasive Organisms (MIO) was initiated for consideration. The presentation was focused on the opportunity for the WGITMO to lead a discussion on the benefits of working with a Global Organisation to develop common terminologies, methodologies and principles on the management of MIO. Examples were provided of similar organisations providing advice on global issues such as health and climate change. The World Organisation for Animal Health (OIE) was suggested as a potential model to illustrate how the WGITMO is already leading on some of the principles of a Global Approach to the management of MIO. A discussion on the practicality of a global approach and a broader mission vs a step-wise approach to provide advice and effect change.

Annex 6: AQUANIS 2017 Summary

Table 1. Update of AquaNIS records during the reporting period (2017-03-01 – 2018-01-29):

LME – Large Marine Ecosystem, IE – Introduction Event (a NIS registered in a recipient region). Updates made, open access (in black); No updates, open access (in light blue); Updates made, restricted access (in red), No updates, restricted access (in green)

LME	COUNTRY	TOTAL # IE	CONTRIBUTORS OF NEW IE RECORDS (2017-03-01 – 2018-01-29)	# OF NEW IE RECORDS (2017-03-01 – 2018-01-29)
7. Northeast U.S. Continental Shelf	Canada	8	Kyle Matheson: 8	8
8. Scotian Shelf	Canada	21	Kyle Matheson: 21	21
9. Newfoundland-Labrador Shelf	Canada	18	Kyle Matheson: 18	18
18. Canadian Eastern Arctic - West Greenland	Canada	2		
20. Barents Sea	Norway	12	Stephan Gollasch: 1	1
	Russia	3		
21. Norwegian Sea	Norway	30	Stephan Gollasch: 9	9
22. North Sea	France	10	Amelia Curd: 1, Stephan Gollasch: 2	3
	Netherlands	217	Stephan Gollasch: 47	47
	Germany	180	Stephan Gollasch: 27	27
	Belgium	133	Stephan Gollasch: 50	50
	Norway	70	Stephan Gollasch: 13	13
	Sweden	73	Stephan Gollasch: 5	5
	Denmark	63	Stephan Gollasch: 16	16
	United Kingdom (Britain)	61		
23. Baltic Sea	Denmark	61	Stephan Gollasch: 23	23
	Estonia	35		
	Finland	45		
	Germany	102	Stephan Gollasch: 29	29
	Latvia	45	Solvita Strake: 5	5
	Lithuania	34		
	Poland	62	Monika Normant: 1, Stephan Gollasch: 3	4
	Russia	82		
	Sweden	53	Ann-Britt Florin: 1, Stephan Gollasch: 1	2
24. Celtic-Biscay Shelf	France	355	Stephan Gollasch: 74	74
	United Kingdom (Britain)	173	Stephan Gollasch: 6	6

LME	Country	Total # IE	Contributors of new IE records (2017-03-01 – 2018-01-29)	# of new IE records (2017-03-01 – 2018-01-29)
24. Celtic-Biscay Shelf	Ireland	102		
25. Iberian Coastal	Spain	137	Stephan Gollasch: 28	28
	Portugal	97	Stephan Gollasch: 22	22
26. Mediterranean Sea	France	92	Amelia Curd: 1	1
	Italy	372	Anna Occhipinti: 19	19
	Croatia	38	Olja Vidjak: 7	7
	Israel	324		
	Tunisia	67		
	Libya	42		
	Egypt	166		
	Lebanon	141		
	Syria	71		
	Greece	111		
	Malta	41		
	Algeria	11		
	Morocco	11		
	Spain	52		
	Albania	7		
	Slovenia	6		
	Cyprus	72		
	Turkey	256		
	Montenegro	4		
62. Black Sea	Bulgaria	75		
	Russia	52		
	Turkey	91		
	Romania	77		
	Ukraine	191		
	Georgia	32		
36. South China Sea	Taiwan	2		
46. New Zealand Shelf	New Zealand	12		
47. East China Sea	Japan	1		
48. Yellow Sea	China	12		
	Korea, Republic of	1		
50. Sea of Japan / East Sea	Russia	1		
	Korea, Republic of	2		
	Korea, Democratic Peoples Republic of	1		
59. Iceland Shelf	Iceland	23	Stephan Gollasch: 1	1
60. Faroe Plateau	Faroe Islands	6	Stephan Gollasch: 1	1
63. Hudson Bay	Canada	6		

LME	COUNTRY	TOTAL # IE	CONTRIBUTORS OF NEW IE RECORDS (2017-03-01 – 2018-01-29)	# OF NEW IE RECORDS (2017-03-01 – 2018-01-29)
Complex				
A1. Macaronesia	Portugal	160	João Canning Clode: 6 Stephan Gollasch: 67	73
	Spain	51	Stephan Gollasch: 3	3
A2. Caspian Sea	Iran	5		
	Russia	24		