STAGES

CONNECTING SCIENCE TO POLICY FOR HEALTHY SEAS

STAGES - Science and Technology Advancing Governance of Good Environmental Status

WORKSHOP REPORT

Further Research Needs on Pressures and their Impact on the Marine Ecosystem under MSFD

Rome, 4-5 September 2013

COOPERATION

www.stagesproject.eu

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no 308473. This publication reflects the views only of the author, and the European Union cannot be held responsible for any use which may be made of the information contained therein.

Table of Contents

Under Grant agreement no 308473.

1. Introduction and background

The STAGES project is a specific support FP7 action addressed to facilitate the implementation of the Marine Strategy Framework Directive (MSFD), and specifically to assist Member States with marine territories to achieve Good Environmental Status (GES) by 2020. The STAGES project has three key objectives:

- Make the knowledge generated through EU and national research funded activities with relevance to MSFD objectives widely accessible to policy and decision makers and to MSFD stakeholders (associated with Work Package 2);
- Identify the needs for further research to improve the scientific underpinning for the implementation of the MSFD (associated with Work Package 3);
- Provide concrete, pragmatic and ready-to-use recommendations on the development of an effective European science-policy platform to support implementation of the MSFD (associated with Work Package 4).

Framed in WP3, and in order to support requirements for Member States established in articles 8 and 11 of the Directive (assessment, determination of GES, establishment of environmental targets and monitoring programmes) STAGES oraganised a series of three workshops the following aims:

1. *The identification of research needs with regard to the implementation of monitoring programmes (Task 3.3)*
2. *The identification of research needs with regard to the pressures and their impacts on marine ecosystems (Task 3.2)*
3. *The identification of research needs with regard to socio-economic analysis (Task 3.4)*

The MSFD Task Group Reports on the Descriptors were finalised in April 2010. These reports identified research needs relating to pressures and impacts on marine ecosystems. However, it is recognised that there has been significant advancements and experience gained in operationalising the Descriptors through work and research carried out by Member States and Regional Seas Commissions, supported and funded by the EC, and coordinated by international scientific organisations such as ICES and the European Marine Board. The purpose of the workshop was to reflect on these developments, to update the list of research needed and in particular to seek to identify research needs that would lead to a more holistic and cross-cutting approach to the monitoring and assessment of pressures and impacts.

Under Grant agreement no 308473.

2. Objectives of the workshop and expected results

This report relates to Workshop 2 - The identification of research needs with regard to the pressures and their impacts on marine ecosystems.
The objectives of the workshop were:

- To share the State-of-the-Art knowledge on pressure-impact relations and on assessing cumulative pressures and subsequent impacts.
- To identify knowledge gaps and uncertainties associated with assessment of cumulative pressures and impacts and potential measures that could be taken to achieve or maintain GES.
- To make recommendations on how these gaps and uncertainties of cumulative impacts could be addressed.
- To produce a prioritised list of research questions to inform future research programme managers and/or decision makers.

The workshop's expected results consisted of a synthesis of knowledge gaps and needs for further research on the effects of pressures and impacts on the marine environment under the MSFD.

The results of the workshop will be communicated to the European Commission and the MSFD working groups via the STAGES consortium.

3. Participants

The Co-Chairs welcomed the participants and this was followed by a short introduction to the STAGES project and Terms of Reference of the Workshop by Wojciech Wawrzynski (ICES). The value of the research data base developed by STAGES under WP2 was emphasised and participants encouraged to use it and to provide feedback on their own research to ensure it is maintained up to date.

Unfortunately the information gaps reported by Member States in their Article 8, 9 and 10 reporting were not available to the workshop other than on the EIONET site (http://cdr.eionet.europa.eu/recent_etc?RA_ID=608) and the extraction and analysis of this information was not a viable option.

The Regionals Seas Commissions and the PERSEUS and SEAS-ERA projects along with a number of invited experts were invited to present their work at the workshop. The list of presentations is available in the agenda at Annex 1 and the presentations at Annex 3.

Under Grant agreement no 308473.

NO. OF PARTICIPANT	NAME AND AFFILIATION OF PARTICIPANTS
1	Enrico Barbone (JRC)
2	Irene Barrio (CEDEX)
3	Patrick Camus (IFREMER, STAGES)
4	René Dekeling (NI Ministry of Infrastructure and Environment, Sub-Group Chair)
5	Mark Dickey-Collas (ICES)
6	Lisette Enserink (NI Ministry of Infrastructure and Environment/ OSPAR Agenda)
7	João Ferreira (University of Lisbon, Sub-Group Chair)
8	Francois Galgani (IFREMER)
9	Caroline Gernez (IFREMER)
10	Jannica Haldin (ICES)
11	Michiel Kotterman (IMARES, WAGENINGEN UR)
12	Amund Mage (NIFES)
13	Irina Makarenko (BSC)
14	Beatriz Moralez Nin (SEAS-ERA)
15	Lene Buhl Mortensen (IMR)
16	John Mouat (OSPAR)
17	Eugene Nixon (Marine Institute Ireland, Co-Chair)
18	Sergej Olenin (Klaipeda University)
19	Stuart Rogers (CEFAS, Sub-Group Chair)
20	Jacek Tronczynski (IFREMER)
21	Laura Uusitalo (HELCOM)
22	Celia Vassilopoulou (PERSEUS project)
23	Yvonne Walther (Swedish University of Agricultural Sciences, Co-Chair)
24	Wojciech Wawrzynski (ICES, STAGES)

Under Grant agreement no 308473.

4. Methodology

Prior to the workshop a set of criteria to identify research needs was distributed in the form of a questionnaire to each participant. The criteria followed the Driver-Pressure-State-Impact-Response (DPSIR) model and the Risk Assessment framework (see report of the Marine Board, Boyd et al., 2008) and the draft OSPAR Science Agenda. Presentations are available on the STAGES website. A total of 73 responses were received and these formed the basis for discussion at the workshop, both in terms of science needs and to structure the prioritisation process. Three responses on Hydrographical Conditions were received, however, as there were no experts on this issues present at the workshop the focus was confined to the thematic issues listed below:

1. Biodiversity Group with Descriptors 1 (Biodiversity), 2 (Non-indigenous species), 4 (Marine food web) and 6 (Sea floor integrity)
2. Contaminants & Nutrients Group with Descriptors 5 (Eutrophication), 8 (Contaminants) and 9 (Contaminants in fish and other seafood)
3. Disturbances Group with Descriptors 10 (Marine litter) and 11 (Underwater energy, including noise)
4. Commercially exploited fish Group for Descriptor 3 (Commercially exploited fish and shellfish)
5. Hydrographical Conditions Group for Descriptor 7 (Hydrographical conditions)

Both in the questionnaire and during the workshop every effort was made to identify research needs that were cross-cutting and covered more than one of the Descriptors.

The workshop groups decided to use the questionnaire responses as the basis for discussions in breakout groups. The questionnaire responses were organised into the thematic groups as shown in Table 1. D3, Commercially exploited fish, was included in the Biodiversity Group to ensure the relationship between fishing pressures and fisheries derived data could be included in the biodiversity, food webs and sea floor integrity discussions.

Under Grant agreement no 308473.

Table 1: Questionnaire responses received by Descriptor and Theme		
THEME	DESCRIPTOR	NO. OF QUESTION-NAIRE RESPONSES
Biodiversity and Commercial Exploited Fish	1	9
	2	4
	3	6
	4	6
	6	3
Contaminants and Nutrients	5	6
	8	9
	9	2
Disturbances	10	14
	11	11
Hydrographical Conditions	7	4

To ensure compatibility between breakout groups it was agreed that the selection process should eliminate duplication and overlap: similar needs would be combined and specific needs would be extracted from visions considered to be too broad and for which the level of detail matched a call for research, not a research proposal per se.

In addition it was agreed that the following general criteria would be applied:

- Maturity of the research question and potential match with MSFD deadline (short term or long term needs from a MSFD point of view):
- Legislative push;
- Severity of the pressure and impact on the ecosystem;
- Acute data gap that precludes societal and economic factors;

- Geographical scale and applicability across all European seas. More regional research needs were also taken into account;
- Both cumulative and synergetic effects.

It was agreed to use free text as it provides greater flexibility to elaborate on some of the more complex issues and where possible to record the links with the questionnaires. This process also allowed reference back to the original questionnaires for additional information and justification.

On Day 2 the participants formed four breakout groups, corresponding to the Themes described in Table 1. Each breakout group used their expert knowledge to refine and further develop the responses contained in the questionnaires. After lunch the workshop reconvened in plenary to discuss and finalise the overall workshop output. The Chair of each breakout group presented their work. Each presentation was followed by open discussion on the suggested outcomes and amended as appropriate for approval of plenary.

Illustration 1: The breakout group on theme 1: Biodiversity hard at work

Under Grant agreement no 308473.

Illustration 2: Each of the Theme breakout groups presented the result of the groups work during the final section of the workshop. The results were opened for discussion and amended if needed.

The workshop Chairs thanked all the participants for their hard and efficient work over the two days in dealing with such broad topics. It was agreed that the draft report would be circulated to all participants for comment before being finalised by the workshop Chairs.

Under Grant agreement no 308473.

Section 5: Results
Theme 1 - Biodiversity

D.1 Biodiversity

Research Needs	Justification/ Prioritisation
1. Develop and apply new technologies for rapid biodiversity discovery, especially environmental genomics and other 'omics' technologies, for improved understanding of functional biodiversity. 2. Develop indicators for cetaceans to provide a greater understanding of species distribution and abundance. 3. Develop methods for integrating long term monitoring studies that account for pressures on biodiversity and integrate these into regional sea integrated marine observation systems. 4. Develop methods for considering synergistic, cumulative, and antagonistic effects of human pressures on biodiversity. 5. Develop methods to account for long-term consequences of human pressures on marine ecosystems especially considering climate change, and the implications of ocean acidification on ecosystems. 6. Develop and validate operational habitat definitions. For these develop and validate ecologically relevant thresholds of change between levels of conservation status taking account of natural variability, structure and function, and species abundance and distribution.	The overriding purpose of the research needs under D1 is to operationalise the MSFD indicator of GES on biological diversity, including considerations of appropriate scales for management. The workshop participants recognised that time limitations affected how comprehensive the list of research needs could be. Attention was focused on the need to make the structural indicators of biodiversity operational, emphasising the need to develop new methods to support species distribution and abundance. Recognising the benefits of Integrated Monitoring Networks, similar to those provided by EuroGOOS, will have direct benefits to the effective interpretation of multiple datasets between Member States in regional seas. **Reference to Questionaires:** Q OSPAR, Q RWS, Q PERSEUS, D1 SEAS ERA, D1 Biodiversity

D.2 Non indigenous species

Research Needs	Justification/ Prioritisation
1. Development of a risk based criteria to highlight key pathways of non indigenous species (NIS) introduction, hot spot areas and secondary spread in order to assess effectiveness of management measures. 2. Develop methods to measure the magnitude of bio-invasion impacts on the marine ecosystem and ecosystem services, including considerations for threshold reference points. 3. The role of NIS in confounding assessments of GES by modifying the performance of existing indicators, such as those describing benthic quality	Research needs linked to the development of GES for NIS should focus on identifying pathways of introduction to support preventative measures, and scale of environment impacts once NIS have been established. There has been sufficient progress made with D2 since the joint ICES/JRC meeting to suggest a clear way forward with implementation of necessary measures. The research needs to support them are described in supporting documents

D.4 Marine food web

Research Needs	Justification/ Prioritisation
1. The consequences for food web structure and function of fishing all stocks at Maximum Sustainable Yield (MSY) and consider the impacts of changes in fishing selectivity. 2. Develop methods that describe consequences of shelf seas biogeochemistry on plankton communities, especially nutrient fluxes, to inform the application of indicators of food web production ratios. 3. Techniques and approaches that support the implementation of food web indicators to describe productivity of key ecosystem components of regional seas. 4. Develop methods to identify change in food web structure. These will be used to quantify fundamental threats and risk to ecosystem functioning and the provision of ecosystem services. 5. Methods that discriminate between effects on food webs caused by pressures of human activities and those caused by change in system carrying capacity through climatic effects.	Research questions are related to developing practical methods to quantify the role of key components (fish, plankton) in food web function, in terms of both structure and function. Disentangling the effects of human activities from those of climate change is also considered necessary for further research in order to apply practical management measures under D4. Research into food web ecology is complex and demanding, and there are many aspects of trophic interactions that require further study, so it is important that recommendations for research needs fill specific gaps related to MSFD implementation. Emphasis on understanding the functions of key structural fauna should be a focal point. In particular, understanding the effects of broader environmental conditions on food webs, e.g. those caused by nutrient loading in regional seas and climatic factors, was recognised as important to understanding food web dynamics. However, practical needs of Member States under this descriptor remain the development of techniques to support the implementation of structural food web indicators and those describing productivity of key parts of the food web. These must relate to regional seas, as well as Member States waters, in order to be fully effective. **Reference to Questionaires:** Q OSPAR, Q RWS, Q PERSEUS, D4 SEAS ERA

Theme 1 - Biodiversity *cont.*

D.6 Sea floor integrity

Research Needs	Justification/ Prioritisation
1. Develop methods to evaluate the risk of the spatial and temporal distribution of human activities (trawling, mining, renewable energy, etc.) on sensitive and vulnerable benthic habitats and species. This can only be undertaken with broader access to satellite location of international fleets. 2. Integrate seafloor habitat sampling and biological/physical models, with appropriate ground truthing, to allow Member States to identify areas under greatest risk as a priority for management.	The lack of open access to data describing the location of human activities, especially the Vessel Monitoring System (VMS) data describing location of EU fleets, limits the progress that can be made with pressure-based descriptors. Understanding characteristics of the benthic community are central to implementing D6, and the practicality of generating detailed maps, while limiting the economic cost of doing so, highlighted the importance of using combined modelling approaches, appropriately ground truthed with physical and biological data. Such benthic models are expected to have wider applicability to the MSFD, particularly for other biodiversity descriptors in D3. **Reference to Questionaires:** Q HELCOM, Q RWS, Q PERSEUS

Theme 2 - Contaminants and Nutrients

D.5 Eutrophication

Pressures	Impacts	Knowledge Gaps	Research Needs	MSFD Relevance	Justification/ Prioritisation
Nutrient loading (both anthropogenic and natural), harmful algal blooms (HAB).	Elevated algal biomass, species shifts (D1 biodiversity, D2), reduced light availability (D6), low dissolved oxygen (D1, D4, etc.), and HAB (D9); with consequences for benthic and pelagic communities including food webs (D1, D3, D4), and human health (seafood D9). Tourism, fish kills (D3), aquaculture closures (socio-economics).	Relative role of pressures (including transboundary impacts), links between pressure (e.g. atmospheric input) and state, including reversibility pathways and targets, and economic importance.	1. Assessment for the MSFD of relationship between pressure and state, taking into account natural processes and ecosystem susceptibility. The specific points are: (a) Natural background nutrient enrichment compared to human-related sources, through development/application of land-ocean models, taking into account point and diffuse sources, ocean boundaries, and atmospheric contributions; (b) Effects of nutrient loads and ratios, together with physical factors, on species composition, with emphasis on harmful algae, with the aim of broadening the range of eutrophication symptoms that can be successfully modelled, and on improving knowledge on reversibility, given the likelihood of baseline shifts and regime changes; (c) Rapid phytoplankton species identification, origin, early detection, and prediction of HAB, e.g. by improved remote sensing and by molecular methods. 2. Economic impacts of eutrophication, including economic impacts of eutrophication reduction – full analysis including costs to agriculture and benefits to water quality.	Establish what impacts nutrient control measures may have, what cannot be controlled, and the (economic) cost-benefit of measures.	Geographic: EU, basin wide natural boundaries scales. Severity: Impact on human systems environmental services and social benefits; ecological. **Reference to Questionnaire:** D5 UnivLis, Q PERSEUS, Q OSPAR

Theme 2 - Contaminants and Nutrients *cont.*

D.8 Concentration of contaminants are at levels not giving rise to pollution effects

Pressures Identification	State Change/Shift and Impacts	Knowledge Gaps	Research Needs	Justification / Prioritisation
- Inputs and loads of contaminants (such as priority and hazardous priority substances (PHS)) into the marine environment; - Inputs derive mainly from land-based (rivers and coastal run-offs, atmospheric deposition and fallouts, direct discharges and groundwater submarine discharge) and sea-based sources (maritime transport, exploitation, etc.); - They may be local and/or transboundary; present-day and past. In MSFD assessments, the identification and determination of contaminant loads allows for a better evaluation of the relative importance of local versus distant sources of pollution. This can provide much needed data for modelling efforts that allow information to be spatially visualised and synthesised so that it is more informative for stakeholders and policy and management bodies.	The anthropogenic pollution pressures on the ecosystem lead to state change and adverse impacts (ecological and societal) in the marine environment. - Elevated anthropogenic chemical pressures may influence ecosystem biological structures and functions (including biodiversity decline, impairment of reproduction of marine biota, deterioration of their survival capacity, etc.); - The state change can also lead to impacts on the human systems (ecosystem services and societal benefits): food provision and its quality, fisheries and aquaculture, human health, maritime transport and harbour activities, tourism and recreation – amenities and valued species conservation.	- Current knowledge of pollution effects in marine biota at various levels of ecological organisation is insufficient. For MSFD GES assessments, there is a need to develop threshold levels of biological responses, taking into account natural processes and ecological structure and functioning of the ecosystem (e.g. food web transfer); - The knowledge of pollution pressures on the wider marine environment (deep/open sea) and a more systemic perspective from sources to sink (→ better information on total sources of hazardous substances of interest and on total loads via water and the atmosphere to the marine environment; → mass balance of contaminants) is insufficient.	Our scientific knowledge of the functional relationships between pollution pressures and its impacts, and the consequent responses contains significant gaps. Effective utilisation of MSFD to improve marine environmental quality will be greatly enhanced by improvements of knowledge in key areas as listed below: 1. Development of thresholds/target/assessment levels for GES and biological effects/responses evaluation a. Transfer of contaminants through marine food webs and their effects at different trophic levels (taking into account bioaccumulation /biomagnification, natural ecological processes and modelling); b. Development of methodologies and techniques for biological effects including contaminant mixture actions, effects on genetic composition of populations; c. Assessment of anthropogenic pressure: determination of regional specific background concentrations derived taking into account the geochemical and oceanographic variability between regions; allowing also assessment of pollution trends and setting environmental indicators. 2. Pollution pressures on the wider marine environment scales a. Development of baseline studies on fate and effects of pollution in deep and open European seas; b. Assessments of large-scale fluxes of priority hazardous substances: at sub-regional, oceanic basin-wide scales and at air-sea and water-sediment compartment interfaces; c. Development of cost-effective new strategies and techniques for pollutant monitoring at wider marine environment scales.	Geographic: EU, basin wide natural boundaries scales. Severity: Impact human systems environmental services and social benefits; influence on key ecosystem biological structures and functions. **Reference to Questionnaire:** Q HELCOM, Q OSPAR, Theme 2 IFREMER, D8 MED SEAS ERA, Q RWS

Feedback Loop, Drivers, Pressures, Impacts and Responses	State Change/ Shift and Impacts	Notes	Etc.
- The pressures may be related to contaminants sources/and more generally societal drivers i.e. distinct human activities releasing and emitting chemical substances into natural environment; - The determination of loads is a valuable tool for assessing the effectiveness of measures/to reduce pollution pressures; - The measurement of contaminant levels and expression of pollution biological effects is the means of confirmation of GES.	The anthropogenic pollution pressures on the ecosystem lead to state change and adverse impacts (ecological and societal) in the marine environment. - Elevated anthropogenic chemical pressures may influence ecosystem biological structures and functions (including biodiversity decline, impairment of reproduction of marine biota, deterioration of their survival capacity). - The state change can also lead to impacts on the human systems (ecosystem services and societal benefits): food provision and its quality, fisheries and aquaculture, human health, maritime transport and harbour activities, tourism and recreation – amenities and valued species conservation.	The two research questions developed above assimilate the overall list of nine D8 research questions listed in the distribution sheet.	European seas are affected by inputs of various chemical contaminants, including nutrients, trace elements, artificial radionuclides and hazardous organic substances with Persistent Organic Pollutants (POPs), biocides, hormones, and drugs. Our knowledge of concentration levels, fluxes, and behaviour within the water and sediment columns and especially their toxicological impacts on the ecosystem varies depending on the group of contaminants. The coastal areas are expected to face increasing anthropogenic pressures. Because of the particular importance of the atmospheric inputs of hazardous substances, the open waters are also greatly affected by chemical contamination, especially through the bioaccumulation/biomagnification processes within marine food webs. Within the context of MSFD implementation, the future research and monitoring efforts should strive to include key actions which allow the relationships between pressures and environmental impacts to be established while focusing on issues that are major threats to GES in European seas. The assessment of the pressures and impact of pollution on marine systems at global and regional scales should also allow evaluating and ranking the vulnerability of marine ecosystems to such anthropogenic threats and development of new policies of marine pollution management.

Theme 2 - Contaminants and Nutrients *cont.*

D.9 Contaminants in fish and seafood						
Pressures	**Research Needs**	**Impacts**	**Knowledge Gaps**	**MSFD Relevance**	**Justification/ Prioritisation**	**Notes**
Contamination of the marine environment for all seafood for all marine sub-regions, including linkage to loading (D8). The workgroup is explicitly excluding microbiological contaminants, parasites, and phytotoxins, although it is recognised that these play a role in food safety, the interpretation of D9 is that chemical contaminants are the object of analysis.	Assessment for the MSFD of the distribution of relevant substances in aquatic food products, including links to D8 - Contaminants: (a) Collaborative work with D8 on pathways of contamination, toxicokinetics and ecotoxicology with emphasis on substances where limits are set (i.e. mercury, cadmium and PCBs) (b) Variability of concentrations of relevant substances in different edible parts of seafood (account for variability of diet in the EU space e.g. white meat/ brown meat); (c) Levels of mercury in fish fillets from fish species high in the food chain (pathways, geographical variability and means to circumvent seafood above upper limits to get access to markets. (d) Long-term development of dioxins and dioxin-like PCB levels in marine fats and oils as well as oily fish; (e) Epidemiological studies on emergent contaminants.	Product rejected for human consumption (economic, food security).	Specific regulations for emergent contaminants, some edible parts of organisms, and selected pathways (top predators, oily fish, shellfish).	Promote better management of seafood safety.	Geographic: EU, basin wide natural boundaries scales. Severity: impact on human systems environmental services and social benefits.	The research question developed above assimilates the two D9 Research Questions listed in the distribution sheet.

Theme 3 - Disturbances

D.10 Marine litter					
Research Needs	Justification/ Prioritisation Research Need 1	Justification/ Prioritisation Research Need 2	Justification/ Prioritisation Research Need 3	Justification/ Prioritisation Research Need 4	Justification/ Prioritisation Research Need 5
1. Determination of sources and fates of litter in the marine environment 2. Determine the relationship between the types and amounts of marine litter in the environment and the degree of 'harm' caused at a population and individual level 3. Determine degradation processes for marine litter and the impact on trend evaluation 4. Development of additional monitoring tools to quantify the pressure from marine litter 5. Socioeconomic assessment	The evaluation of sources and links between hydrodynamic factors (velocity, turbidity, turbulence, density of water masses, residual circulation and other forcing variables) and the behaviour of the different types of litter in the marine environment (varying according to nature, size and composition) will give a better identification of sources, activities generating litter (fishing, industry, tourism, etc.), transport dynamics, destinations and accumulation zones (gyres, canyons, bays, etc.). It will enable the backtracking of marine litter to follow accidental inputs and understand regional connectivity (transboundry transportations). Research should support the development a GIS platform and a large- scale EU wide model for river/surface/water column/sea floor litter current transportation to enable the location/evaluation of sources, destinations (accumulation areas) and backtracking of litter. This will enable the development of a common EU wide tool to better understand sources/effect relationships and strongly support adequate measures and management schemes. This will also support the understanding of transport of alien/invasive/pathogen species that use litter as vectors (link with D2). **References to Questionnaires** D10 IFREMER, Q BSC, Q HELCOM, Q RWS, Q PERSEUS	Ingestion of, and entanglement in, marine litter are serious mortality factors for many marine species. However, there are only a few studies trying to quantify the effects at molecular, physiological and population level and define effects for specific litters (plastics, ghost nets, etc.). Understanding the ecological impact of litter, including microplastics, on marine organisms and ecosystems will need upstream research relating quantities and size of litter to specific lethal or sublethal effects in relation to different environmental conditions. Recommendation: Establish the specific environmental consequences, by types of litter/ microlitter, from metabolism to ecosystems level effects. This will enable science-based definition of threshold levels when measuring impacts and will therefore help to better define GES and targets. **References to Questionnaires** Q BSC, Q HELCOM, Q OSPAR, Q PERSEUS,	The persistence through time a key characteristic of some forms of marine litter. We need a better understanding about rates of degradation in the environment (plastics, degradable materials, bio plastics, etc.) and about leachability of litter related chemicals (such as phtalates, bisphenol A, etc. in the cases of plastics). Microlitter particles are a recently described phenomenon and our knowledge of the accumulation and environmental consequence of this material are relatively limited. Moreover, lower detection limits actually do not allow the detection and quantification of smaller sized particles, including nanoparticles that may have environmental consequences. Recommendations: There is a need for a better understanding of processes and rates of degradation of the various types of litter in the environment. The influence of external factors (temperature, depth, etc.) must be also considered. Ultimately, the detailed "biogeochemistry" of litter in the marine environment will be available and provide universal background information for trends evaluation and support directed measures to specific types of litter/component. **References to Questionnaires** D10 IFREMER, Q PERSEUS	There is a need for research to support the development of additional monitoring tools and indicators for areas where there are currently gaps in the understanding of the pressure from marine litter, such as riverine litter and species for ecological impact indicators (e.g. shearwaters, turtles, etc.). This should include standards/ baselines, data management/ quality assurance, extension of monitoring protocols to all MSFD regions/sub-regions. In support to monitoring, repeatability, optimisation, robustness and reliability of methods will require further research to develop large scale measurements and efficient interpretation of litter data. Recommendations: Develop automated monitoring systems (ship-based cameras, microlitter quantification etc.) and impact indicators (EcoQO for sea turtles, alternative species for bird indicator). Rationalise monitoring (standards/baselines; data management/quality insurance; extend monitoring protocols to all MSFD sub regions); this will enable a harmonised monitoring approach dedicated to MSFD and a better evaluation of trends. **References to Questionnaires** D10 IFREMER, Q OSPAR, Q RWS, Q PERSEUS	Evaluation of direct costs of marine litter to the maritime industry, fishing industry, local authorities and governments and in terms of impacts on ecosystems goods and services is essential for the development of measures and to ensure that they are cost effective. This has not been prioritised as an outcome of this workshop as it will be addressed by the next STAGES workshop. **References to Questionnaires** D10 IFREMER

Theme 3 - Disturbances *cont.*

D.11 Introduction of energy, including underwater noise

Research Needs	Justification/ Prioritisation Research Need 1	Transfers Functions	Geographic Extent	Justification/ Prioritisation Research Need 2	Geographic Extent	Justification/ Prioritisation Research Need 3	Geographic Extent
1. Determine population effects of low- and mid-frequency impulsive noise on marine life in order to establish targets (for 2018/2021 MSFD cycle). 2. Effects of increased ambient noise levels on marine life, in order to establish targets for future MSFD cycles. 3. Determine which additional parameters (other than currently used pressure parameters) are needed to characterise sound sufficiently.	Direct effects: effects from impulsive noise (e.g. seismic, pile driving, sonar, etc.), on marine life; describing effect levels, type of response (e.g. physiological effects, disturbance, behavioural changes) and severity of these responses; i. Direct effects of noise are better understood than they were 15 years ago and (for a limited number of species, mostly marine mammals) these direct effects can be quantified to some extent (e.g. disturbance/ injury thresholds) ii. For marine mammals, the occurrence of physiological effects is probably limited. More subtle effects like behavioural change which lead to energy loss are likely to happen at low exposure levels and on a significantly larger scale, and therefore may lead to population level effects; iii. Effects on other species, fish, invertebrates are not well known, Prioritising research: - Needed for MSFD assessment of GES and target setting (deadline 2018/2021) - most Member States have not been able to set concrete targets for impulsive noise because of lack of data. - Data gap that may preclude development of wind-energy since uncertainty about ecological effects may be an objection to licensing. - There is concern that accumulation of impulsive noise sources leads to population/ecosystem effects, this is the main effect addressed by impulsive noise indicators as developed for MSFD.	Ecological significance of direct effects (disturbance/ temporary habitat loss) is unclear but frameworks are to some extent available (PCAD/PCoD)	EU wide, much of the knowledge needed is generic and individual Member States would not be responsible for filling research gap. EU targets for sustainable energy at stake if development of Offshore Wind Energy (OWE) is delayed.	Ambient noise levels have increased in the past 50 years mostly due to shipping activity. This increase might result in the masking of biologically relevant signals (e.g. communication calls in marine mammals and fish) considerably reducing the range over which individuals are able to exchange information. It is also known that marine mammals alter their communication signals in noisy environments which might have adverse consequences. It is further likely that prolonged exposure to increased ambient noise leads to physiological and behavioural stress. Thus chronic exposure to noise can permanently impair important biological functions and may lead to consequences that are as severe as those induced by acute exposure. Pressure/impact relations of increased ambient noise levels are not understood. a. There is growing information on effects of increased ambient noise levels, effects identified include i. Reduction of echolocation range (quantifiable using models) ii. Reduction of communication range (quantifiable?) iii. Changes of calling frequency iv. Shifts in predator-prey relations Of these effects, no quantitative data exist, although reduction of echolocation or communication ranges can be quantified to some extent using modelling approach. However, even in this case the effective communication ranges are not known and relevance of reduction of communication ranges cannot be assessed. Prioritising research: - Needed for MSFD assessment of GES and target setting (deadline 2018/2021)- most MS have not been able to set concrete targets for ambient noise because of effects of ambient noise are unknown. - Since shipping noise is omnipresent and continuous, there is potential for effects at the ecosystem level.	EU wide to global scale. Much of the knowledge needed is generic and individual Member States would not be or feel responsible for filling this specific research gap.	Although much attention has been given to effects on marine mammals, relatively little attention has been given to the sensitivity of fish and other organisms, including marine invertebrates. The Commission Decision of 2010 describes sound in terms of (pressure) level, but fish and many invertebrates are probably sensitive to particle motion, and not to the sound pressure. a. The monitoring programmes will provide information on sound pressure (including average values) but not levels of particle motions. b. Where sound exposure experiments have been carried out on fish and/or marine invertebrates, particle motion has rarely been measured and the effects of it are thus not known. Prioritising research: The MSFD assessment of GES and target setting (deadline 2018/2021) makes use of pressure parameters and these may be insufficient for verification that GES is actually achieved.	EU wide. This specific knowledge is generic and individual MS would not be responsible for filling research gap.

Items not addressed					Future Work
Impacts of noise from other sources (e.g. leisure craft and echosounders); the European Commission Technical Subgroup on Underwater Noise (TSG Noise) will address whether additional sound sources of concern should be addressed at the MSFD-level.	Assessment of effects of ambient noise is practically impossible because there is almost no data on baseline or historical data on ambient noise levels in European waters. This is an important knowledge gap, however this should be addressed by the monitoring programmes that should start in European waters in 2014 and (in theory) can provide this data in time for the 2018 assessment.	Assessment of effectiveness of mitigation measures was considered not to be part of this workshop.	Distribution of marine life: data on the abundance at the relevant temporal scale of marine life is needed to determine to what extent sensitive populations may be affected (and thus essential for the 2018 MSFD assessment). This knowledge is regularly collected for other purposes (e.g. to determine numbers of individuals within species being by-caught in relation to population size) and this may be sufficient for the 2018 MSFD assessment.	Priorities identified during the workshop were not the result of a group process, as only one underwater noise expert was present. Coupled with the limited time available at the the workshop it was recommended that the STAGES project should contact TSG Noise to further review research needs and to provide STAGES with a further improved list of research needs.	Future work: In September 2013 a EU-contract was awarded to CEFAS/NPL (UK) and TNO (NL), addressing impacts of noise and use of propagation models to predict the recipient side of noise; within this contract existing literature and results from research project will be reviewed, and gaps in the current knowledge of impacts need to be identified and an inventory of specific additional research needed should be made.

Theme 4 - Commercially Exploited Fish

D.3 Commercially exploited fish and shellfish

Research Needs	Justification/ Prioritisation
1. Determining targets and reference points for fish stocks with limited data in relation to set descriptors (including more stock assessments) especially for shellfish. 2. Modelling spatial pressures of fishing in relation to ecosystem sensitivities and the structure of stocks. 3. The impact of fishing by-catch on the populations of protected, endangered or threatened species (PETS). 4. Consequences for fisheries management of changes in exploited marine population distributions and productivity. 5. Methods development for quantification of fishing pressure from small scale and recreational fisheries including the impact of discarded fishing gear.	State change/shift and impacts: In general, many of the research needs to implement F targets (fishing level targets) and B targets (biomass targets) for commercial fisheries are being addressed. However, fishing can be considered a major pressure on most European seas so the D3 descriptors cannot be considered in isolation of the additional impacts to GES of fishing pressure. It is clear from the national initial assessments that little consideration has been given to the determining of GES when considering locally managed shellfish or data limited stocks. Whilst some bodies (STECF, ICES) are making progress on assessing finfish stocks with limited data, there are few national or international bodies determining methods for shellfish. None of the STAGES WS2 questionnaires addressed the issue of shellfish, yet targeting the assessment of the impact of recreational and small scale fisheries was considered relevant by the workshop following advice from the Baltic and Mediterranean seas. Effective fisheries management measures require information about the spatial distribution of fishing pressure and impacts. The experience of the EFIMAS and FIMPAS projects show that management measures need such knowledge to be effective. The impact of fishing pressure on other descriptors was raised in the questionnaires. The pressure managed through the CFP (fishing) impacts widely across European seas. This needs to be accounted for throughout many of the other descriptors. The by-catch of PETS was included due to social objectives to conserve those organisms. **Reference to Questionaires:** Q BSC, Q HELCOM, Q RWS, Q PERSEUS, D3 SEAS ERA

Theme 5 - Hydrographical Conditions

D.7 Hydrographical conditions				
Research Needs	Justification/ Prioritisation Research Need 1	Justification/ Prioritisation Reasearch Need 2	Notes	
1. To develop a relevant and harmonised definition of "permanent alteration" both in terms of hydrographic conditions and species and habitats to ensure consistency in assessing impacts of major projects. 2. Models to predict the alterations in hydrographical conditions are needed so as to ensure thorough assessment of proposed major projects can be undertaken prior to their approval. This requires knowledge of the sensitivity of ecosystems and their functioning at a broad scale as well as the identification of the parameters needed to model changes in hydrographical conditions (e.g. shear stress).	Define permanent alteration of the state of hydrographic conditions or species and habitats due to pressure caused by major developments especially where there are likely to be transboundary implications. This is needed to ensure consistency in assessing the spatial extent of the hydrographical alterations of habitats and their functioning. **References to Questionnaires:** STAGES Questionnaire WS2 OSPAR final	For future large projects, this generic information needs to be available at an early stage to decide on potential impacts on hydrographical conditions. Bottom shear stress is a good indicator of changes in the dynamic environment of the seabed. The sensitivity of benthic fauna is one of the major information needs to assess major project proposals against D7 and to inform the consenting decision and forward planning process. The changes in current can influence the migration of pelagic fauna and can change the salinity that influences both pelagic fauna and benthic fauna. 2a1 Define the parameters needed to model the bottom shear stress in such a way that the effect of hydrodynamic changes on benthic fauna can be predicted 2a2 Knowledge on sensitivity of benthic fauna populations to changes of dynamic environment focussed on the relation between bottom shear stress and benthic fauna. 2b1 Define the parameters needed to model the current changes in such a way that the effect of hydrodynamic changes on larvae and juvenile fish can be predicted 2b2 Knowledge focused on sensitivity of larvae and juvenile fish to changes of direction of migration. 2c1 Define the parameters needed to model the change in salinity in such a way that the effect of salinity changes on marine fauna can be predicted. The priority should be on the items mentioned under 1 and 2a, because these items are normally not addressed elsewhere. The model approach is very important to define the indicators under D7 and to avoid unnecessary and expensive field monitoring, by restricting the area for monitoring. The items mentioned under 2b and 2c are in most cases standard in Environmental Impact Assessment (EIA) procedures for large sale projects. Therefore and also because they are very location specific this should be addressed in EIA. In terms of the MSFD there should be a pressure to incorporate this in the EIA for large projects with an impact on marine environment. **References to Questionnaires:** D7 bottom shear stress and D7 Bottom shear stress parameters	Given there were no hydrographical experts to deal with D7 among the participants, the responses of the three questionnaires were used to prepare a draft output and this was circulated to the relevant respondents for their observations. Input from circulation has been taken into account while writing the report.	

6. General Conclusions

The workshop participants were aware of the breadth of the issues being discussed and that there are very many experts outside the STAGES process that may have different views than those expressed in this report. Methods for dealing with synergistic, cumulative, and antagonistic effects of human pressures on biodiversity is a significant challenge identified by the workshop. Research on this in a number of projects is underway or nearing completions (e.g. ODEMM). The outputs of such research needs to be compiled and assessed. However, there was a broad range of expertise at the workshop and every effort was made to avoid bias and to reflect genuine research questions that, if answered, would ultimately help Member States and Regional Seas Commissions deliver on their obligations under the MSFD.

The workshop recommends that the STAGES coordinator seek the opinion of the Noise and Litter Technical Subgroups set up under the EU's Working Group on GES and, if necessary, to include their observation in the final STAGES Report to the Commission.

The workshop recommends that the Socio-economic Workshop considers the research needs identified in this report, which focused primarily on ecological pressures and impacts, with a view to identify those which also have significant socio-economic impacts.

Annex:
STAGES Workshop on research needs with regard to the pressures and their impacts on marine ecosystems.

Radisson Blu Hotel, Rome,
Room: Conference Sette, 7th floor,
4-5 September 2013

4th September	
09:00	Welcome address by the workshop Chairs *Yvonne Walther (Swedish University of Agricultural Sciences) and Eugene Nixon (Marine Institute Ireland)*
09:15	Brief overview of STAGES and the workshop ToRs *Wojciech Wawrzynski (ICES)*
9:30	Presentations from Regional Seas Commissions *Laura Uusitalo (HELCOM), Irina Makarenko (BSC), John Mouat (OSPAR)*
10:30	Coffee Break
11:00	*Celia Vassilopoulou (PERSEUS project)*
11:15	*Beatriz Moralez-Nin (SEAS-ERA project)*
11:30	Identification of research priorities - criteria and attributes *Lisette Enserink (Dutch Ministry of Infrastructure and Environment)*
11:45	**Theme 1 Biodiversity Group** D1: Biodiversity *Lene Buhl Mortensen (IMR)* D2: Non indigenous species *Sergej Olenin (IMR)* D4: Marine food webs *Stuart Rogers (CEFAS)* **Theme 2 Contaminants and nutrient group** D5: Eutrophication *João Ferreira (Universidade Nova de Lisboa)* D8: Contaminants *Jacek Tronczynski (IFREMER)* D9: Contaminants in fish and seafood *Amund Mage (NIFES) and Michiel Kotterman (WAGENINGEN UR)*
13:30	Lunch

Under Grant agreement no 308473.

14:30	**Theme 3 Disturbances group** D10: Marine litter *Francois Galgani (IFREMER)* D11: Underwater energy *Rene Dekeling (Ministerie van Infrastructuur en Milieu)* **Theme 4** D3: Commercially exploited fish and seafood *Mark Dickey-Collas (ICES)*
16:00	Summing up of the 1st day *(Chairs)*
5th September	
09:00-10:30	Discussions: selection of research priorities, justification of choice, drafting of ready-to-use recommendations.
10:30-11:00	Coffee Break
11:00 – 13:30	Discussions cont.
13:30	Lunch
14:30 - 16:00	Discussions cont.
16:00 – 17:00	Conclusions, summing up

Under Grant agreement no 308473.