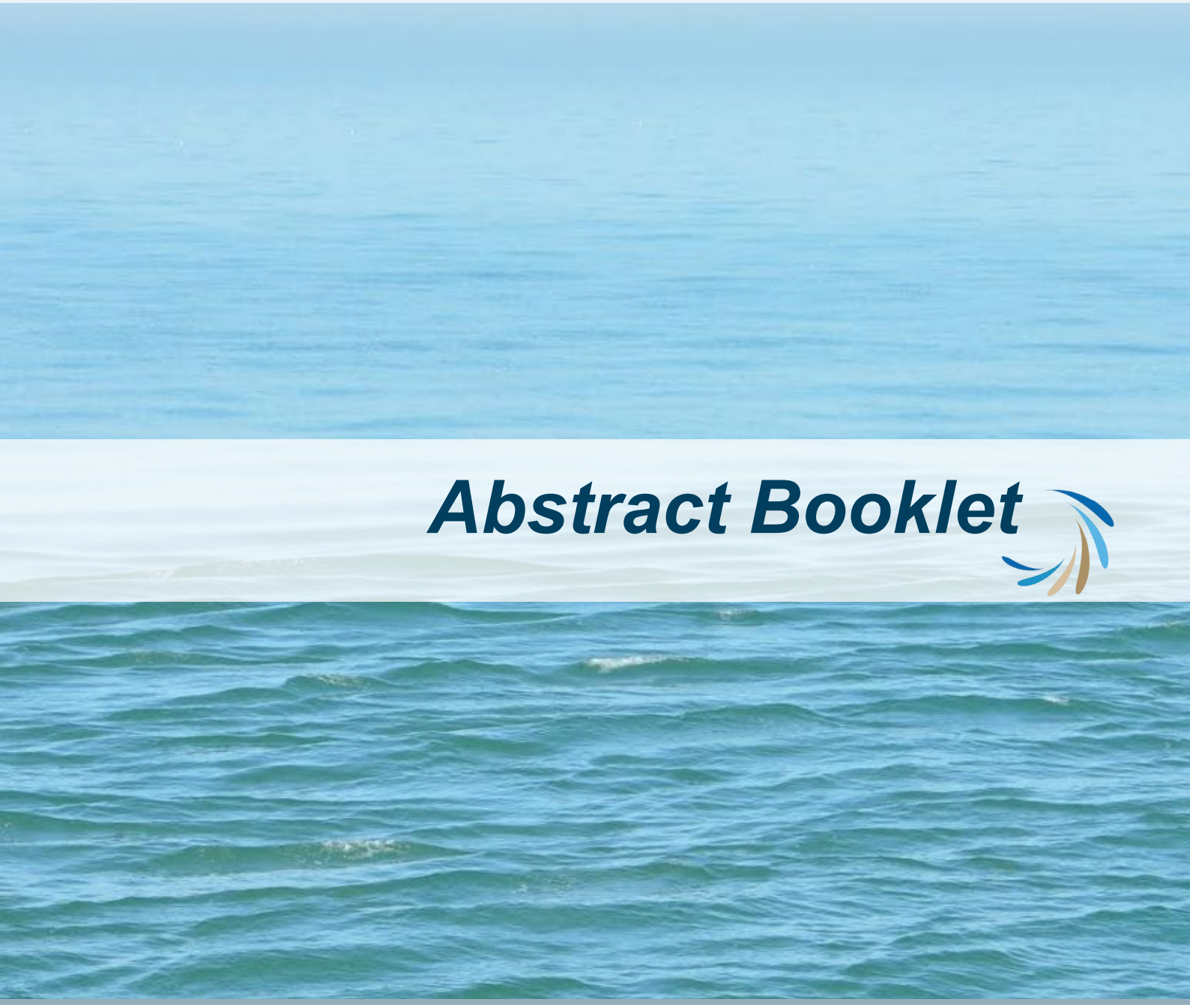
NORTH SEA

Open Science Conference
Ostend, Belgium, 7-10 November 2016

Interdisciplinary Science in support of Marine Management



Abstract Booklet

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Welcome

Welcome to the North Sea Open Science Conference!

Oceans and seas are of capital importance to their bordering countries and beyond. This is particularly true for the North Sea surrounded by heavily populated and industrialised countries. Industries have been exploiting the North Sea for many decades. This ever expanding exploitation asks for a well-deliberated management that allows for a sustainable conservation of the marine ecosystem's structures, functions and services. Managerial frameworks such as the Marine Strategy Framework Directive are key to such ecosystem-based management within which industrial aspirations and environmental concerns are assessed and deliberated. Evidence-based management builds on a firm knowledge base on ecosystem structures and functions, how these are potentially impacted by human activities, and how they can be best managed. The North Sea Open Science Conference specifically addresses these concerns, screens state-of-the-art knowledge, discusses and searches for solutions and prospects to enlarge the scientific basis for a sustainable ecosystem-based management of the North Sea.

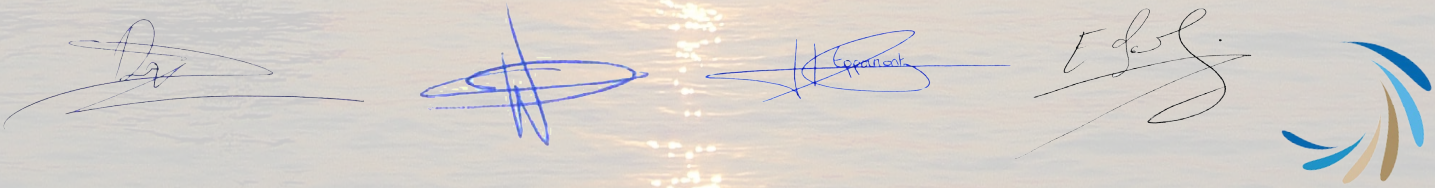
With environmental scientists, social scientists, policy makers, marine managers and industries around the table, the North Sea Open Science Conference succeeds in collating a high level of cross-disciplinary expertise and cross-sectoral interests. All participants are indispensable for a unique science-policy-society trialogue in search for answers to the challenging questions of how to best manage and safeguard our North Sea. Inspired by six state-of-the-art keynotes, 56 oral presentations, 52 poster presentations and two participatory sessions, we collectively walk the journey from reviewing the North Sea's scientific backbone, over an exploration of the new era in environmental monitoring and assessment, to designing concepts for a sustainable North Sea management. We will showcase present-day knowledge on the structural and functional spatio-temporal patterns and processes within the North Sea ecosystem, both from a physico-chemical and biological perspective. We will learn about innovative and integrated approaches for assessing the North Sea ecosystem status. We will discuss North Sea usage and management issues needed to secure a long-term sustainable exploitation of the socio-economic potential of the North Sea.

The North Sea Open Science Conference has made an ambitious choice to move away from just another series of presentations, to a format stimulating and maximising interaction. 13' plenary presentations provide cross-cutting views and questions related to current and future research and management of the North Sea. These are interspersed by 3' flash presentations summarising key focused research findings and provocative management questions. The guided thematic poster walks will make a poster session never to be the same again. Two participatory sessions will finally identify how research results presented in the thematic sessions can inform science, management and policy strategies. We will jointly identify research gaps and priorities that arise from management and policy needs. This format will create a great opportunity to exchange knowledge and thoughts among the participants, stimulating potential future interaction and collaboration.

You want more? A multitude of side events open to all participants will increase interactions even more. Witness the official signing of the Blue Growth Memorandum of Understanding by the Belgian Secretary of State for the North Sea and the Belgian maritime industries. Enjoy the nice seaview conference dinner. Relax and learn about our local bird populations during a post-conference trip to the 'Zwin' nature reserve.

All available pieces for the giant puzzle of the North Sea science and management are on the table. Let us now collectively get the pieces together and identify those pieces missing for a sustainable management of the North Sea!

Steven Degraer, Vera Van Lancker and Hilde Eggermont, conference organisers
Estelle Balian, chair organising committee



Committees

Organising Committee

Dr. Steven Degraer	Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment (OD Nature)
Dr. Vera Van Lancker	Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment (OD Nature)
Dr. Hilde Eggermont	Belgian Biodiversity Platform - Royal Belgian Institute of Natural Sciences (RBINS)
Estelle Balian	Belgian Biodiversity Platform - Royal Belgian Institute of Natural Sciences (RBINS)
Dimitri Brosens	Belgian Biodiversity Platform - Research Institute for Nature and Forest (INBO)
Pierre Huybrechts	Belgian Biodiversity Platform - Royal Belgian Institute of Natural Sciences (RBINS)
Sigrid Maebe	Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment (OD Nature)
Nicolas Noé	Belgian Biodiversity Platform - Belgian Science Policy Office (BELSPO)

Scientific Committee

Dr. Silvana Birchenough	The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) (UK)
Dr. David Cox	Belgian Science Policy Office (BELSPO) (BE)
Dr. Bavo De Witte	Institute for Agricultural and Fisheries Research (ILVO) (BE)
Dr. Mike Elliott	University of Hull (UK)
Dr. Francisco Hernandez	Flanders Marine Institute (VLIZ) (BE)
Dr. Thomas Kirk-Sörensen	Technical University of Denmark – DTU (DK)
Dr. Geneviève Lacroix	RBINS, Operational Directorate Natural Environment (OD Nature) (BE)
Dr. Sophie Le Bot	University of Rouen (FR)
Dr. Han Lindeboom	IMARES Wageningen UR (NL)
Dr. Henning Reiss	University of Nordland, Faculty of Biosciences and Aquaculture (NO)
Dr. Jan Reubens	Ghent University (BE) & Flanders Marine Institute (VLIZ) (BE)
Dr. Karline Soetaert	Royal Netherlands Institute of Sea Research (NIOZ-Yerseke) (NL)
Dr. Vanessa Stelzenmüller	Thünen Institute (DE)
Dr. Thaiënne Van Dijk	Deltares (NL)
Dr. Saskia Van Gaever	Belgian Health, Food Chain Safety and Environment FPS (BE)
Dr. Steven Degraer	RBINS, Operational Directorate Natural Environment (OD Nature)
Dr. Vera Van Lancker	RBINS, Operational Directorate Natural Environment (OD Nature)
Dr. Hilde Eggermont	Belgian Biodiversity Platform - RBINS

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The Directorate Natural Environment (OD Nature) envisages being a "centre of excellence in fundamental and applied research of biodiversity and ecosystems in support of the protection and sustainable management of the natural environment."

To realise this vision, we have a fourfold mission:

1. The study of the biotic and abiotic components of the natural environment and the interactions of the systems that form part of it.
2. To provide scientific expertise including running a monitoring program for the North Sea and capacity building in the field of biodiversity in developing countries.
3. The management and improvement of databases and major scientific instruments such as the RV Belgica.
4. Representing the Federal state in international bodies and instruments.

Around 100 collaborators are spread over 3 locations in Brussels and Ostend. They have a large and diverse expertise and a strong reputation in their fields that include ecology, molecular biology, nature conservation and protection, biodiversity, chemistry, hydrodynamics, modelling, databases and image processing. This expertise is applicable to terrestrial, freshwater and marine environments worldwide.

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The Belgian Biodiversity Platform provides services to the Belgian scientific community engaged in biodiversity research. We are a Belgian Federal Science Policy Office (BelSPO) initiative that works in cooperation with Belgian federated authorities.

As a science-policy interface, we provide neutral and scientifically credible information on all aspects of biodiversity science.

We offer services related to data publication, management and use, science networking, training and capacity building, as well as think-tank activities.

The Belgian Biodiversity Platform is a multidisciplinary team composed of natural and social scientists (see our personnel section) that provides adequate services to Belgian scientists.

The Belgian Biodiversity Platform was created in 2001 in order to align biodiversity research priorities in Belgium. In 2004, the organisation merged its activities with two Belspo initiatives on biodiversity information (GBIF and Biodiv-Belnet) in order to become an information and communication hub on biodiversity science and research.

Table of Contents

Programme

Time	Topic
November 7th	*R: Regular talk; S: Short talk*
10.00AM - 1.00PM	Registration and poster set-up
1.00PM - 2.00PM	Lunch
2.00PM - 2.30PM	Steven Degraer, Vera Van Lancker and Hilde Eggermont, conference organisers: Welcome to the conference
	Philippe De Backer, Belgian State Secretary for the North Sea
	Camille Pisani, General Director, Royal Belgian Institute of Natural Sciences (RBINS)
	Estelle Balian, chair organising committee: Get started!
2.30PM - 3.30PM	Opening Keynote: Prof. Melanie Austen. Plymouth Marine Laboratory (UK)
	Keynote Prof. Mike Elliott :Towards an MSFD-compliant research and management plan for the North Sea ; University of Hull (UK)
3.30PM - 4.00PM	Break
4.00PM - 6.00PM	Theme 1: Scientific backbone of the North Sea ecosystem: adequacy of the knowledge base? Chair: Dr. Henning Reiss, University of Nordland, Faculty of Biosciences and Aquaculture (NO)
	(R) Quante, Markus: The international North Sea Region Climate Change Assessment (NOSCCA) – an analysis of the scientific legitimate knowledge for science and decision making. Helmholtz-Zentrum Geesthacht, Institute of Coastal Research(DE)
	(S) Ruddick, Kevin: 30 years of changes in Belgian waters as observed (or not) by high resolution satellites. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(R) Frid, Chris: Opening the window on seafloor change: How understanding changes as time series extend. School of Environment, Griffith University (AU)
	(S) De Backer, Annelies: Long-term ecosystem changes in the Belgian North Sea revealed by 30 years environmental monitoring of soft sediment fauna. Institute for Agricultural and Fisheries Research (ILVO) (BE)
	(R) Daewel, Ute: On the relevance of higher trophic levels for modelling long term ecosystem dynamics in the North Sea. Helmholtz Centre Geesthacht, Institute of Coastal Research (DE)
	Questions and Answers
	(S) Mascioli, Francesco: Subtidal Mapping Program of the Lower Saxony Coastal and Marine Waters (Germany). Coastal Research Station, Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN) (DE)
	(S) Propp, Claudia: Standardized seafloor mapping in the German Exclusive Economic Zone (EEZ). Federal Maritime and Hydrographic Agency (BSH) (DE)
	(S) Hademenos, Vasileios: Need of a 3D geological framework underpinning marine exploitation strategies. Ghent University, Dep. Geology (BE)
	(S) Dannheim, Jennifer: Large-scale / high-resolution information systems – a new backbone for conservation and monitoring in the North Sea. Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (DE)
	(S) Pesch, Roland: Spatial Modelling of biotopes and species for marine nature conservation and marine spatial planning in the German Exclusive Economic Zone of the North Sea. BIOCONSULT Schuchardt&Scholle GbR (DE)
	(S) Wrede, Alexa: Effects of German Bight top bioturbators on biogeochemical cycling and sediment turnover. Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (DE)
	(S) Vanaverbeke, Jan: The interaction between macro and micro-organisms affects biogeochemical cycles in coastal sediments. Royal Belgian Institute for Natural Sciences (BE)
	(S) Birchenough, Silvana: Structural and functional variability of benthic assemblages at three contrasting sites in the North Sea. Cefas (UK)
	Questions and Answers
	Synthesis
6.00PM - 8.00PM	Social Event

November 8th	
8.30AM - 11.00AM	**Theme 1 (continued): Scientific backbone of the North Sea ecosystem: adequacy of the knowledge base?**
	(S) Larsen, Martin M: The EMODnet platform: Data and presentation of Nutrients and hazardous substances cases. Århus University, Dep. of Bioscience (DK)
	(R) Dulière, Valérie: What is the origin of nitrogen in the North Sea. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(S) De Witte, Bavo: Zn and Cu increases at the Belgian continental shelf: linked to antifouling? Institute of Agricultural and Fisheries Research (BE)
	(R) Van Colen, Carl: Context-dependent effects of ocean acidification on soft-sediment biodiversity and ecosystem functioning. Ghent University Dep. Biology (BE)
	(R) Barbut, Leo: How larval dispersal of flatfish is impacted by life traits? Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(S) Verhelst, Pieterjan: Acoustic telemetry as a tool for cod stock assessment. Ghent University, Dep. of Biology (BE)
	(R) Robson, Laura & Johnson, Gareth: Managing fisheries in MPAs: how do we account for natural disturbance in mobile sediments? Joint Nature Conservation Committee (JNCC) & Marine Space (UK)
	Questions and Answers
	(R) Wolfshaar van de, Karen: Spatial explicit multi-species model: effects of area closures on fish biomass and catch. IMARES (NL)
	(S) Lacroix, Geneviève (presenter Steven Degraer): Impact of man-made structures on hard substrate species connectivity patterns in the North Sea. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(S) De Mesel, Ilse: Population genetics and phylogeography of Patella (Mollusca, Gastrapoda) to assess the role of wind turbines as stepping stones for non-indigenous species in the Southern North Sea. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(S) Derweduwen, Jozefien (presenter Kris Hostens): Is the feeding behaviour of soft substrate demersal fish influenced by the presence of wind farms? Institute for Agricultural and Fisheries Research (ILVO) (BE)
	(R) Lemmen, Carsten: The large scale impact of offshore windfarm structures on pelagic primary production in the southern North Sea. Helmholtz-Zentrum Geesthacht (DE)
	(S) Vandenberghe, Thomas: MarineMammals.be: improving marine mammal stranding data collection. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	Questions and Answers
	Synthesis
11.00AM - 11.30AM	Break
11.30AM - 1.00PM	Participatory discussion
1.00PM - 2.30PM	Lunch and posters
2.30PM - 3.30PM	Theme 2: A new era in environmental monitoring and assessment: what is at stake?
	Keynote: Dr. Dolf de Groot: Goods and services of the North Sea ecosystem. Wageningen University, (NL)
	Keynote: Prof. Adriaan Rijnsdorp: Key driver-pressure-state relationships in the North Sea. What have we learned from past research initiatives? IMARES & Wageningen University (NL)
3.30PM - 4.00PM	Break
4.00PM - 6.00PM	Theme 2 (continued): A new era in environmental monitoring and assessment: what is at stake? Chair: Dr. Silvana Birchenough, The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) (UK)
	(S) Van der Zande, Dimitry: Space-borne ocean colour observations: a valuable tool for monitoring the water quality in the North Sea. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(R) Desmit, Xavier: Past, present and future eutrophication levels in the North East Atlantic. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(S) Vanhellemont, Quinten: Aquatic applications of (very) high resolution satellite imagery. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(R) Kromkamp, Jacco C.: A new innovative way for semi-automated measurements of phytoplankton primary production. NIOZ (NL)
	(S) Deschutter, Yana: Understanding the response of zooplankton biodiversity and functioning in the North Sea as multistressor environment. Ghent University, Dep. Biology (BE)
	Questions and Answers
	(R) Van Hoey, Gert: Ecosystem status assessment: one step at a time! Institute for Agricultural and Fisheries Research (ILVO) (BE)
	(S) Colson, Liesbet: The foreshore: an ecological valuable ecosystem in danger. Ghent University, Dep. Biology (BE)
	(S) Deneudt, Klaas: Building an innovative and multidisciplinary marine biodiversity observatory for Lifewatch. VLIZ - Flanders Marine Institute (BE)
	(S) Devriese, Lisa: A DNA (meta)barcoding approach to tackle marine benthic biodiversity. Institute for Agricultural and Fisheries Research (ILVO) (BE)
	(S) Bieser, Johannes: Modelling the air-sea exchange of mercury in the North- and Baltic Sea. Helmholtz Zentrum Geesthacht (DE)
	(R) Carpenter, Angela: Oil Pollution in the North Sea: The impact of governance measures on oil pollution over several decades. University of Leeds, School of Earth and Environment (UK)
	Questions and Answers
	Synthesis
6.00PM - 8.00PM	Poster session with thematic poster walks - Cocktail

November 9th	
8.30AM - 11.00AM	Theme 2: A new era in environmental monitoring and assessment: what is at stake?
	(R) Adamopoulou, Argiro: Integrated monitoring of nonpolar compounds with the use of Passive Samplers. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(S) Huysman, S: Is our North Sea contaminated with endocrine disrupting compounds? Ghent University (BE)
	(R) O'Hara Murray, Rory (presentation Alejandro Gallego): Modelling the near- and far-field effects on the physical environment of maximizing tidal stream energy extraction in the Pentland Firth, Scottish waters. Marine Scotland Science (UK)
	(S) Lacroix, Geneviève: Will soles be more numerous and more connected in a warmer world? Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(R) Delerue-Ricard, Sophie: No anonymity for fish: tracing sole juveniles arriving at the Belgian nursery combining genomics, otolith microchemistry and otolith shape analysis. KU Leuven & Institute for Agricultural and Fisheries Research (ILVO) (BE)
	(S) Reubens, Jan: Acoustic receiver network - the need for range testing. Flanders Marine Institute & Ghent University (BE)
	(R) Savina, Esther: Ecosystem Approach: fishing gear technical contributions and challenges for passive gears in the North Sea. DTU Aqua (DK)
	Questions and Answers
	(S) Papili, Sonia (presenter Olga Lopera): High frequency response on seafloor signature: structure for an innovative methodology for modern monitoring. Ministry of Defence (BE)
	(R) Gaida, Timo C.: Classification of seabed sediments in the Cleaver Bank area using multi-beam echo-sounders. Group Acoustics, Section ANCE, Department Control and Operations, Faculty of Aerospace Engineering, Delft University of Technology (NL)
	(S) Montereale-Gavazzi, Giacomo: Can multibeam-derived acoustic backscatter be used to monitor changes in seabed habitats? Royal Belgian Institute of Natural Sciences & Ghent University (BE)
	(S) Pirlet, Hans: Historical maps of the coastal zone of the North Sea. Flanders Marine Institute (BE)
	(R) Jenkins, Chris (presentation Sonia Papili): A Demonstration of the Global Seafloor Substrates system dbSEABED. University of Colorado Boulder, INSTAAR (USA)
	(S) Butler, Paul: The establishment of long baselines for environmental monitoring using high resolution sclerochronological archives. School of Ocean Sciences, Bangor University (UK)
	Questions and Answers
	Synthesis
11.00AM - 11.30AM	Break
11.30AM - 01.00PM	Participatory discussion
1.00PM - 2.30PM	Lunch and posters
2.30PM - 3.30PM	Theme 3: Sustainability: one for all, all for one? Chair: Dr. Vanessa Stelzenmüller, Thünen Institute (DE)
	1. Keynote: Dr. Robbert Casier: Marine Spatial Planning, the wider context. UNESCO, Marine Programme World Heritage Centre (FR)
	2. Keynote: Ir. Frank Verschraegen: The Blue Cluster, a project with guts. DEME Group (BE)
3.30PM - 4.00PM	Break
4.00PM - 5.00PM	Theme 3 (continued): Sustainability: one for all, all for one?
	(R) Hartley, John: The role of Strategic Environmental Assessment in delivering sustainability - a long term North Sea case history. Hartley Anderson Ltd (UK)
	(S) Cormont, Anouk ((presenter Peter Verweij): Constraints in the common pool of the continental shelf: fixed mineral resources in a dynamic environment. Alterra Wageningen UR (NL)
	(R) Degrendele, Koen: What is the role of the economy in marine management, i.c. sand extraction? FPS Economy - Continental Shelf (BE)
	(S) Terseleer, Nathan: Towards sustainable use of seabed resources using a combined monitoring-modelling approach, Belgian part of the North Sea. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	(R) Jong de, Maarten: The ecological effects of deep sand extraction and implications for the future. De Jong EcoLogical consultancy & Building with Nature (NL)
	Questions and Answers
5.00PM - 7:30PM	Science-Industry Session (co-organised by Flanders' Maritime Cluster)
	During this session we will debate on offshore test facilities serving both the industry and scientific community (see tab science-industry session). The session will be closed with the signing of a Memorandum of Understanding on Blue Growth between the Belgian State Secretary for the North Sea, Philippe De Backer, and the Belgian Maritime Industries.
8.00PM - 10.30PM	Conference Dinner

November 10th	
8.30AM - 11.00AM	Theme 3 (continued): Sustainability: one for all, all for one?
	(S) Andrusaitis, Andris: Building a joint research and innovation programme for northern European regional seas: Towards sustainable blue economy in the North Sea and the Baltic Sea regions. BONUS, the joint Baltic Sea research and development programme (FI)
	(R) Van Hoey, Gert (presenter Michael Fettweis): Environmental impact assessment in line with the EU Nature Directives. Institute for Agricultural and Fisheries Research (ILVO) (BE)
	(S) Lonsdale, Jemma: Developing an estuarine planning support system: a case study for the Humber Estuary, Eastern England. Cefas & University of Hull (UK)
	(R) Reach, Ian: Identifying North Sea herring Clupea harengus spawning habitat, assessing environmental effects from UK dredging areas and adaptive environmental management. MarineSpace Ltd (UK)
	(S) Rambo, Henrike: Assessing the effects of fishing displacement due to offshore wind farms on demersal fish biodiversity in the German North Sea EEZ using spatial Bayesian Modelling. Thünen-Institute of Sea Fisheries (DE)
	(S) Rumes, Bob: Scraping the bottom of the barrel - Assessing the impact of bottom trawling fisheries on ecosystem functioning and ecosystem services in a Habitats Directive area. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
	Questions and Answers
	(R) Gimpel, Antje: Tools and methods to support an Ecosystem Approach to Aquaculture (EAA) - a gap analysis. Thünen Institute of Sea Fisheries (DE)
	(S) Pecceu, Ellen: Using a systematic conservation planning approach to enhance the marine spatial planning process in Europe. Institute for Agricultural and Fisheries Research (ILVO) (BE)
	(S) Phillips, Becky: Developing innovative tools to improve the quality and efficiency of offshore Marine Protected Area assessments in the UK. Joint Nature Conservation Committee (JNCC) (UK)
	(R) Willsteed, Edward: Cumulative effects of marine renewable energy developments: scale and perspective. Cranfield University (UK)
	(R) Blanz, Benjamin: Modelling ecosystem economy interaction dynamics. Universität Hamburg (DE)
	Questions and Answers
	Synthesis
11.00AM - 11.30AM	Break
11.30AM - 12.30PM	Reflections on conference achievements : Dr. Mark Dickey-Collas, International Council of the Sea (ICES) (DK)
	Closure of the conference
12.30PM - 1.30PM	Lunch
1.30PM - 6.00PM	Field Trip - Birdwatching

Poster Walks

We have identified 7 thematic poster walks stimulating interaction amongst the poster presenters and the audience.

Walk 1: Ecosystem bio- and geodiversity (8 posters)

- Kint, Lars: Versatility of marine geological databases in view of MSFD related assessments. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
- Heteren van, Sytze: Seabed sediment: a geological surrogate for North Sea benthic ecosystems. TNO – Geological Survey of the Netherlands (NL)
- De Clercq, Maikel: A high-resolution DEM for the Top-Paleogene surface of the Belgian Continental Shelf. Ghent University, Dep. Geology (BE)
- De Clercq, Maikel: A First Assessment of Belgian Continental Shelf Prehistory. Ghent University, Dep. Geology (BE)
- Cheng, Chiu: Feedback of benthic organisms to bedforms in the North Sea. Royal Netherlands Institute for Sea Research (NIOZ) (NL)
- Breine, Naomi: Update on the soft-bottom benthic habitats in the Belgian Part of the North Sea, with new functional information. Institute for Agricultural and Fisheries Research (ILVO) (BE)
- Artigas Luis Felipe: On the use of automated approaches for addressing Pelagic Habitats Indicators for the Marine Framework Directive (MSFD). LOG CNRS - Université du Littoral Côte d'Opale (FR)
- O'Flynn Sarah : Distribution, structure and functioning of low-resilience benthic communities and habitats of the Dutch North Sea (DISCLOSE). Royal Netherlands Institute for Sea Research (NIOZ) (NL)

Walk 2: Ecosystem dynamics (5 posters)

- Desmit, Xavier: Spatial patterns of chlorophyll a variability in the North East Atlantic. Royal Belgian Institute for Natural Sciences (RBINS) (BE)
- Nohe, Anja (presenter Reinhoud de Blok): Long-term phytoplankton monitoring data (1970-2010) from the Belgian North Sea reveal shifts in seasonal dynamics and community composition. Ghent University, Dep. Biology (BE)
- Alsebai, Mohammed: A 11-year study to understand long-term changes in macrofaunal communities in the Belgian part of the North Sea. Ghent University, Dep. Biology (BE)
- Mavraki, Ninon: Food web analysis of fouling communities in the Belgian part of the North Sea. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
- De Borger, Emil: Upscaling small-scale environmental studies of the Southern Bight of the North Sea by biogeochemical modelling. Ghent University, Dep. Biology (BE) & NIOZ (NL)

Walk 3: Ecosystem assessments (6 posters)

- Tyberhein Lennert: EMODnet gridded abundance products: a tool to facilitate ecosystem assessments. Flanders Marine Institute (VLIZ) (BE)
- Fettweis, Michael: Tools to support the monitoring of MSFD descriptors 6 'Sea-floor integrity' and 7 'Hydrographical conditions'. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
- Van Oyen, Tomas: Impact of anthropogenic measures on the Scheldt mouth morphodynamics. Flanders Hydraulics Research (BE)
- Van den Eynde, Dries: Effect of aggregate extraction on MSFD descriptor 7 (hydrographic condition) in the Hinder Banks area (Belgian Continental Shelf). Royal Belgian Institute for Natural Sciences (RBINS) (BE)
- Toussaint, Elise: Towards investigating the effect of fining and hardening of marine coastal areas on ecosystem functioning in the Belgian part of the North Sea (BPNS). Royal Belgian Institute of Natural Sciences (BE)
- Hitchin, Becky: Novel methods to assess the impacts of oil and gas decommissioning within Special Areas of Conservation. JNCC (UK)

Walk 4: Ecosystem health (7 posters)

- De Cauwer, Karien: Evaluation of the Belgian coastal waters in the frame of the EU Water Framework Directive. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
- Lagring, Ruth: The implementation of a data management plan to uplift historical data: long-term change detection in the Belgian Continental Shelf. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
- Bekaert, Karen: Determination of the best normalizing parameter for heavy metals in sediments of the Belgian Part of the North Sea (BPNS). Institute of Agricultural and Fisheries Research (ILVO) (BE)
- Madgett, Alethea: Bioaccumulation of Persistent Organic Pollutants and Trace Metals in North Sea Food Webs and their Relationship with Trophic Level and Fatty Acid Signatures. Marine Scotland Science and Robert Gordon University (UK)
- Van Colen, Carl: PLASTOX: Direct and indirect ecotoxicological impacts of microplastics on marine organisms. Ghent University, Dep. Biology (BE)
- De Tender, Caroline (presentation by co-author): The dynamic bacterial colonization on plastic: an exposure experiment at sea. Institute of Agricultural and Fisheries Research (ILVO) (BE)
- Jauniaux, Thierry: Causes of death of harbour porpoises (Phocoena phocoena) stranded on the Belgian coastline (1990-2015). University of Liege (BE)

Walk 5: Fisheries (7 posters)

- Moreau, Kelle (presenter Els Torreele): Survey-based stock assessments versus sustainability assessments: interpretation and communication problems. Institute of Agricultural and Fisheries Research (ILVO) (BE)
- Noack, Thomas (presentation Esther Savina): Danish seine – Ecosystem effects of fishing. Technical University of Denmark, National Institute of Aquatic Resources (DK)
- Tiano, Justin: Differential effects of electrical pulse and conventional beam trawl fisheries on sediment biogeochemistry. Royal Netherlands Institute for Sea Research (NIOZ) (NL)
- Rambo, Henrike: Disentangling spatial pressure-state relationships between marine biodiversity and fishing. Thünen-Institute of Sea Fisheries (DE)
- Rybicki, Sandra: Comparison of the diversity of groundfish assemblages at different spatial scales in the North Sea – Implications for future monitoring programmes. (DE)
- Vandendriessche, Sofie: "A wind of change" in recreational fisheries? Recreational fishermen and wind farms: current use and perception. Institute of Agricultural and Fisheries Research (ILVO) (BE)
- Beauchard Olivier : Life-history strategies of North Sea benthic macroinvertebrates: typology and indication of beam-trawl fishing impact. Netherlands Institute for Sea Research (NIOZ) (NL)

Walk 6: Innovative Modelling and Monitoring (8 posters)

- Van Lancker, Vera: MSFD-compliant investigative monitoring of the effects of intensive aggregate extraction on a far offshore sandbank, Belgian part of the North Sea. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
- Lopera, Olga: New methodology for modern monitoring. Ministry of Defence (BE)
- Missiaen, Tine: Development of an efficient survey methodology for the prospection of buried palaeolandscapes and archaeology in the southern North Sea. Ghent University, Dep. Geology (BE)
- Missiaen, Tine: Innovative acoustic technique for 3D prospection of intertidal areas. Ghent University, Dep. Geology (BE)
- Noble-James, Tammy (presenter Laura Robson): Combining Vessel Monitoring System (VMS) and benthic habitat data to investigate pressure-state relationships in offshore MPAs. Joint Nature Conservation Committee (JNCC) (UK)
- Baetens, Katrijn: Quantifying and visualizing the skill of biogeochemistry models in reproducing satellite chlorophyll patterns with binary metrics: a validation. Royal Belgian Institute of Natural Sciences (RBINS) (BE)
- Ivanov, Evgeny: Developing a hydrodynamical model of the Southern Bight of the North Sea for impact studies. University of Liege, Department of Astrophysics, Geophysics and Oceanography (BE)
- Ponsar, Stéphanie: Estimation of model error prior to long term simulations of climate change impact on storm surges and waves at the Belgian Continental Shelf. Royal Belgian Institute of Natural Sciences (RBINS) (BE)

Walk 7: Governance (5 posters)

- Bonne, Wendy: Joint Programming Initiative Healthy and Productive Seas and Oceans. JPI Oceans (BE)
- Grehan, Anthony: A Trans-Atlantic assessment and deep-water ecosystem-based spatial management plan for Europe 'ATLAS'. National University of Ireland – Galway (IRL)
- Kafas, Andronikos: Overview of offshore energy planning efforts in the North Sea – The NorthSEE project. Marine Scotland Science (UK)
- Reach, Ian: The use of marine aggregate sector environmental data to enable robust Marine Protected Area designation in the UK. MarineSpace Ltd (UK)
- Van Lancker, Vera: Building a 4D Voxel-Based Decision Support System for a Sustainable Management of Marine Geological Resources. Royal Belgian Institute of Natural Sciences (RBINS) (BE)

Others (5 posters)

- Beermann, Jan: Large-scale information systems - valuable tools for the assessment of the ecological quality status for MSFD purposes in the North Sea. Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (DE)
- Borges, Alberto: Methane dynamics in the Belgian coastal zone, a contribution to the BELSPO project "4 decades of Belgian marine monitoring" (4Demon). University of Liège (BE)
- Borges, Alberto: Ocean acidification in the Belgian coastal zone, a contribution to the BELSPO project "4 decades of Belgian marine monitoring" (4Demon). University of Liège (BE)
- Dekker, Evelien (presenter Valérie Dulière): How vertical swimming behavior affects a jellyfish journey? Utrecht University (NL)
- Winter, Christian: The project WIMO: Scientific Monitoring Concepts for the German Bight. Bremen University, MARUM Center for Marine Environmental Sciences (DE)

Posters in main conference hall (4 posters)

- Deprez, Tim: EMBRC.be – The Belgian node of the European Marine Biological Resource Centre. Ghent University, Dep. Biology (BE)
- Deprez, Tim: IMBRSea – The upcoming International Master in Marine Biological Resources. Ghent University, Dep. Biology (BE)
- Mascart, Thibaud: The Blue training online one-stop-shop platform: MarineTraining.eu. Ghent University, Dep. Biology (BE)
- Mascart, Thibaud: EMBRIC – The European Blue Bio-Economy cluster for aquaculture and biotechnology innovations . Ghent University, Dep. Biology (BE)

Oral Presentation

Theme 1:

Scientific backbone of the North Sea ecosystem: adequacy of the knowledge base?

Barbut Leo

Royal Belgian Institute of Natural Sciences

Author(s): Léo Barbut [1,2] , Clara Groot Crego[2], Sophie Delerue-Ricard[1,3], Andreas Vanden Bavière[3], Ilaria Coscia[2], Johan Robbens[3], Filip A.M. Volckaert[2], Geneviève Lacroix[1]

Affiliation(s) :

[1] Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment, Brussels, Belgium

[2] Laboratory of Biodiversity and Evolutionary Genomics, University of Leuven (KU Leuven), Leuven, Belgium

[3] Institute for Agricultural and Fisheries Research (ILVO), Oostende, Belgium

How larval dispersal of flatfish is impacted by life traits ?

Among fish, early life stages are critical in determining dispersal and recruitment. Effective fishery management requires the understanding of how spawning grounds and nurseries are connected and what processes influence larval retention, dispersal and population dynamics. Especially for species with a long pelagic larval phase and where the recruitment is strongly constraint by access to nurseries, like flatfish. The transport of flatfish larvae from the spawning grounds to the nurseries is driven by hydrodynamic processes, but the final dispersal pattern and larval survival is affected by environmental factors, physiology, behaviour and reproductive strategies (spawning period and spawning grounds). Here we use a particle-tracking transport model (Larvae&Co) coupled to a 3D hydrodynamic model to assess the connectivity pattern between spawning grounds and nurseries of four commercial flatfish species in the North Sea. We analyse comparatively the impact of different life traits on dispersal of sole (*Solea solea*), plaice (*Pleuronectes platessa*), turbot (*Scophthalmus maximus*) and flounder (*Platichthys flesus*).

Keywords: Flatfish dispersal, Connectivity, Fish Recruitment

Birchenough Silvana

Cefas

Author(s): Silvana Birchenough[1] and Stefan Bolam[1].

Affiliation(s) :

[1] The Centre for Environment, Fisheries and Aquaculture Science UK.

Structural and functional variability of benthic assemblages at three contrasting sites in the North Sea.

This study examines the seasonal drivers and consequences of structure and function (via key mediating processes, bioturbation and secondary production) of benthic infaunal and epifaunal communities at three differing ecohydrodynamic regions in the North Sea. These three sites are influenced by distinct environmental factor(s). Our analysis evidenced that the sediment chlorophyll a concentration is related to the community structure/function at a transitional site (the Oyster Ground) between seasonally stratified and well-mixed regions. In contrast, at a permanently well-mixed site (Sean Gas Field in the German Bight) changes in water-column temperature were the main influence to the benthic community structure. Lastly, at a seasonally stratified site (north of Dogger Bank) silt and clay % was the most important factor determining these communities.

Seasonal variability was also observed at all these sites and over the structure of these benthic systems. This work helps to understand the role of ecosystem mechanisms thereby studying benthic faunal structure and seabed processes, through biomass production (e.g. secondary production) and physical structuring of sediments (e.g. bioturbation processes). In addition, these results help our understanding of the contribution of benthic systems to carbon cycling and nutrient fluxes. This work highlights the importance of considering epi and infauna communities, whilst studying of seabed systems and the value of a combined structural and functional properties for the study of seabed systems. Particularly, on how the fauna are responding to environmental variations across three distinctive areas. This new ecological knowledge on how these systems function strengthen the traditional structural benthic assessments.

Keywords: macrobenthos, production, bioturbation, epifauna and infauna, seabed integrity and MSFD.

Daewel Ute

Helmholtz Centre Geesthacht, Institute of Coastal Research

Author(s): Ute Daewel, Corinna Schrum

Affiliation(s) : Helmholtz Centre Geesthacht, Institute of Coastal Research

On the relevance of higher trophic levels for modelling long term ecosystem dynamics in the North Sea

The majorities of marine ecosystem models target only parts of the trophic food chain separately. This implicates difficulties of these models to consistently simulate the major controls of marine ecosystems and to distinguish between 'bottom-up', 'top-down' or 'wasp-waist' controlled systems. This poses major constraints to the modelling approach at both ends of the simulated trophic food chain. Here we propose a consistent NPZD-Fish modelling approach (ECOSMO E2E) to address the above-mentioned problem in lower trophic ecosystem modelling, and to understand how the implementation of higher trophic levels in a NPZD model affects the simulated response of the North Sea ecosystem to changes in climate and river nutrient loads.

On the basis of the 3d coupled ecosystem model ECOSMO, both fish and macrobenthos were included in the model formulation as functional groups that are linked to the lower trophic levels via predator-prey relationships. The model allows investigating bottom-up impacts on primary and secondary production and cumulative fish biomass dynamics, but also top-down mechanisms on the lower trophic level production. The model is integrated over a 61 year long (1948-2008) hindcast period in the North Sea ecosystem and the variability in nutrient dynamics and primary production are analysed with respect to changes in the atmospheric and river nutrient forcing. To address the relevance of the newly implemented trophic levels for the simulated model response, we compare the results from ECOSMO E2E with the results from the basic NPZD model version of ECOSMO integrated over the same time period.

Keywords: Ecosystem modelling, ECOSMO E2E, NPZD-FISH model

Dannheim Jennifer

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

Author(s): Jennifer Dannheim, Lars Gutow, Jan Holstein, Dario Fiorentino, Thomas Brey

Affiliation(s) : Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

Large-scale / high-resolution information systems – a new backbone for conservation and monitoring in the North Sea

Large-scale/high-resolution integrated marine ecological information systems combine diverse ecological and environmental data with high resolution in space, time and ecological structure (biodiversity, trophic relationships etc.). This holistic approach opens new ways for analysing and modeling ecological patterns and processes and creates a platform for the development and the application of advanced management and conservation tools.

Within the North Sea benthic system, species occurrence patterns and benthic processes are shaped and changed by natural and anthropogenic drivers. Knowledge on species or group specific "natural corridors of variation" in space and time are important to discriminate anthropogenic effects from natural background variability, particularly as the benthos contributes to numerous ecosystem goods and services (biodiversity, food resources etc.). Rare and endangered species play a crucial role in maintaining biodiversity of benthic systems.

In 2013, the "red list", the status of endangered species in German waters, was revised and published. Regrettably, the red list classification of marine benthic species often lacks a scientifically sound foundation, due to insufficient occurrence data. We use an extensive information system on benthic invertebrates in the German North Sea (>9000 stations x >740 species) for analysis of occurrence and spatial distribution of benthic species. We evaluate (a) how rare "red listed" species really are, (b) their spatial distribution, and (c) their functional role in the system by their biological traits. Our 'red list' case study shows that large-scale/high-resolution information systems constitute a sound scientific base for improved monitoring assessments and ultimately for a sustainable ecosystem management.

Keywords: information system, spatial distribution, functional traits, benthos, endangered species

De Backer Annelies

Institute for Agricultural and Fisheries Research (ILVO)

Author(s): Annelies De Backer, Gert Van Hoey, Kris Hostens

Affiliation(s) : Institute for Agricultural and Fisheries Research (ILVO), Aquatic Environment and Quality, Bio-environmental research group, Oostende, Belgium

Long-term ecosystem changes in the Belgian North Sea revealed by 30 years environmental monitoring of soft sediment fauna

More than 30 years environmental monitoring revealed shifts in the coastal macrobenthos community and the offshore demersal fish assemblage of the Belgian North Sea (BNS) in the beginning of the years 2000. The shift in the offshore demersal fish assemblage could be related to climate parameters, while the coastal macrobenthic shift was mainly related to physical habitat changes.

Since 1984, several locations in the BNS have been yearly sampled in autumn, considering three ecosystem components: macrobenthos, epibenthos and demersal fish. As the samples are not directly impacted by human activities (except fisheries), the time series allowed us to study the 'natural' variability over time. For all ecosystem components, a clear differentiation between a coastal and offshore assemblage was seen, so we investigated whether both changed differently over time, and whether the three ecosystem components showed similar trends. We linked the observed biological changes to a number of environmental variables, reflecting both climate and physical changes. Besides long-term trends at the assemblage level, some trends were apparent at species level as well. Some Lusitanian fish species, like lesser weever Echiichtys vipera, solenette Buglossidium luteum, scaldfish Arnoglossum laterna and sand sole Pegusia lascaris, increased in numbers since the late 90s. On the other hand pouting Trisopterus luscus showed a steep decline over time, which seems to be correlated to the NAO index. The density of the bivalves Abra alba and Kurtiella bidentata and the ophiuroid Ophiura ophiura increased significantly since 2004 in the coastal area, related to an increase of finer sediments. Another bivalve Spisula subtruncata was the only benthic species showing a strong decreasing trend over time.

Keywords: time series, ecosystem changes, macrobenthos, epibenthos, demersal fish, Belgian part of the North Sea

De Mesel Ilse

Royal Belgian Institute of Natural Sciences

Author(s): Ilse De Mesel[1], Steven Degraer[1], Isa Schön[2]

Affiliation(s) : [1]Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management, Oostende and Brussels, Belgium; [2] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Freshwater Biology, Brussels, Belgium

Population genetics and phylogeography of Patella (Mollusca, Gastrapoda) to assess the role of wind turbines as stepping stones for non-indigenous species in the Southern North Sea

With the introduction of offshore wind farms in the shallow waters (<50m) of the Southern North Sea, a new habitat for benthos has been created. Vertical hard structures extend from the sandy seabed to the sea surface. Species otherwise being restricted to coastal habitats could now invade offshore areas. Monitoring in Belgian waters confirmed the hypothesis that the introduced hard substrata of offshore wind farms play an important role in the establishment and the expansion of populations of both indigenous and non-indigenous species (NIS). We will present first data of an ongoing study on the population genetics of the NIS Patella vulgata, typically found in the intertidal zone and now also occurring on Belgian windfarms. We are screening mitochondrial (COI) and nuclear (microsatellites) markers to assess genetic connectivity between Patella populations along the European coast and identify the origin of the novel populations on the wind farms. These results will, in combination with dispersal modelling (see presentation of Lacroix et al.), elucidate the dispersal pattern and connectivity of Patella along the North Sea, and the role of wind farms as stepping stones for indigenous and non-indigenous species.

Keywords: COI, microsatellites, connectivity, NIS

De Witte Bavo

Institute of Agricultural and Fisheries Research (ILVO)

Author(s): B. De Witte[1], A. Ruttens[2], B. Ampe[1], N. Waegeneers[2] , J. Gauquie[1] , L. Devriese[1], K.Cooreman[1], K. Parmentier[3]

Affiliation(s) : [1]Institute of Agricultural and Fisheries Research, Animal Sciences Unit - Aquatic Environment and Quality, Ostend, Belgium; 2Veterinary and Agrochemical Research Center (CODA CERVA), Trace Element Service, Tervuren, Belgium; 3Royal Belgian Institute of Natural Sciences, OD Nature, Ecochem, Oostende, Belgium

Zn and Cu increases at the Belgian continental shelf: linked to antifouling?

The Belgian Continental Shelf contains 5 dredged spoil disposal sites which are monitored 2 times a year. Results on chemical analyses data from 2005 to 2014 were evaluated, applying a linear mixed-effect model in R. Within the model, the effect of time, season and sludge disposal site, relative to associated reference sites, is studied. PCB concentrations are not decreasing whereas Hg concentrations are increasing at dredged spoil disposal site S2. An increase of Zn concentrations was noticed at dredged spoil disposal sites Oostende and Nieuwpoort, whereas Cu concentrations increased at disposal site Nieuwpoort. Remarkably, these are the least intensively used disposal sites and the dredged spoil at these sites originates from the least industrialised areas. Results suggest that Cu and Zn concentration increase may be related to the use of Cu- and Zn based antifouling agents, which use increased after the TBT-ban. Source investigation revealed different Cu and Zn point sources at harbour Oostende. At Nieuwpoort harbour, no point sources were identified, probably related to adequate measures at boat- and shipyards during blasting or painting of boat hulls.

Keywords: antifouling, chemical pollution, heavy metals

Derweduwen Jozefien (Kris Hostens)

Institute for Agricultural, Fisheries and Food Research (ILVO)

Author(s): Jozefien Derweduwen, Jan Ranson & Kris Hostens

Affiliation(s) : Institute for Agricultural and Fisheries Research (ILVO), Aquatic Environment and Quality, Bio-environmental research group, Oostende, Belgium

Is the feeding behaviour of soft substrate demersal fish influenced by the presence of wind farms?

Wind farm constructions introduce hard substrates into the sandy environment of the Belgian North Sea. These are rapidly colonized by epifauna which may provide 'new' food for the already present demersal fish. The diet of two abundant species (dab Limanda limanda and lesser weever Echiichthys vipera) was investigated to detect any changes in feeding behaviour after the construction of the C-Power wind farm. The fullness index and prey diversity of lesser weever were not affected by the presence of the wind farm. However, the diet composition did change: lesser weever consumed less mysids Gastrosaccus spinifer and less crabs Brachyura, but significantly more of the amphipod Jassa herdmani - a typical hardsub species - both in the control and for sure in the impact area. Also for dab, the fullness index did not significantly change: the values were slightly higher within the wind farm, both before and after construction, and were in general lower after construction in both impact and control zones. On the other hand, prey diversity and composition of the dab diet were clearly influenced by the presence of the wind farm. After construction, the number of prey species was higher in the impact area, with the amphipods Nototropis swammerdamei and J. herdmani and the polychaete Lanice conchilega mainly contributing to this difference. In conclusion, the observed differences in feeding behaviour of both demersal fish species within and in the direct vicinity of the wind concession zone are clearly related to the presence of the wind farm constructions. Consequently, it can be stated that the so-called reef effects, related to the 'newly' available epifauna, do expand into the surrounding soft sediments.

Keywords: wind farm, feeding behaviour, demersal fish, Belgian Part of the North Sea

Desmit Xavier

Royal Belgian Institute of Natural Sciences

Author(s): Desmit X.[1], Thieu V.[2], Dulière V.[1], Campuzano F.[3], Silvestre M.[2], Garnier J.[2], Sobrinho J.[3], Pinto L.[3], Gypens N.[4], Lancelot C.[4], Neves R.[3], Ménesguen A.[5], Billen G.[2] & Lacroix G.[1]

Affiliation(s) :

[1] Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environments, Brussels, Belgium

[2] UMR METIS, Université Pierre et Marie Curie (UPMC)/CNRS, Paris, France

[3] Instituto do Mar (IMAR), Lisbon, Portugal

[4] Université Libre de Bruxelles (ULB), Ecologie des systèmes aquatiques (ESA), Brussels, Belgium

[5] IFREMER, Dynamiques de l'Environnement Côtier (DYNECO), Plouzané, France

Past, present and future eutrophication levels in the North East Atlantic

Anthropogenic eutrophication remains a considerable stressor to marine ecosystems worldwide. In the North East Atlantic waters (NEA), most countries sustain coastal eutrophication with toxic algal blooms and ecological nuisances. Marine eutrophication in the NEA directly relies on nutrient enrichment at the river outlets, which is linked to human activities and land use in the watersheds. The question rises of whether the human society can reduce its nutrient emissions by changing its land use without compromising its food security. A new generic river model (PyNuts-Riverstrahler) was designed to estimate the point and diffuse nutrient emissions (N,P) to the rivers depending on land use in the watersheds across Western Europe (agro-food systems, urban structures, wastewater treatment plants). The resulting loads from the river model have been used as inputs to three marine ecological models (BioPComs, EcoMars3d, Miro&Co) covering together a large part of the NEA from the Iberian shelf to the Southern North Sea. The modelling of the land-ocean continuum allowed quantifying the impact of changes in land use on marine eutrophication in the NEA. A "pristine-like" scenario was tested to scale the current level of eutrophication with respect to an absolute "natural" level. "Future" scenarios were also tested to appraise the impact of the actual EU recommendations (WFD, MSFD), and to propose a more radical but still realistic scenario. It is shown that a paradigmatic change in agricultural practices combined with a large-scale demitarian diet might sensibly reduce both riverine and marine eutrophication.

Keywords: Eutrophication, model scenarios, land-ocean continuum, North East Atlantic

Dulière Valérie

Royal Belgian Institute of Natural Sciences

Author(s): V. Dulière[1] , N. Gypens[2], Ch. Lancelot[2], P. Luyten[1] , G. Lacroix[1]

Affiliation(s) :

[1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium; [2] Université Libre de Bruxelles, Ecology of Aquatic Systems, Belgium

What is the origin of nitrogen in the North Sea

Over the last decades, changes in the marine nutrients concentrations resulted from growing anthropogenic pressure. This led to cultural eutrophication which remains an ecological nuisance and a serious societal challenge for many coastal environments. Appropriate nutrient reduction strategies should therefore operate in a way that they efficiently minimize the adverse effects of eutrophication. Therefore, it is crucial to identify the human activities responsible for the eutrophication problems. This challenge for coastal waters is complex as (1) many nutrient sources and pathways exist, (2) nutrients can cause eutrophication nuisances far from their source of origin, and (3) nutrients undergo several biogeochemical processes and transformations during their journey along the river-ocean continuum. In this study, a 3D marine ecological model (MIRO&CO-v2) was used to simulate the response of the coastal ecosystem. This model results from the coupling of a 3D hydrodynamic model (COHERENS v2; Luyten 2011) with a biogeochemical model (MIRO; Lancelot et al. 2005) which has been designed for Phaeocystis-dominated ecosystems such as the southern North Sea. The nutrient tracking approach of Ménesguen et al. (2006) has been adapted and implemented in the MIRO&CO-v2 to track the nitrogen fate in the different components of the ecosystem, and trace it back to its sources. This method allows estimating the nitrogen contributions from oceanic and continental sources (riverine and atmospheric). The focus will be given over the southern North Sea for 2000-2010. Origin of nitrogen content in Phaeocystis will be assessed. Zones of river influence will be estimated and the importance of nitrogen atmospheric depositions compared to oceanic and riverine nitrogen loads will be discussed.

Keywords: tagging, nitrogen, eutrophication, model, marine ecosystem, southern North Sea

Frid Chris

School of Environment, Griffith University

Author(s): Chris Frid, David Clare, Bryony Caswell, Matt Spencer and Leonie Robinson

Affiliation(s) : School of Environment, Griffith University

Opening the window on seafloor change: How understanding changes as time series extend

The sea floor underpins, or is a major contributor, to many economically and socially important ecosystem services. However, the remoteness, the large areas involved, the cost of studying them and the logistical challenges, all constrain our understanding of how these systems function and the links between natural and anthropogenic drivers, the state of the sea floor ecosystem and the provision of the ecosystem services. Drawing on two benthic time series extending back to 1972, we consider how our understanding of the dynamics of the sea floor in the central western North Sea has evolved as the length the time series has expanded. As the data window has opened out, so simple ecological explanations have given way to recognition of complex dynamics with decadal quasi steady states interspersed with periods of rapid change and with ecosystem functioning decoupled from taxonomic turnover. The implications for civilisation as we know it can be discussed.

Keywords: Benthos, Dove Time Series, taxonomic change, functional change

Hademenos Vasileios

Ghent University, Dep. Geology

Author(s): Vasileios Hademenos[1], Lars Kint[2], Tine Missiaen[1], Jan Stafleu[3] & Vera Van Lancker[1,2]
[1]Affiliation(s) : Ghent University, Dep. Geology. Renard Centre of Marine Geology, Belgium
[2] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium
[3] Geological Survey of the Netherlands, TNO, The Netherlands

Need of a 3D geological framework underpinning marine exploitation strategies

Within the framework of the BELSPO Brain-be project TILES (Transnational and Integrated Long-term Marine Exploitation Strategies) 3D geological voxel models of the subsurface (up to -30m) of the southern part of the North Sea are being developed. Voxels are 3D pixels or cuboids, which are here filled primarily with geological data from boreholes and seismic lines. Each voxel in the model describes a unique value of one of 7 lithological classes ranging from clay to gravel, or the occurrence probability of it. As such, detailed information on the availability of different sediment types is provided, including their volumes, e.g., in blocks of 200*200*1m, or even 100*100*0.5m for local case studies. Additionally, uncertainties in the data sources are classified, and major data and knowledge gaps identified. Such a geological framework is the fundament of a more sustainable use of marine resources. Examples relate to determining the depths of major substrate-bound habitat changes, as well as optimal selection of areas where sufficient material can be found for a specific purpose (e.g., for beach nourishment or industrial use).

Keywords: Resource estimation, 3D Voxel model, North Sea, sand extraction

Lacroix Genevieve (Steven Degraer)

Royal Belgian Institute of Natural Sciences

Author(s): Lacroix Geneviève, Kerckhof Francis, Schön Isa, Degraer Steven, De Mesel Ilse

Affiliation(s) : Royal Belgian Institute of Natural Sciences (RBINS), OD Nature

Impact of man-made structures on hard substrate species connectivity patterns in the North Sea

Pelagic life stages are critical in determining invertebrate and fish dispersal and connectivity in the marine environment. Man-made structures such as wind farms start proliferating in the North Sea. They could act as stepping stones and allow species to expand their distribution range over large distances. Effective marine management requires the understanding of how (artificial) hard structures are ecologically connected and what processes influence larval retention and dispersal. The transport of marine organisms from the spawning grounds to settlement areas is driven by hydrodynamic processes. However, the final dispersal pattern, larval survival and successful settlement of the larvae are affected by environmental factors, physiology, behaviour and reproductive strategies (spawning period/areas). Biophysical models help assessing the dispersal potential of marine species during their pelagic phase. Here, we use a particle-tracking transport model coupled to a 3D hydrodynamic model (Larvae&Co), to assess the larval dispersal of Patella vulgata in the North Sea and to quantify the increase of connectivity of disconnected populations as a consequence of man-made structures. Our results will contribute to a better understanding of the impact of man-made structures on larval dispersal and connectivity in the North Sea.

Keywords: Particle tracking model, hard structures, connectivity, Patella, North Sea

Larsen Martin M.

Århus University, department of Bioscience

Author(s): Martin M. Larsen[1], Alessandra Giorgetti[2], Jesper H. Andersen[3]

Affiliation(s) : [1]Aarhus University, department of Bioscience, Glostrup; [2]Istituto Nazionale di Oceanografia e di Geofisica Sperimentale-OGS, Sezione di Oceanografia-OCE, National Oceanographic Data Center/IOC-NODC, Trieste (ITALY); [3]NIVA Denmark Water Research, Winghouse, Copenhagen

The EMODnet platform: Data and presentation of Nutrients and hazardous substances cases

Following the EU Marine Knowledge 2020 agenda and the related roadmap, the European Marine Observation and Data Network (EMODnet) initiative was launched by DG MARE through a stepwise approach, to provide access to marine data and derived data products from seven thematic groups: bathymetry, geology, physical habitats, chemistry, biology, physics and human activity.

The EMODnet chemistry project consists of 32 partners and 14 sub-contractors, representing 46 institutes of 29 European coastal countries. The project have collected a meta-database with inputs from the almost all major European monitoring institutions, with the possibility to do a one stop shopping of data from the individual institutes by a simple portal. The data have been quality assured and products on Nutrients, other eutrophication parameters and hazardous substances have been produced.

The North Sea is one of 5 regional seas in the EMODnet project, and data products on nutrient development in the North Sea over the last 40 years will be presented, highlighting the availability of historic and present time data and problems discovered with the datasets from contributors. Although nutrients are a considerable threat, also hazardous substances can have impact on the North Sea Ecosystem. The availability of data on Hazardous substances will be discussed, and an aggregation mechanism for hazardous substances (CHASE) will be presented. Finally the portal will be shortly demonstrated for access to national data and data from other regional seas.

Keywords: EMODnet, data availability, nutrients, Hazardous substances, CHASE

Lemmen Carsten

Helmholtz-Zentrum Geesthacht

Authors: Kaela Slavik, Carsten Lemmen, Wenyan Zhang, Onur Kerimoglu and Kai Wirtz

Affiliation: Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung, Institute of Coastal Research, Germany

The large scale impact of offshore windfarm structures on pelagic primary production in the southern North Sea

As society struggles to find solutions to mitigate climate change, the demand for renewable energy technology has increased. In particular, investment in offshore wind energy has proliferated, with projections estimating a 40 fold increase in total offshore wind electricity in the European Union over the next 15 years. Built with the goal of reducing the environmental impacts associated with traditional energy production, the ecological impacts of offshore windfarm structures at larger spatial scales is not yet well understood, with most studies focusing on individual windfarms and turbines. The consequences are of particular importance in the southern North Sea, where the offshore windfarm expansion is focused. Our study investigates how the accumulation of epifaunal biomass on submerged substrate, or biofouling, at offshore windfarms impacts pelagic primary production in the southern North Sea at larger spatial scales. Biofouling, a process governed predominantely by the filter feeder *Mytilus edulis*, alters the surrounding benthic and pelagic environment. We reconstruct the distribution of *Mytilus edulis* in the southern North Sea and generate scenarios of increased potential distribution based on the current understanding of turbine locations and *Mytilus edulis* settlement patterns at offshore wind turbines. These maps are coupled through the Modular System for Shelves and Coasts (MOSSCO, http://www.mossco.de) to state-of-the-art and high resolution hydrodynamic and ecosystem models to reveal the impact of offshore windfarm structures in the southern North Sea on ecosystem functioning at a larger spatial scale. First results indicate that there is a small but non-negligible local impact, which becomes more pronounced during the bloom, and limited effects at larger spatial scales.

Keywords: Mytilus edulis, MOSSCO, ecosystem modelling, primary production, offshore windfarms, phytoplankton

Mascioli Francesco

NLWKN - Coastal Research Station, Norderney

Author(s): Francesco Mascioli, Andreas Wurpts

Affiliation(s) : Coastal Research Station, Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN), Norderney, Germany

Subtidal Mapping Program of the Lower Saxony Coastal and Marine Waters (Germany)

The NLWKN-Coastal Research Station of Norderney carries out a long-term project to map the Lower Saxony subtidal waters of Wadden Sea and North Sea, as required by the FFH and MSFD European Directives. Within the project, most efforts are addressed to apply objective mapping methods reducing influences of human subjectivity into the final results. This is a necessary requirement to produce repeatable results, analyse the seabed spatio-temporal variation within continuous monitoring efforts and ensure comparability with results of national and international projects. The scientific Approach carried out by Coastal Research Station is based on the characterization of surficial sediments, bedforms and substrate structures. Recent technological advancements of swath bathymetric systems and subbottom profilers drastically improve the effectiveness of this approach in shallow waters and led to new technological standards for the seabed mapping. Preliminary results show that morphological information can be extracted from DEMs by mean of geomorphometric approach. The morphometrical parameters assume a geological and geomorphological meaning by the quantitative comparison with backscatter intensity, samples and subbottom profiles. A basic requirement for this approach is the ability of swath bathymetrical systems to simultaneously provide bathymetry and backscatter with high spatial precision. This allows to compute absolute backscatter and quantitatively compare morphology and seabed composition. Even though the fast advances of underwater technologies and scientific approaches, a standard procedure for backscatter survey and processing, as well as standard habitat classification schemes, are of primary importance to improve the approach objectivity.

Keywords: Seabed mapping, geomorphometry, backscatter, Lower Saxony

Pesch Roland

BIOCONSULT Schuchardt&Scholle GbR

Authors: Roland Pesch[1], Bastian Schuchardt[1], Carmen-Pia Günther[1], Tim Bildstein[1]

Affiliation: [1] BIOCONSULT Schuchardt & Scholle GbR,, Germany

Spatial Modelling of biotopes and species for marine nature conservation and marine spatial planning in the German Exclusive Economic Zone of the North Sea

The talk at hand focusses on the application of data driven methods to model the spatial distribution of benthic biotopes and species in the German Exclusive Economic Zone (EEZ) of the North Sea. According maps may serve as a spatial reference system for requirements and actions arising from different provisions of the European Union and national laws. They may furthermore be used to account for spatial claims of threatened and representative biotopes and species for marine spatial planning issues. In Germany corresponding maps are currently produced on different spatial scales in a project funded by the Federal Agency for Nature Conservation. As one important result of the a first phase of the project between 2011 and 2014 six soft bottom biotope types could be derived and mapped for the entire EEZ including parts of the coastal zones on a broad spatial scale. Benthic communities were at first calculated by use of fuzzy clustering algorithms applied on site specific benthic sampling data. Next, the site specific community data were intersected with full coverage geodata on e.g. topography and sediments. Statistical associations were quantified in terms of Random Forest models and then applied on the full coverage information to map benthic soft bottom biotopes. The same procedure was applied on presence / absence data on representative and threatened benthic infauna species. The biotopes calculated reflect scientific knowledge on the occurrence of benthic communities in the North Sea and were therefore accounted for in the currently developed German Red List of Endangered Marine Biotope in the North Sea. Biotopes and species maps may furthermore be used as an input to account for spatial claims of benthic environments in marine spatial planning operations.

Keywords: Predictive modelling, marine spatial planning, nature conservation, biotope mapping

Propp Claudia

Federal Maritime and Hydrographic Agency of Germany (BSH)

Author(s): Claudia Propp[1], Alexander Bartholomä[2], Christian Hass[3], Peter Holler[2], Svenja Papenmeier[3], Peter Richter[4], Klaus Schwarzer[4], Franz Tauber[5], Manfred Zeiler[1]

Affiliation(s) :

[1] Federal Maritime and Hydrographic Agency (BSH); [2] Marine Research Department, Senckenberg am Meer (SaM); [3] Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Wadden Sea Station Sylt (AWI); [4] Kiel University, Institute of Geosciences, Sedimentology, Coastal and Continental Shelf Research (CAU-IfG); [5] Leibniz Institute for Baltic Sea Research Warnemünde (IOW)

Standardized seafloor mapping in the German Exclusive Economic Zone (EEZ)

When implementing EU Directives, detailed information of seabed sediment types is a prerequisite for the identification, monitoring and protection of marine benthic biotopes. BSH in Germany started a new sediment mapping program in cooperation with the Federal Agency for Nature Conservation based on side scan sonar and ground truthing using grab sampler and underwater video. To establish a standardized mapping procedure, BSH and its project partners AWI, CAU, IOW and SaM have developed a technical guideline on the requirements for the collection, processing and interpretation of backscatter data. For the latter, standardized strategies for the classification and discrimination were defined for different seafloor sediment types.

Different levels of classification were introduced primarily based on the FOLK scheme. For the German North Sea, sand is classified according to a national scheme to meet the requirements for biotope modelling on the sandy shelf of the German North Sea. All these data are combined in one sediment map, together with additional information about the genesis of sediment types as well as the type of transition between them. The technical guideline comprises a national catalogue of characteristic backscatter images of sediment types occurring in German waters.

The guideline has been discussed with experts from state agencies for nature conservation and environmental protection or commented by consultancies in civil and environmental engineering. It is tailored to support German governmental marine mapping tasks, but will soon be extended for mapping specifications applied in coastal zones. An alignment with similar efforts of the EU countries is planned promoting the production of standardized maps that can easily be connected across European borders.

Keywords: sediment map

Quante Markus

Helmholtz-Zentrum Geesthacht, Institute of Coastal Research

Author(s): Markus Quante, Franciscus Colijn, Ingeborg Nöhren and the NOSCCA author team

Affiliation(s) : Helmholtz-Zentrum Geesthacht, Institute of Coastal Research, Geesthacht, Germany

The international North Sea Region Climate Change Assessment (NOSCCA) – an analysis of the scientific legitimate knowledge for science and decision making.

The entire North Sea region is currently being affected by a changing climate and will be affected according to all available projections in the upcoming decades. For example since about 1980 the sea surface temperature in the Southern North Sea rose by more than 1.5°C and over the last 100 years a sea level rise of approximately 20 cm has been observed. Related changes in the marine and coastal ecosystems have already been observed or are to be expected. Science and decision making i.e. focusing on adaptation measures for this ecologically important and economically very active region needs a sound and spatially well resolved analysis of observed and projected changes.

The Institute of Coastal Research of the Helmholtz-Zentrum Geesthacht has initiated a comprehensive climate change assessment for the Greater North Sea region and adjacent land areas. NOSCCA has developed into an independent international initiative involving scientists from all countries in the region. Writing teams guided by lead authors compiled the chapters of the NOSCCA-report, which were subject of an independent scientific review. The assessments comprises past and current climate change and climate change projections for the North Sea, the atmosphere and river flows as well as impacts of climate change on marine, coastal, and terrestrial ecosystems, and on socio-economic sectors, as fisheries, agriculture, urban climate, recreation, coastal defense, offshore activities, air quality and coastal zone management. The NOSCCA report was published by Springer in summer 2016.

Here we will introduce the initiative and present selected findings on climate change signals in physical and chemical parameters characterising the North Sea and related impacts i.e. on the marine and coastal ecosystem.

Keywords: regional climate change, North Sea climate change assessment

Robson Laura and Johnson Gareth

Joint Nature Conservation Committee (JNCC), MarineSpace Ltd

Author(s): Johnson, G.E.L.[1], Caneco, B.[2], Latto, P.[1], Warner, I.[1], Kaiser, M.J.[3], Donovan, C.[2], Carter, A.J.[4] and Robson, L.M.[4]

Affiliation(s):

[1] MarineSpace Ltd, U.K. ; [2] DMP Statistical Solutions Ltd, U.K.; [3] Bangor University, U.K. ; [4]Joint Nature Conservation Committee (JNCC), U.K.

Managing fisheries in MPAs: how do we account for natural disturbance in mobile sediments?

One of the most common evidence gaps when establishing management measures for demersal fisheries within mobile sediment MPAs has been in understanding the potential physical effects of towed gear on benthic assemblages. The difficulty is largely because mobile sediment ecosystems are intrinsically dynamic and have high background levels of natural spatial and temporal variability. This study aimed to identify metrics that could detect effects of natural disturbance and fishing on infaunal assemblages in mobile sediments. These were tested on case study MPAs, including Dogger Bank SCI and the Wash and North Norfolk Coast (WNNC) SAC in the southern North Sea. Species richness, taxonomic distinctness, M-AMBI and biological traits of infauna were modelled against environmental variables such as sediment composition, current and wave energy, shear stress, and fishing activity. For Dogger Bank SCI, all the metrics demonstrated relationships with biogeographic region, shear stress, and models of natural disturbance. There was a small negative relationship between some biological traits and distance from fishing activity, but its contribution to model fit was relatively small. For the WNNC SAC, species richness, M-AMBI, and a selection of biological traits demonstrated a significant relationship with fishing activity, although inter annual variability made up the largest contribution to model fit. Analysis of a 24-year site monitoring dataset showed that episodic disturbance through storm surges and cold winters caused much larger variance between years compared to any within year. The results of the work will support development of proportionate management measures for fishing activities within mobile sediment MPAs, with recommendations for future work proposed in the study.

Keywords: Demersal fishing, Pressures, Impacts, Natural disturbance, Human activity

Ruddick Kevin

Royal Belgian Institute of Natural Sciences

Author(s): Kevin Ruddick and Quinten Vanhellemont

Affiliation(s) : Royal Belgian Institute of Natural Sciences/ODNature

30 years of changes in Belgian waters as observed (or not) by high resolution satellites

The opening up of free data archives from both new satellite missions (e.g. Landsat-8, Sentinel-2A) and historical missions (e.g. Landsat-5) provides a valuable opportunity to assess changes in suspended sediments and Phaeocystis blooms over the last 30 years. This period includes significant human activities such as the construction of the port of Zeebrugge and of offshore windmills and the introduction of nutrient reduction policies to reduce eutrophication.

In this presentation the complete archive of Landsat imagery of Belgian waters will be processed and analysed along with the latest imagery from the new Sentinel-2A mission. Careful attention is paid to defining algorithms that may be applied to all missions and to understanding the impact of any differences in the satellite missions (spatial resolution, temporal coverage, spectral bands, signal:noise, calibration uncertainties, etc.) on the merged time series and the possibility of detecting change.

The imagery will be used to explain processes of and, where possible, detect changes in sediment transport and blooms of Phaeocystis globosa.

Keywords: Satellite data, sediment transport, Phaeocystis

Van Colen Carl

Ghent University - Research Group of Marine Biology

Author(s): Carl Van Colen[1], Ulrike Braeckman[1], Katja Guilini[1], Dirk Van Gansbeke[1], Karline Soetaert[2], Magda Vincx[1], Jan Vanaverbeke[3]

Affiliation(s) :

[1] Marine Biology Research Group, Ghent University, Gent, Belgium; [2] Royal Netherlands Institute for Sea Research. Estuarine and Delta Systems, Yerseke, the Netherlands; [3] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment (OD Nature), Marine Ecology and Management, Brussels, Belgium

Context-dependent effects of ocean acidification on soft-sediment biodiversity and ecosystem functioning

Anthropogenic carbon dioxide emissions are rapidly changing seawater pH and carbonate chemistry. In this presentation we demonstrate that research needs to incorporate spatio-temporal environmental contexts, e.g. the seasonal dynamics in resource availability, to effectively support management decisions for the conservation of marine ecosystems in a high CO2 world. In a first study we reared larvae of the clam Macoma balthica throughout their entire 3-week pelagic stage under ambient (pH 8.1) and acidified (pH 7.8) conditions, and temporal differences in food abundance that may result from differential responses of phytoplankton and clam larvae to changing oceanic conditions. Starvation of larvae during the first week enhanced the reduction in larval growth found under acidified conditions, and also enhanced the percentage of pediveliger larvae with developed shell abnormalities. In a second study we demonstrate that ocean acidification, as mimicked in the laboratory by a realistic pH decrease of 0.3, significantly reduced sediment community oxygen consumption on average by 60% and benthic nitrification rates on average by 94% in both coastal permeable and fine sandy sediments in February (pre-bloom period), but not in April (bloom period). Changes in biogeochemical cycling most likely resulted from changes in the activity of the microbial community during the two-week incubations. As benthic nitrification makes up the gross of ocean nitrification, a slowdown of this nitrogen cycling pathway in both permeable and fine sediments in winter, could therefore have global impacts on coupled nitrification-denitrification and hence eventually on pelagic nutrient availability.

Keywords: Ocean acidification, benthic biogeochemical cycling, shellfish, phytoplankton

van de Wolfshaar Karen

Wageningen Marine Research

Author(s): K.E. van de Wolfshaar, R. van Hal, D. Benden, T. van Kooten

Affiliation(s) : Wageningen Marine Research

Spatial explicit multi-species model: effects of area closures on fish biomass and catch

Spatial aspects of fisheries management gain in importance as regional seas are bursting with human activity and the societal pressure for nature conservation. As part of the EU-project Aquacross, we use a spatially explicit multi-species food web model of the North Sea to explore the consequences of area closures (Natura 2000 and MSFD) for trawl fisheries on their catches. Total biomass increases for some target species while biomass of pelagic prey species decrease, showing that the changes are driven not only by the direct effects of reduced fishing mortality, but also by higher order ecological interactions. Further analysis shows that local closures can also affect length-frequency distribution and diet of fish stocks. We explore the food web effects of scenarios contrasting spatial (area closure) and non-spatial (effort reduction) fishery management measures, and a mixture of the two (area closure and effort reduction).

Keywords: MPA, size, model, North Sea

Vanaverbeke Jan

Royal Belgian Institute of Natural Sciences

Author(s): Maryam Yazdani Foshtomi[1], Ulrike Braeckman[1], Sofie Derycke[1,2], Frederik Leliaert[1,3], Anne Willems[4], Magda Vincx[1], Jan Vanaverbeke[1,5]

Affiliation(s) :

[1] Ghent University, Biology Department, Marine Biology Research Group, Belgium; [2] Royal Belgian Institute for Natural Sciences, Operational Directorate Taxonomy and Phylogeny, Belgium; [3] Botanic Garden, Belgium; [4] Ghent University, Department of Biochemistry and Microbiology, Laboratory of Microbiology, Belgium; [5] Royal Belgian Institute for Natural Sciences, Operational Directorate Natural Environment, Belgium

The interaction between macro and micro-organisms affects biogeochemical cycles in coastal sediments

Interactions between organisms of different sizes can affect biogeochemical cycling in marine sediments. Macrofaunal organisms rework the sediment and introduce oxygen in deep sediment layers by bioturbation and bio-irrigation. This alters the physico-chemical properties of the sediment and affects the microbial communities involved in key ecosystem processes. Coupled nitrification/denitrification is such an important ecosystem process as it provides the water column with inorganic nutrients while it partly removes N as N2 from the marine ecosystem, alleviating eutrophication. We investigated how the macrofauna-microbe interaction affects the marine benthic N-cycle in coastal intertidal and subtidal sediments. We focused on the diversity of ammonia-oxidising and/or denitrifying bacteria and Archaea, by assessing how macrofaunal activities affect their diversity at the community level or functional gene level. We show that the diversity of metabolically active ammonia-oxidising bacteria (OAB) and Archaea (AOA) affected nitrification and N-mineralisation. Separate models demonstrated a significant and independent effect of macrofaunal activities on community composition and richness of total bacteria, and diversity indices AOA. Diversity of AOB was significantly affected by macrofaunal abundance. In the intertidal, the patterns in denitrifying bacteria were similarily affected by the bio-irrigation activity of the polychaete Lanice conchilega. In general, we conclude that the activities of the macrofauna increase the spatial complexity in space and time, thereby modulating the link between microbial diversity and ecosystem functioning in marine sediments.

Keywords: biodiversity ecosystem functioning

Vandenberghe Thomas

Royal Belgian Institute of Natural Sciences

Author(s): Thomas Vandenberghe[1], Steven Degraer[2], Thierry Jauniaux[3], Francis Kerckhof[2], Bob Rumes[2], Serge Scory[1], Elise Toussaint[2] and Jan Haelters[2]

Affiliation(s) :

[1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgian Marine Data Centre (BMDC) , Belgium
[2] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management (MARECO) , Belgium
[3] University of Liège, Faculté de Médecine Véterinaire, Belgium

MarineMammals.be: improving marine mammal stranding data collection

The marine mammals website (www.marinemammals.be) is the result of a long-standing colla-boration between the Royal Belgian Institute of Natural Sciences (RBINS) and the University of Liège (ULg) and provides access to data from 50 years of marine mammal observations in Belgium. The site consists of two main parts, i.e. 'observations' and the Belgian Marine Mammal Biobank, a tissue bank (BMMB or just Biobank). While observations can be publicly consulted, the biobank is focused on scientific users. Overall, the website aids in collecting data on strandings, necropsies, ad hoc observations and dedicated surveys of any marine mammal (pinnipeds and cetaceans) occurring in Belgian waters. It allows to gather successive observations of any individual and to identify the probable causes of death of stranded animals and facilitates data flow to (international) reporting instances.

Ad hoc stranding and observational data are in a standardised way entered by RBINS staff. In order to support and refine the cause of death as assessed on the beach, necropsies and resulting samples are performed and recorded in the database as well. The system also keeps track of all the marine mammal tissue samples stored in the vaults of the Department of Morphology and Pathology of the ULg, which contain over 20000 samples. The target audience of the BMMB is a wide range of scientists: biologists, veterinarians, toxicologists, microbiologists, pathologists,... In the near future, those interested in lending out samples will be able to register on the site and browse trough the available samples.

Keywords: Marine mammals, Belgium, Biodiversity, Occurence data, Tissue bank, Data management

Verhelst Pieterjan

Ghent University, Marine Biology Research Group

Author(s): Pieterjan Verhelst[1,2,3,4], Jan Reubens[1,3], Peter Goethals[4], Ans Mouton[2,4], Tom Moens[1]

Affiliation(s) :

[1] Marine Biology Research Group, Ghent University, Ghent, Belgium
[2] Research Institute for Nature and Forest (INBO), Brussels, Belgium
[3] Flanders Marine Institute, Ostend, Belgium
[4] Laboratory of Environmental Toxicology and Aquatic Ecology, Ghent University, Ghent, Belgium

Acoustic telemetry as a tool for cod stock assessment

All around the world, fish stocks have declined tremendously during the last decades. Multiple causes can be addressed, working on different levels of the ecosystem: overfishing, habitat destruction and modification, pollution, disease and climate change. To restore stocks, a better understanding of fish movement and behaviour in relation to habitat use and environmental requirements is needed. In this study, we focused on Atlantic cod (Gadus morhua), one of the economically most important fish of Europe. Acoustic telemetry is a promising technique to unravel fish movement in the marine environment and was therefore applied on cod: fish were tagged with an acoustic transmitter, which emits a signal that can be detected by receivers. The LifeWatch ESRI observatory funded a network of such receivers in the Scheldt Estuary and the Belgian Part of the North Sea. This gave us the ability to track fish over a wide area and between different habitats (e.g. marine versus estuarine environment). An added value of acoustic telemetry is that it provides information on the individual level, rather than species level, resulting in more detailed observation of fish behaviour. This leads to new insights in complex fish migrations. The results of this study show seasonal migration between offshore habitats (i.e. windmill farm, shipwrecks) in summer and inshore habitats (i.e. coastal zone and Scheldt Estuary) from autumn till early spring. This information could contribute to a more efficient stock assessment and help to restore the population, by adding a spatio-temporal component to fishing quotas.

Keywords: Telemetry, stock assessment, cod

Wrede Alexa

Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

Author(s): Alexa Wrede[1], Jennifer Dannheim[1], Lars Gutow[1], Thomas Brey[1]

Affiliation(s) : [1]Alfred Wegener Intitute Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

Effects of German Bight top bioturbators on biogeochemical cycling and sediment turnover

Loss of macrofaunal bioturbation and bioirrigation activity may strongly reduce benthic biogeochemical cycling and thus ecosystem functioning. The identification of bioturbating key species in the marine benthic realm is therefore of high importance for ecosystem management purposes. In this study top bioturbators in the German Bight were identified by mapping the trait based bioturbation potential (BPc) for 423 North Sea stations. BPc mapping highlighted the importance of Amphiura filiformis, Echinocardium cordatum and Nucula nitidosa as major bioturbating species in the German Bight. Effects of their bioturbation and bioirrigation activity on silicate, ammonium and nitrate flux were investigated in laboratory experiments. While E. cordatum significantly influenced biogeochemical cycling, effects of A. filiformis remained inconclusive probably due to arm regeneration. N. nitidosa showed little impact on biogeochemical cycling, although the bivalve was found to be an important bioturbator. E. cordatum may thus be considered an essential mediator of biogeochemical cycling in the sediment water interface as well as one of the most important bioturbators in the German Bight.

Keywords: Sediment reworking, Bioirrigation, Bioturbation potential, Amphiura filiformis, Echinocardium cordatum, Nucula nitidosa

Posters

Theme 1:

Scientific backbone of the North Sea ecosystem: adequacy of the knowledge base?

Alsebai Mohammed

Ghent University - Marine Biology Research Group

Author(s): Mohammed Alsebai[1], Katherine Brownlie[1], Jan Vanaverbeke[2], Ann Vanreusel[1], Carl Van Colen[1]*

Affiliation(s) :
[1] Ghent University, Marine Biology Research Group, Department of Biology.; [2] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management.

A 11-year study to understand long-term changes in macrofaunal communities in the Belgian Part of the North Sea

Long-term monitoring of bio indicators is essential to report changes and regime shifts in ecosystem status. Such changes can result from both global and local drivers, and their potential interactions. In soft-sediment benthic communities, the relative importance of broad scale (e.g. climate phenomena such as severe winters) and local drivers (e.g. change in sediment composition) for long-term change and stability are not well understood. This study aimed 1) to report the temporal changes that occurred in macrobenthic communities from different habitats, and 2) to identify the main governing factors of such temporal change. Therefore biological and environmental data was sampled from three coastal and three offshore stations located in the Belgian part of the North Sea over a 11-year period (2003-2013). A significant interaction between location and time on the macrofaunal community composition, abundance and contribution of dominant species was found. Furthermore, preliminary data analysis shows significant correlations between yearly macrobenthos attributes and the annual average of; suspended sediment concentration, water column salinity, temperature, chlorophyll-a, and median grain-size concentration illustrating the potential role of both local and global processes in determining macrobenthos community stability.

Keywords: Long-term changes; Macrobenthic community; Climate change; Anthropogentric disturbance; spatio-temporal variability; environmental variables ; Belgian Part of the North Sea.

Borges Alberto V.

University of Liège

Author(s): Alberto V. Borges[1], Thomas Vandenberghe[2], Francis Strobbe[2], Karien De Cauwer[2], Ruth Lagring[2]

Affiliation(s) :

[1] University of Liège

[2] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium

Ocean acidification in the Belgian coastal zone, a contribution to the BELSPO project "4 decades of Belgian marine monitoring" (4Demon)

The open ocean is a major sink of anthropogenic CO2, however the accumulation of anthropogenic CO2 has altered carbonate chemistry in surface waters since pre-industrial times, and is expected to continue to do so in the coming centuries. Ocean acidification of surface waters corresponds to the increase of CO2 and of H+, the decrease of pH, of CO32-, and of the saturation state of calcite and aragonite, all related to shifts in thermodynamic equilibria in response to the input of anthropogenic CO2 from the atmosphere. Changes of saturation state of calcite and aragonite call have negative impacts on marine organisms some of which have an important economic value for tourism (coral reefs) or fisheries (shellfish, …). In coastal waters, other factors in addition to the absorption of anthropogenic CO2 could also affect carbonate chemistry at decadal time-scales. Atmospheric inputs of nitrogen or sulfur could lead to enhanced acidification, while eutrophication could counter to acidification. In the frame of the BELSPO project "4 decades of Belgian marine monitoring" (4Demon), we compiled available historical data-sets of pH in the Belgian coastal zone. The data-set spans at from 1970 to 2015, and totals > 8,800 values. The emerging pattern from the annual means is an increase of pH from the early 1970's to the mid 1980's, and then a decrease on-wards. This pattern could be related to changes in primary production related to eutrophication and nutrient reduction policies.

Keywords: Ocean acidification, eutrophication, Belgian coastal zone

Borges Alberto V.

University of Liège

Alberto V. Borges[1], Willy Champenois[1], Nathalie Gypens[2], Bruno Delille[1], Jérôme Harlay [1], Kevin Ruddick[3], Bouchra Nechad[3], Thomas Vandenberghe[4], Francis Strobbe[4], Karien De Cauwer[4], Ruth Lagring[4]

Affiliation(s) : [1] University of Liège, Belgium
[2] Université Libre de Bruxelles, Belgium
[3] Remote Sensing and Ecosystem Modelling, Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium
[4] Belgian Marine Data Centre, Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium

Methane dynamics in the Belgian coastal zone, a contribution to the BELSPO project "4 decades of Belgian marine monitoring" (4Demon)

Methane is the second most important greenhouse gas after CO2. Yet, there remains an important uncertainty on estimates of the sources and sinks of CH4, and how their variations can affect the atmospheric CH4 growth rate and burde. The open ocean is a very modest source of CH4 to the atmosphere compared to other natural and anthropogenic CH4 emissions. Coastal regions are more intense sources of CH4 to the atmosphere than open oceanic waters. The high CH4 concentrations in surface waters of continental shelves are due to direct CH4 inputs from estuaries and from sediments where methanogenesis is sustained by high organic matter sedimentation. Biogenic or thermogenic CH4 can accumulate in large quantities in sub-surface seabed (gassy sediments) in deep and shallow areas, and can be released as bubbles (gas flares) or by pore water diffusion. We report a data-set of CH4 concentrations in surface waters of the Belgian coastal zone (BCZ) in spring, summer and fall 2010 and 2011. This is a coastal area with multiple possible sources of CH4 such as from rivers and gassy sediments. This is a contribution to BELSPO projects BELCOLOUR-II and 4Demon.

Breine Naomi

Institute for Agricultural and Fisheries Research (ILVO)

Author(s): Naomi T. Breine[1], Annelies De Backer[1], Carl van Coolen[2], Tom Moens[2], Gert van Hoey[1], Kris Hostens[1]

Affiliation(s) : [1]Institute for Agricultural and Fisheries Research (ILVO), Aquatic Environment and Quality, Bio-environmental research group, Belgium
[2] Ghent University, Department of Biology, Marine Biology Research Group, Belgium

Update on the soft-bottom benthic habitats in the Belgian Part of the North Sea, with new functional information

Soft-bottom macrobenthic habitats are an essential part of the marine ecosystem and so their healthy status is strived for. Previously, four soft-bottom macrobenthic habitats were distinguished in the Belgian part of the North Sea: the coastal Macoma balthica and Abra alba habitats, and the offshore Nephtys cirrosa and Ophelia borealis habitats. The current study provides a revision, based on an enlarged dataset with 10 more years of data (1994-2012) and an increased spatial coverage. In addition, the habitats are also described functionally by means of biological traits. The structural characteristics in the muddy Macoma balthica, fine muddy sand Abra alba, and well sorted medium sand Nephtys cirrosa habitats showed no obvious changes compared to previous studies. However, a new coastal fine muddy sand Magelona-Ensis directus habitat is described, with low diversity values and a dominance of alien species Ensis directus. Also, the offshore Ophelia borealis habitat, previously characterized by low diversity and abundance, is now renamed as Hesionura elongata, still characterized by medium to coarse sands, but now showing high diversity and moderate abundances. Functionally, the most remarkable differences were observed between the coastal and the offshore habitats. In the relative coarser, permeable sands in the offshore area, we find more free living, mobile polychaetes and crustaceans, whilst the finer sand habitats have more sessile, tube building and burrow dwelling species. This is apparent in differing trait values for living habit, feeding mode, mobility and bioturbation. This study illustrates how an appropriate spatial and temporal coverage within a baseline dataset is required as a proper starting point to assess the structural and functional state of an area.

Keywords: macrobenthic habitats, Belgian part of the North Sea, structural and functional traits

De Clercq Maikel

Ghent University, Dep. Geology

Author(s): Maikel De Clercq[1], Tine Missiaen[1], Freek S. Busschers[2], Marc De Batist[1]

Affiliation(s) :

[1] Renard Centre of Marine Geology, Department of Geology, Ghent University, Campus Sterre, Ghent, Belgium;
[2] TNO - Geological Survey of the Netherlands, Utrecht, The Netherlands.

A First Assessment of Belgian Continental Shelf Prehistory

Little attention has been paid in Belgium to submerged prehistoric landscapes and to the related underwater cultural heritage (UCH). This is deplorable in view of the increasing pressure of commercial activities at sea and the unique setting of the Belgian Continental Shelf (BCS), close to the nearby confluence of major Late Quaternary fluvial systems at times of lower sea level. Moreover, the relatively thin and fragmented Quaternary sediment cover renders prehistoric sites extremely vulnerable to disturbance of commercial activities and to natural erosion at the seabed, as most of these occur at limited burial depth. Based on a solid stratigraphical framework between the Quaternary deposits and the archaeological heritage that is buried within, an archaeological potential map (APM) of the BCS can be developed. Such a map provides a degree of quality at any given location whether the site is likely to contain UCH or not. This should help avoid or reduce any unnecessary damage to buried heritage and simultaneously increase the cost-efficiency of commercial activities at sea.

A first major step towards an APM concerns the development of an improved geological model of the Quaternary deposits, based on all existing and newly collected seismic, core data. The new model provides a first glimpse of the potentially preserved prehistoric archaeology within the Quaternary layers in the context of the associated landscape remnants. Combining the layer model with information and knowledge from the neighbouring Dutch, French and UK North Sea area as well as from Belgian and Dutch coastal onshore areas has allowed new insights into submerged landscapes and their potential for UCH on the BCS.

Keywords: Belgian Continental Shelf, Quaternary, Top-Paleogene, paleovalley, stratigraphy

De Clercq Maikel

Ghent University, Dep. Geology

Author(s): Maikel De Clercq[1], Vasileios Chademenos[1], Tine Missiaen[1] & Vera Van Lancker[1,2]

Affiliation(s) : [1] Ghent University, Dep. Geology. Renard Centre of Marine Geology, Belgium [2] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium

A high-resolution DEM for the Top-Paleogene surface of the Belgian Continental Shelf

A 1:250.000 scale map of the surface of the Top-Paleogene for the Belgian Continental Shelf was created based on extensive analyses of older and recent geological and geophysical datasets. The Top-Paleogene is an important polygenetic unconformity that truncates older strata of the Paleogene and to a smaller extent some of Neogene age from the overlying Quaternary deposits. As such it represents the base of the latter. The represented surface has been diachronously shaped and reworked through Late Quaternary times by different geological processes (e.g., fluvial, marine, estuarine, periglacial). Additionally, the offshore surface has been attached to the landward Top-Paleogene surface and was transformed into a uniform 3D surface allowing new and better interpretations to be used for multidisciplinary scientific research (e.g. geology, archaeology, palaeogeography) and commercial applications (e.g. wind farms, aggregate extraction, dredging).

Keywords: Belgian Continental Shelf, geology, geomorphology, Paleogene, Quaternary

Fettweis Michael

Royal Belgian Institute of Natural Sciences

Author(s): Michael Fettweis [1], Matthias Baeye [1], Qilong Bi [2], Marion Chapalain [3], Jeroen De Bisschop [4], Valérie Dulière [1], Xavier Lurton [3], Giacomo Montereale Gavazzi [1,4], Marc Roche [5], Xiaotang Shen [2], Erik Toorman [2], Dries Van den Eynde [1], Vera Van Lancker [1,4], Romaric Verney [3], Qinghui Zhang [2]

Affiliation(s) : [1] Royal Belgian Institute of Natural Sciences, OD Nature, Brussels, Belgium
[2] KULeuven, Hydraulics Laboratory, Leuven, Belgium
[3] Ifremer, Brest, France;
[4] Ghent University, Department of Geology, Belgium
[5] FPS Economy, Continental Shelf Service, Belgium

Tools to support the monitoring of MSFD descriptors 6 'Sea-floor integrity' and 7 'Hydrographical conditions'

The subject of the BELSPO financed INDI67 project is the development and evaluation of integrative indicators in order to evaluate GES and the human impact on seafloor integrity and hydrographical conditions. Bottom shear stress, turbidity and seabed/habitat types are selected as key parameters. They relate to seafloor and water column dynamics and their variability is linked to the forces that waves and currents exert on the seafloor and on the particles in the water column and to biological processes. Furthermore, changes in these parameters are often induced by human activities or natural dynamics. Natural and human-induced forcings influence sediment transport (and hence the fate of pollutants), light availability in the water (and hence primary production), functioning of benthic ecosystems through deposition and erosion of sediments (and hence smothering to sealing of the sea floor or abrasion).

Turbidity and bottom shear stresses are currently measured and modelled. Bottom shear stress and seabed/habitat type are included in the Belgian MSFD monitoring programme, while turbidity is not yet included. For the proposed indicators a number of scientific and operational challenges need resolving before measurements and model results can be fully integrated in the monitoring programme. These challenges include i) improvement of the understanding of processes (flocculation, turbidity, acoustic imaging of seabed dynamics); ii) development of new process-based numerical modules in existing models (flocculation, drag modulation, current-wave bottom shear stress, seabed composition); iii) assessment of the uncertainty of measurements and models; and iv) provision of time- and cost-effective seabed mapping strategies.

Keywords: Turbidity, bottom shear stress, MSFD Indicators

Ivanov Evgeny

University of Liège, Department of Astrophysics, Geophysics and Oceanography, MAST (Modelling for Aquatic Systems)

Author(s): Ivanov E. [1], Capet A.[1], Barth A. [1], Delhez E. [2], Soetaert K. [3], Grégoire M. [1]

Affiliation(s) :

[1] University of Liege, Department of Astrophysics, Geophysics and Oceanography, Belgium.

[2] University of Liege, Department of Aerospace and Mechanical Engeneering, Belgium.

[3] Royal Netherlands Intitute for Sea Research, Department of Estuarine and Delta Systems, The Netherlands.

Developing a hydrodynamical model of the Southern Bight of the North Sea for impact studies

In the frame of the Brain FaCE-It project (Functional biodiversity in a Changing sedimentary Environment: Implications for biogeochemistry and food webs in a managerial setting), the impact of fining and hardening resulting from dredging and wind farms installation on the sediment grain size distribution has to be assessed at the scale of the Southern Bight of the North Sea (SBNS) with a particular focus on the Belgian Coastal Zone (BCZ). With this aim, the ROMS-COAWST tri-dimensional (3D) hydrodynamic model is implemented to simulate the hydrodynamics in the SBNS. At its open boundaries with the Atlantic Ocean and the North Sea, the model is forced with the results of a coarse resolution model available from Mercator. A high resolution of 250 m is used in the area of the BCZ where the accuracy of model predictions needs to be refined. Model currents, tides, temperature and salinity fields will be described and first validation exercises with satellite and local data will be presented and discussed in regards with the objectives of FaCE-It. In a next step, the model will be coupled with a sediment transport in order to describe the dynamics of suspended particulate materials (SPM) and the distribution of the seafloor sediment grain size. When finalized the hydrodynamic model will be coupled with a diagenetic model and will provide environmental conditions for scaling up local foodweb studies that are performed in the frame of FaCE-iT. The final aim is to assess the impact of substrate modifications due to aggregate extraction and wind farms on the biogeochemistry, benthic functionality and food webs at local (around the wind farm) and regional scales (SBNS).

Keywords: hydrodynamic, high resolution modeling, sediment transport, Belgian coastal Zone, Southern Bight of the North Sea

Mavraki Ninon

Royal Belgian Institute of Natural Sciences

Author(s): Ninon Mavraki[1], Ilse De Mesel[1] & Steven Degraer[1]

Affiliation(s) : [1]Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management, Brussel and Oostende, Belgium

Food webs and species interactions within fouling communities at offshore artificial hard substrates

Fouling communities are highly affected by a variety of environmental factors, such as water depth and substratum orientation, as well as by species interactions. For example, even slight modifications in the abundance of a species can alter the trophic interactions of the whole community. The aim of the present study is to disentangle food webs (C-flow) and species interactions within fouling communities in Belgian offshore wind farms as to evaluate the impact of artificial reef communities onto the natural surrounding ecosystem. First, the possibility of a "biofilter" action from the organisms that comprise a fouling community will be studied by measuring the feeding/biodeposition ratios. Second, species trophic interactions in (a) different offshore wind farms habitats (e.g. erosion protection layer and piles), (b) a variety of depths and (c) in different taxa will be investigated through stable isotope analysis. Finally, pulse chase experiments will be conducted in order to investigate the path that carbon follows (13C labeled) in the food chain and quantify what is accumulated, deposited and lost through the metabolic process. From the above, a model of the fouling community species interactions will be constructed. This study will provide concrete knowledge on food webs and habitat formation in offshore wind farm fouling communities regarding both their ability to filter organic particles and their interactions with other taxa inhabiting the same substratum, forming the basis for further exploration of the impact of offshore wind farms on the southern North Sea ecosystem functioning. This research is part of the "Functional biodiversity in a Changing sedimentary Environment: Implications for biogeochemistry and food webs in a managerial setting, FaCE-It" project.

Keywords: biodeposition, organic particles, c-flow, species interactions, biofilter, epifauna

Nohe Anja (Reinhoud de Blok)

University of Ghent, Department of Biology, Laboratory of Protistology & Aquatic Ecology

Author(s): Anja Nohe[1], Ruth Lagring[2], Karien De Cauwer[2], Annelies Goffin[3], Lennert Tyberghein[3], Klaas Deneudt[3], Xavier Desmit[2], Wim Vyverman[1] and Koen Sabbe[1]

Affiliation(s) :

[1] Protistology & Aquatic Ecology Laboratory, Biology Department, Ghent University, Ghent, Belgium; [2] Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment, Brussels, Belgium; [3] Flanders Marine Institute (VLIZ), Oostende, Belgium

Long-term phytoplankton monitoring data (1970-2010) from the Belgian North Sea reveal shifts in seasonal dynamics and community composition

Marine monitoring programs are useful to detect spatial patterns and long-term trends in marine phytoplankton biomass and composition. While in Belgium's neighbouring countries (the Netherlands, Germany and France) phytoplankton monitoring programs have existed for several decades, Belgium lacked a coordinated program until the 2000's. In the framework of the 4DEMON BRAIN-be project (www.4demon.be), we have compiled and intercalibrated historic and recent datasets on phytoplankton species composition and biomass from the Belgian North Sea (BNS) from the 1970s onwards. In this analysis we focus on diatom and dinoflagellate abundance, which are two important phytoplankton groups in the BNS. Because of a data gap in the 1980s until the mid of the 1990s, we separately analysed diatom and total dinoflagellate abundance in the 1970s and 1990s/2000s. The first analysis shows that both diatom and dinoflagellate abundances have increased during the last decades. In addition, modelling approaches show that the seasonal pattern of diatom abundance varies between different areas of the BNS. While diatoms in the coastal zone usually exhibited two distinct blooms in the 1970s, a larger peak in the spring and a smaller peak in the late summer, from the 1990s onwards the coastal diatoms tend to develop only one pronounced spring bloom. Offshore, however, the seasonal diatom abundance has two peaks and can locally also reach relatively high winter abundances. Dinoflagellate abundance shows two peaks, typically a small peak in late spring and a second bigger peak in late summer/early autumn. Furthermore, our data show a shift in community composition and an increase in several phytoplankton genera (e.g. Pseudo-nitzschia, Guinardia and Thalassionema).

Keywords: phytoplankton; Belgian North Sea; seasonality; long-term trends; spatio-temporal patterns

Ponsar Stéphanie

Royal Belgian Institute of Natural Sciences

Author(s): Stéphanie Ponsar, Patrick Luyten and Dries Van den Eynde

Affiliation(s) : Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium

Estimation of model error prior to long term simulations of climate change impact on storm surges and waves at the Belgian Continental Shelf

The CORDEX.be project is a BRAIN-be project of the Belgian Science Policy Office, grouping 8 Belgian universities or scientific institutes, executing research on global climate change impacts, to create a coherent scientific basis for climate services in Belgium. One of the objectives of the project is to produce high resolution climate simulations for Belgium of the Representative Concentration Pathways studied in the 5th Coupled Model Inter-comparison Project. As such, it constitutes the Belgian contribution to the worldwide CORDEX project, which aims at providing regional climate simulations from global climate models. Local impacts of climate change will be estimated on urban climate, crop production, vegetation emission and storm surges and waves.

To study the impact of global climate changes on storm surges and waves, long term (90 years) simulations will be conducted for three scenarios. In the Belgian Coastal Zone, the impact on sea surface elevation will be examined by performing simulations with the regional ocean model COHERENS while the WAM model will be applied to assess the effects on waves. To evaluate the changes in simulated storm surges and wave climate, it is important to estimate the model accuracy on beforehand. Therefore, prior to the long term simulations, the model error will be evaluated during the evaluation period 1981-2010. This evaluation run can at the same time be used to tune the models for the meteorological forcing that will be used for the long term simulations, to optimize the model accuracy. A comparison of simulated variables to observed ones will be reported, based on the computation of root mean square error, model bias, correlation coefficient and scatter index.

Keywords: model validation, climate change, storm surges, waves, Belgian Continental Shelf

Tiano Justin

The Royal Netherlands Institute for Sea Research (NIOZ)

Author(s): Justin Tiano[1], Adriaan Rijnsdorp[2] and Karline Soetaert[1]

Affiliation(s) :

[1] Royal Netherlands Institute for Sea Research- NIOZ Yerseke, Yerseke, The Netherlands

[2] Wagenigen University and Research, Marine Research, IJmuiden, The Netherlands

Differential effects of electrical pulse and conventional beam trawl fisheries on sediment biogeochemistry

The controversial use of electrical stimulation as a fishing aid for commercial fisheries may provide a more environmentally friendly alternative to conventional beam trawl methods. Traditional trawling techniques can be particularly damaging to benthic habitats, however, little is known about the effects of electrical pulses on sediment biogeochemical processes and ecosystem functioning. This project will compare and analyse the impacts of electric pulse and conventional fishing methods on the benthic ecosystem with an emphasis on sediment biogeochemistry. We hypothesize that the two methods will produce contrasting effects on species survival and/or activity, along with differing biogeochemical repercussions. We will investigate this topic through a series of field sampling campaigns and controlled experiments. Short and long-term effects of both fishing methods on sediment nutrient cycles will be assessed. North Sea benthos and their functional characteristics will also be determined. This research will provide a better understanding of the biogeochemical consequences related to electric pulses on marine ecosystems. Additionally, these results will contribute to a more comprehensive assessment of this new fishing method.

Keywords: Electrical stimulation, fisheries, ecosystem functioning , biogeochemistry, sediment, North Sea

Toussaint Elise

Royal Belgian Institute of Natural Sciences

Author(s): E. Toussaint[1], U. Braeckman[2], T. Moens[2], K. Soetaert[3] and J. Vanaverbeke[1]

Affiliation(s) : [1]Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Brussels, Belgium; [2]Ghent University, Department of Biology, Marine Biology Research Group, Ghent, Belgium; [3] Royal Netherlands Institute for Sea Research- NIOZ Yerseke, Yerseke, The Netherlands

Towards investigating the effect of fining and hardening of marine coastal areas on ecosystem functioning in the Belgian part of the North Sea (BPNS)

Sediments and the inhabiting macrofauna play an important role in the functioning of coastal marine environments. Human activities in these environments result in two obvious pressures on the sediment: hardening from the installation of offshore wind farms (OWFs) and fining in the vicinity of sand extraction sites and in OWFs. This study is part of the FaCE-It project and aims at understanding the impacts of those pressures on biogeochemical cycling and on the food web structure.

In order to understand benthic ecosystem functioning in different types of sediment, we will measure nutrient fluxes in closed-core incubations sampled along a gradient from fine to coarse sediments, including sediments subjected to fining. Bio- and physical irrigation will be quantified by adding a bromide tracer to the overlying water and following the decreasing concentration over time. With those data, we will estimate the total flux of degradable organic carbon deposited at the sediment surface, its degradation rate and transformation and assess the effect of bioturbation and bio irrigation on benthic ecosystem functioning.

Along the same sediment gradient, we will study the macrobenthic food web using stable isotope analysis. Furthermore, the overall food web will be investigated at 3 stations characterized by fine sediment, coarse sediment and an OWF to compare the food web complexity in areas with and without OWFs. These data will finally be used to build a quantitative food web using linear inverse modeling (LIM). To constrain this model, individual respiration rate measurements and pulse chase experiments will be conducted. This combined approach will allow assessing the effect of fining and hardening of marine coastal areas on important ecological processes on the scale of the BPNS.

Keywords: bioirrigation, ecosystem functioning, linear inverse model, macrobenthos, nutrients fluxes, oxygen consumption, stable isotopes

van Colen Carl

Ghent University - Marine Biology Research Group

Author(s): Andy Booth[1], Carl Van Colen[2],Kaori Sakaguchi-Söder[3], Paula Sobral[4], Laura Airoldi[5], Richard Sempere[6], Jan Andries Van Franeker[7], Kerstin Magnusson[8], Thomas Doyle[9], Iurgi Salaverria[10], Dorte Herzke[11], Amaia Orbea[12], Geir Wing Gabrielsen[13], Hartmut Nies[14], Tamara Galloway[15], Albert van Oyen[16]

Affiliation(s) : [1] SINTEF Materials and Chemistry, Trondheim, Norway; [2] Marine Biology Research Group, Ghent University, Gent, Belgium; [3] Technical University of Darmstadt, Darmstadt, Germany; [4] NOVA.ID FCT, Caparica, Portugal; [5] Alma Mater Studiorum - University of Bologna, Ravenna, Italy; [6] Aix-Marseille Université, Mediterranean Institute of Oceanography, Marseille, France; [7] IMARES Wageningen UR, Den Helder, Netherlands; [8] IVL Swedish Environmental Research Institute, Göteborg, Sweden; [9] National University of Ireland Galway, Galway, Ireland; [10] Norwegian University of Science and Technology, Trondheim, Norway; [11] Norwegian Institute for Air Research, Tromsø, Norway; [12] Universidad del País Vasco/Euskal Herriko Unibertsitatea, Leioa, Spain; [13] Norwegian Polar Institute, Tromsø, Norway; [14] Federal Maritime and Hydrographic Agency, Hamburg, Germany; [15] University of Exeter, Exeter, United Kingdom; [16] Control and Research Analysis Thermoplastics, Bocholt, Germany

PLASTOX: Direct and indirect ecotoxicological impacts of microplastics on marine organisms

PLASTOX is one of four consortia under the JPI Oceans Pilot Action "Ecological Aspects of Microplastics" and consists of 15 partners from 11 Member States. The project will investigate the ingestion, foodweb transfer, and ecotoxicological impact of microplastics (MPs), together with persistent organic pollutants (POPs), metals and plastic additive chemicals, on key European marine species and ecosystems. The influence of MP physicochemical properties (size, shape, surface area and composition) on these processes will be evaluated. Laboratory tests and mesocosm studies will be combined with field-based observations and field experiments across a wide range of European marine environments. To bridge the current gap between laboratory assessment using commercially available feedstock MPs and the additive/pollutant-loaded MPs that dominate the marine environment, plastic litter collected from the marine environment will be milled into MPs. Adsorption and desorption behaviour of organic and inorganic pollutants to MPs will be investigated using a range of common POP and metal contaminants, identifying which physicochemical properties are most influential. Uptake through ingestion and other routes will be investigated, and attempts made to quantify MP accumulation in marine organism tissues using state of the art analytical approaches. Acute and sublethal ecotoxicological effects of MPs will be assessed on marine organisms from phyto- and zooplankton to (shell)fish and seabirds, representative of the full range of economically important marine living resources in the EU. PLASTOX will culminate in a series of experiments bringing together the knowledge generated about MPs and POPs/metals to study the combined fate and effects of these marine contaminants in food web studies.

van den Baviere Andreas

ILVO, KU Leuven, OD Nature

Author(s): Vanden Bavière Andreas [1,2], Delerue-Ricard Sophie [1,2], Barbut Léo[2,3], Lacroix Geneviève[3], Robbens Johan[1] and Volckaert Filip [2]
Affiliation(s) : [1] Institute for Agricultural and Fisheries Research, Ostend, Belgium, E-mail: andreas.
[2] Laboratory of Biodiversity and Evolutionary Genomics, KU Leuven, Leuven, Belgium
[3] Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

B-FishConnect: a multi-disciplinary approach targeting flatfish connectivity and population dynamics in the Southern North Sea.

Marine populations display some of the most extreme patterns of spatial and temporal heterogeneity in demographic factors. Larval dispersal connects distant subpopulations, with strong implications for population dynamics and persistence, biodiversity conservation and fisheries management. Due to a highly complex window between biological needs and favorable environmental factors, marine species are very susceptible to perturbations in the environment. This leads to unpredictable reproductive success, high larval mortality and obscure population delineations. The B-FishConnect project strength lays in its multi-disciplinary approach. It disentangles the biophysical factors influencing dispersal and recruitment in flatfish. An intensive sampling campaign was set up to gather empirical data of larval and juvenile flatfish in several nurseries on the Belgian part of the North Sea in order to understand local dispersal and recruitment dynamics. Empirical data compared to a Lagrangian larval transport model, coupled with an Individual-Based Model, showed that a short larval duration, tidal migration and high mortality represent the most realistic dispersal scenario. Genomics (ddRADseq), otolith microchemistry and shape analysis allowed to distinguish subpopulations of flatfish on a small spatial scale. Small-scale differences in habitat characteristics were investigated by analyzing juvenile flatfish growth through otolith-analysis, biological indices and stomach metabarcoding. Results show that there is spatial and annual variation in body condition which can influence recruitment variability. The project combines multiple approaches to give insights in population structure, recruitment and dynamics of flatfish in the Southern North Sea.

Keywords: larval dispersal, population connectivity, population dynamics

van Heteren Sytze

TNO – Geological Survey of the Netherlands

Author(s): Sytze van Heteren[1], Vera Van Lancker[2], Fabien Paquet[3], Laure Simplet[4], Rhys Cooper[5], Sophie Green[5], Markus Diesing[6], Kristine Asch[7], Jørgen Leth[8], Odd Harald Selboskar[9], Reidulv Bøe[9], Anu Kaskela[10], Ulla Alanen[10], Aarno Kotilainen[10], Alan Stevenson[5]

Affiliations(s) :[1] TNO - Geological Survey of the Netherlands, The Netherlands; [2] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium; [3] Bureau de Recherches et Géologiques et Minières (BRGM), France; [4] Ifremer, France; [5] Natural Environment Research Council. British Geological Survey, United Kingdom; [6] Centre for Environment, Fisheries and Aquaculture Science (CEFAS), United Kingdom; [7] Federal Institute for Geosciences and Natural Resources (BGR), Germany; [8] Geological Survey of Denmark and Greenland (GEUS), Denmark; [9] Norwegian Geological Survey (NGU), Norway; [10] Geologian Tutkimuskeskus (GTK), Finland

Seabed sediment: a geological surrogate for North Sea benthic ecosystems

Effective, ecosystem-based management of the North Sea brings at least three data-related challenges: transnationality, surrogacy and uncertainty. As geological process-response relationships are not bounded by country borders, there is a need for full-coverage spatial datasets, stimulating neighbors to work together and to harmonize their mapping efforts. Characterizing ecosystems, communities of living organisms in conjunction with non-living components of their environment, requires quantitative knowledge on the correspondence between physical variables such as sediment type to the occurrence of species and communities. Data on physical seabed parameters, which are widely available and relatively cheap to collect, are frequently used as proxies of biological diversity and as indicators of habitat suitability. The biological relevance of the divisions or classes defined within surrogates used is commonly unknown or merely assumed. The associated ambiguity is only one element of uncertainty that needs to be considered. Imperfect remote observation, sampling, sub-sampling, description, analysis, classification and even interpolation also reduce the overall confidence that decision makers can have in geology-based maps. Within the framework of the European Marine Observation and Data Network, 36 marine-geological organizations have been transforming fragmented region-specific data products into publicly available maps covering broader areas (http://www.emodnet.eu/geology). A harmonized 1:250,000 seabed-sediment map represents an important first step in tackling transnationality and in quantifying uncertainty. For the North Sea, additional work has focused on modeling the distribution of mud, sand and gravel on the basis of grain-size data and environmental predictors.

Keywords: sediment map, uncertainty, surrogate, mud, sand, gravel

van Oyen Tomas

Flanders Hydraulics Research

Author(s): Tomas Van Oyen[1,2], Abdel Nnafie[1] & Bart De Maerschalk[1,2]

Affiliation(s) :

[1] Flanders Hydraulics Research, Department of Mobility and Works, Belgium

[2] Ghent University, Dep. Of Civil Engineering, Belgium

Impact of anthropogenic measures on the Scheldt mouth morphodynamics

The Scheldt estuary is located at the border between The Netherlands and Belgium. The estuary has a profound economic value, providing e.g. maritime access to several ports in Belgium and The Netherlands. The Scheldt mouth consists of an extensive shallow region ("Vlakte van de Raan") which is flanked by two deeper shipping channels and several elongated tidal bars. The Vlakte van de Raan is considered of high ecological value and therefore designated Natura 2000 area. Over the past two centuries, the geometry and bathymetry of the Scheldt estuary have profoundly evolved. A significant part of these changes can be attributed to anthropogenic measures such as channel deepening and land reclamation. In this work, we investigate the influence of the estuarine anthropogenic measures on the morphodynamics of the Scheldt mouth area. To this end, we employ a depth-averaged numerical morphodynamic model to describe the hydrodynamics and resulting morphodynamic evolution. We find that especially the embankment of the Sloe tidal basin has profoundly impacted the location and orientation of the main channel entering the estuary; which, in turn might have influenced the location and orientation of the elongated tidal banks in the mouth region. Comparing the numerical modelling results with historical bathymetrical data appears to support our findings.

Keywords: morphodynamics, Scheldt mouth region

Oral Presentation

Theme 2:

A new era in environmental monitoring and assessment: what is at stake?

Adamopoulou Argiro

Royal Belgian Institute of Natural Sciences

Author(s): Argiro Adamopoulou[1], Matthias Baeye[1], Els Monteyne[1], Michael Fettweis[1], Marijke Neyts[1], Koen Parmentier[1] and Herman Van Langenhove [2]

Affiliation(s) :

[1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium

[2] Ghent University, Dep. of Environmental Organic Chemistry and Technology , Belgium

Integrated monitoring of nonpolar compounds with the use of Passive Samplers

The subject of the BELSPO financed NEWSTHEPS project is the development of innovative approaches and techniques that address the current fundamental scientific and methodological issues related to the implementation of Good Environmental Status for Descriptor 8 of the Marine Strategy Framework Directive in national and European waters. Specifically novel and integrated passive sampler (PS) based approaches are developed for monitoring nonpolar compounds. These compounds are determined in PS, in this case silicone sheets, Suspended Particulate Matter (SPM) and in sediment obtaining integrated pollution information. Besides chemical monitoring, the interesting link between the chemical concentrations found in SPM and in the sediment and the corresponding grain size distributions is currently investigated. This potentially allows determining the grain size classes that are associated with the highest concentration of nonpolar compounds in the water column and the seabed. To couple the chemical monitoring with sedimentology during a 2-month experiment at sea, sediment traps were used together with a laser scatterometer for measuring the SPM sizes and CTD sensors for estimating SPM concentration and hydrodynamic conditions. Knowledge to be gained is the nonpolar pollutants concentration difference between the PS, SPM and the sediment and how this is chemically explained; and moreover to link the concentration results with grain sizes, mineralogical composition of the sample, the origin of the sediment and also the presence of black carbon. Last but not least, laboratory experiments with PS, SPM and sediment are needed to sometimes simplify and confirm some of the findings derived from the in situ experiments.

Keywords: Passive samplers (PS), Suspended Particulate Matter (SPM)

Bieser Johannes

Helmholtz Zentrum Geesthacht

Author(s): Johannes Bieser, Corinna Schrum

Affiliation(s) : Helmholtz-Zentrum Geesthacht, Institute of Coastal Research, Geesthacht, Germany

Modelling the air-sea exchange of mercury in the North- and Baltic Sea

Mercury is a toxic substance that is ubiquitous in the environment. Each year, about 2000 tons are emitted into the atmosphere by anthropogenic sources. There, Hg0 is oxidized and subsequently deposited. Between 2000 and 4000 t/a are re-emitted into the atmosphere. Finally, in the ocean the remaining Hg is transformed into methylmercury, a highly toxic substance that accumulates along the food chain. Currently, the air-sea exchange is one of the largest sources of uncertainty in the global Hg cycle.

For this study we developed a coupled three dimensional Eulerian chemistry transport model (CTM) for the North- and Baltic Sea region to investigate the air-sea exchange of mercury. For the atmosphere we used the CTM-CMAQ and for the ocean the ocean-ecosystem model ECOSMO. We implemented photolysis, chemical reactions, and biologically induced transformation for elemental, oxidized, and methylated mercury species into the ocean model. Based on wind speed and temperature, Hg0 is exchanged between the ocean and the atmosphere. The model was set up for a regional domain covering the North- and Baltic Sea region. The coupled model system was run for a period of 14 years from 1993 to 2005.

We evaluated the model using elemental mercury measurements in the surface ocean and the atmosphere. Based on estimated riverine Hg inflow and modelled values for Hg deposition and air-sea exchange we estimated the annual mercury budget for the North- and Baltic Sea. We estimated that the North Sea has an annual mercury surplus of around 2000 kg. The majority of the mercury evasion occurs during summer and autumn, while parts of the North Sea can become a sink for atmospheric mercury during winter.

Keywords: Mercury, air-sea exchange, anthropogenic pollution

Butler Paul

School of Ocean Sciences, Bangor University

Author(s): Paul Butler[1], Michael Carroll[2], John Hartley[3]

Affiliation(s) : [1]School of Ocean Sciences, Bangor University, UK; [2] Akvaplan-niva, Tromsø, Norway; [3] Hartley Anderson Ltd, Aberdeen, UK

The establishment of long baselines for environmental monitoring using high resolution sclerochronological archives

The goal of marine environmental monitoring in the commercial sector is the assessment of the extent to which desired states of the environment are achieved, usually in the context of the impacts of marine infrastructure developments. However, the temporal extent of the baseline is limited by the length of the preconstruction phase to a period that is usually not adequate to assess the full range of natural variability. It is now feasible to address this limitation by accessing information recorded in the shells of long-lived bivalves, a field known as sclerochronology. The key insight is that shell material can be precisely and accurately dated using annual increments formed in the shell. Multicentennial chronologies can be developed by crossdating synchronous patterns of increment widths. Further, the geochemical properties (stable carbon and oxygen isotopic ratios and trace element concentrations) of the material can act as proxies for seabed conditions. This approach has potential for the reconstruction of long baselines of environmental variables, including the ability to compare pre- and post- industrial conditions. However, the identification of indicators of the pre-industrial state does not in itself define a “pristine” environment that can be targeted for the achievement of “good” environmental status (in the context of the MSFD). More realistically, the definition of such a status will require the identification of an acceptable degree of variability in the ecosystem response. It is this degree of variability that can be assessed with the help of shell-based biochronologies. Here, we will discuss the potential of such biochronologies as environmental monitors with particular emphasis on their applicability in the North Sea.

Keywords: Sclerochronology, baseline, bivalve molluscs, proxy archives

Carpenter Angela

University of Leeds, School of Earth and Environment

Author(s): Angela Carpenter

Affiliation(s) : University of Leeds, School of Earth and Environment

Oil Pollution in the North Sea: The impact of governance measures on oil pollution over several decades

Oil pollution entering the marine environment has been an issue of concern for many decades. It can come from riverine or land-based sources, accidental and intentional discharges from ships, or as a by-product of offshore oil extraction. The North Sea saw high levels of oil pollution over many decades; evidence of pollution dates back to 1915 in Netherlands waters. Growing awareness of the impact of oil pollution on the marine environment led, in the late 1960s, to the introduction of measures to reduce or eliminate pollution from shipping and the offshore oil industry in the region. A framework for environmental protection of the North Sea has developed over many decades through governance measures such as international agreements, regional cooperation, and national measures. This paper examines the development of a range of measures to protect the marine environment of the North Sea from oil pollution. It presents data on trends in pollution from ships since the mid-1980s and from oil installations since the early 2000s. Data sources include in-situ monitoring, of installations, and aerial surveillance and satellite monitoring for ship-source pollution. Significant reductions in oil pollution have been identified over more than two decades, although there remain some areas where further action is needed to reduce inputs still further, especially from ageing oil and gas platforms. This paper illustrates that international cooperation can result in a reduction in marine pollution leading to a cleaner environment. It also illustrates how satellite surveillance technology offers a tool for environmental monitoring and increases the potential to identify the source of a pollution incident, raising the possibility of polluters being prosecuted for their actions.

Keywords: oil pollution, North Sea, environmental monitoring, environmental policy, regional cooperation, satellite monitoring, aerial surveillance

Colson Liesbet

University Ghent, Marine Biology Research Group

Author(s): Colson Liesbet[1], Van Hoey Gert[2], Pecceu Ellen[2], Van Colen Carl[1], Vanaverbeke Jan[3]

Affiliation(s) :
[1]Ghent University, Biology Department, Marine Biology Research Group; [2]Institute for Agricultural and Fisheries Research; [3]Royal Belgian Institute of Natural Sciences, OD Nature

The foreshore: an ecological valuable ecosystem in danger

The sandy beaches and foreshore harbor a relative diverse marine ecosystem and are very important as nursery ground. Key components in the foreshore food web are phytoplankton, macrobenthos, hyperbenthos, epibenthos and demersal fish species. In relation to beach and foreshore nourishments at Mariakerke (Belgium) in 2013, an ecosystem based BACI monitoring program of 3 years was put in place. Although beach and foreshore nourishment are generally considered as less harmful, it does put pressure on the local biota. The goal of this study was to evaluate its effect on the community structure and the ecological value of the nourished area.

As the results show, the natural factors (temporal and spatial) drive the variance observed over the different ecosystem components, with some short term local effects. The less mobile macrobenthos was heavily influenced by the beach nourishment, but quickly recovered. This was due to the fact that the nourishment was conducted in late winter, before the recruitment period. The foreshore nourishment didn't have a big influence on the benthic fauna, probably due to the small volume of the nourishment. The more mobile species (epibenthos, fish) were slightly influenced due to changes in the bottom typology in the area (e.g. absence of the beach gullies). Beside this, the species composition in the hyperbenthos fraction shows the value of those areas as nursery and feeding ground. Therefore, an appropriate management of the coastal defense work is necessary to maintain a healthy beach system.

Keywords: nourishment, impact monitoring, benthic fauna

Delerue-Ricard Sophie

KU Leuven & Institute for Agricultural and Fisheries Research

Author(s): Sophie Delerue-Ricard[12], Hanna Stynen[1], Léo Barbut[13], Drew Glatczak[1], Andreas Vanden Bavière[12], Ilaria Coscia[1], Johan Robbens[2], Geneviève Lacroix[3], Gregory Maes[1], Filip A.M. Volckaert[1]

Affiliation(s) :

[1] Laboratory of Biodiversity and Evolutionary Genomics, University of Leuven (KU Leuven), Leuven, Belgium; [2] Institute for Agricultural and Fisheries Research (ILVO), Oostende, Belgium; [3] Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment, Brussels, Belgium

No anonymity for fish: tracing sole juveniles arriving at the Belgian nursery combining genomics, otolith microchemistry and otolith shape analysis.

To improve sustainability, fish stocks need to be monitored at an ecologically meaningful scale. Therefore fisheries management requires to understand population structure. However it is difficult to measure connectivity between populations especially because early-life stages cannot be tagged due to their small size. Success of larval dispersal is the key to connectivity between spawning grounds and nurseries. Solea solea is among the most economically valuable fish species in the North Sea, yet little is known about its population dynamics. In the present study, we investigate the geographical origin of young-of-the-year sole arriving at the Belgian nursery. Previous studies showed that genomic markers, otolith microchemistry and shape can reveal fine scale population structure for other fish species. We ran a sampling campaign and genotyped more than 400 juveniles of sole using the double digest Restriction Site-Associated sequencing (ddRAD) technique. Five hundred high quality Single Nucleotide Polymorphic sites were retained and used to define population structure at a fine spatial (<50 km) and temporal scale (2013-2014). Outlier tests were run to identify markers that could be used for traceability and might show signatures of local adaptation. In addition to the genomic approach, otolith microchemistry and shape were used to reveal small scale population structure. Combining the three different traceability measures increased our assignment power. Results show that southern North Sea populations of sole are highly connected, and that those caught off the Belgian coast are closely related to the Eastern English Channel populations. Improving the discrimination of subpopulations of fish would allow a better traceability and sustainable management of the resources.

Keywords: traceability, connectivity, small-scale, early-life stages, flatfish

Deneudt Klaas

VLIZ - Flanders Marine Institute

Author(s): Klaas Deneudt[1], Jan Reubens[1], Jonas Mortelmans[1], Elisabeth Debusschere[1], Carolien Knockaert[1], Lennert Tyberghein[1], Stefanie Dekeyzer[1], Francisco Hernandez[1], Jan Mees[1]

Affiliation(s) :

[1]Flanders Marine Institute, Belgium

Building an innovative and multidisciplinary marine biodiversity observatory for Lifewatch

To support the marine biodiversity and ecosystem dynamics research community in Belgium, the Flanders Marine Institute (VLIZ) is setting up a local marine biodiversity observatory. This marine observatory aims to apply innovative techniques to generate long term data series that can support marine biodiversity studies on plankton, benthos, fish, birds and mammals. State of the art sensors are acquired and deployed in the field to gather high resolution data on occurrence and behavior of marine organisms and their environment. The observatory combines the installation of sensor networks at selected locations with monthly surveys on the Belgian Part of the North Sea using the Simon Stevin research vessel. The assembled infrastructure includes a flow cytometer for fytoplankton characterisation, video plankton and zooscan for zooplankton imaging, acoustic telemetry devices for fish detection, web cams and GPS trackers for bird observation and tracking, acoustic hydrophones for mammal detection, etc.

This contribution describes the screening and selection of available and applicable technology, the work on establishing the data flow from sensor to the user, translating the raw sensor output to intelligible information, initial design and further optimalisation of the observatory and the efforts undertaken to serve the data and infrastructure to the users.

The construction and operation of this observatory is part of the Flemish contribution to the Lifewatch ESFRI, which is funded by the Hercules foundation, now part of Research Fund - Flanders (FWO).

Keywords: Observatory, Biodiversity, North Sea, Technology, Infrastructure, Data

Deschutter Yana

Ghent University, Marine Biology Research Group

Author(s): Deschutter Yana([1]), Everaert Gert([2]), De Schamphelaere Karel([2]), De Troch Marleen([1])

Affiliation(s) :

([1]) Ghent University, Marine Biology Research Group, Belgium

([2]) Ghent University, Laboratory for Environmental Toxicology and Aquatic Ecology, Environmental Toxicology Unit, Belgium

Understanding the response of zooplankton biodiversity and functioning in the North Sea as multistressor environment

Marine ecosystems are increasingly experiencing multiple disturbances along with the expanding human population. Climatic change leads to physical stressors such as changes in sea water temperature, salinity, and pH, while dissolved nutrients and pollutants in the marine ecosystem are important chemical stressors resulting from human activities. There is still a lack of quantitative data and understanding on how these chemical stressors interact in marine ecosystems and how they combine with climate change. To guarantee a sustained biodiversity and ecosystem functioning in the future, the understanding of the relative importance of the main drivers of change within marine ecosystems is crucial. To obtain a relevant database to underpin ecosystem-based management, we sampled the zooplankton of the Belgian part of the North Sea and its harbors every month for one year (2015). The samples are being analyzed through a multimethodological approach including stereomicroscopic identifications combined with Zooscan analysis, fatty acid profilings and toxicological measurements. First results indicate that both zooplankton communities and toxicant concentrations are very dynamic and heterogeneous within our study area. The obtained database will provide the necessary elements for ecological models unraveling the relative effects of different stressors within the Belgian part of the North Sea. Understanding these interacting effects on various biological levels will help to develop sound Ecological Risk Assessment methods and to establish reliable water quality criteria of chemical pollutants. The developed models will be validated in controlled lab experiments with selected zooplankton species, providing for possible model species to be used as bio-indicators in the future.

Keywords: climate change, pollutants, zooplankton, ecological models

Devriese Lisa

Institute for Agricultural and Fisheries Research (ILVO)

Author(s): Devriese Lisa[1], Haegeman Annelies[2], Maes Sara[1], Ruttink Tom[2], De Backer Annelies[1], Van Hoey Gert[1], Wittoeck Jan[1], Hillewaert Hans[1], De Tender Caroline[1], Hostens Kris[1]
Affiliation(s) : [1] Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences Unit, Aquatic environment and quality, Oostende, Belgium
[2] Institute for Agricultural and Fisheries Research (ILVO), Plant Sciences Unit, Growth and Development, Melle, Belgium

A DNA (meta)barcoding approach to tackle marine benthic biodiversity

Macrobenthos is recognized as a good biological indicator to measure changes in marine ecosystems. However, biodiversity assessments require accurate species identifications, which are commonly based on morphological features. DNA barcoding (species) and metabarcoding (communities) may provide a fast alternative. We developed a DNA metabarcoding method using Illumina MiSeq technology. Various barcoding primers were checked against publicly available sequences to select the most optimal barcode region and primer sequences for the macrobenthos species present in our study area. Next, amplicon sequencing was executed using barcoding primers designed for the 18S target region. DNA extracts of individual species, and of pooled samples in which tissues or DNA extracts of different species were mixed, were amplified using this method. This setup allowed us to check the effectiveness of the primers to detect species in single or mixed samples, and to investigate the relationship between read counts per species and the proportion of species in mixed samples. Based on the 18S target region, 39 of the 50 macrobenthos species were detected. For some species (e.g. Nephtys sp.) this setup will not allow us to discriminate between species of the same genus. As species of the order Amphipoda were not detected, an additional target region (COI) was included. COI amplicons of individual species were Sanger sequenced in anticipation of our COI metabarcoding results. This setup allowed us to evaluate which DNA barcode provides the best taxonomic resolution for the collected macrobenthos species. First results of the COI barcoding approach revealed an advanced taxonomic resolution for species of the order Amphipoda. The 18S and COI barcode sequences were added to our DNA reference library.

Keywords: DNA (meta)barcoding; macrobenthos; amplicon sequencing; 18S; COI

Gaida Constantin Timo

Delft University of Technology, Group Acoustics, Section ANCE, Department Control and Operations, Faculty of Aerospace Engineering

Author(s): Timo C. Gaida[1], Leo Koop[1], Mirjam Snellen[1,2], Dick G. Simons[1], Thaiënne A.G.P. van Dijk[2,3]

Affiliation(s) : [1]Group Acoustics, Section ANCE, Department Control and Operations, Faculty of Aerospace Engineering, Delft University of Technology

[2] Department of Applied Geology and Geophysics, Deltares

[3] Department of Water Engineering and Management, University of Twente

Classification of seabed sediments in the Cleaver Bank area using multi-beam echo-sounders

The grain size distribution of seabed sediments is one of the main parameters determining the composition of marine benthic communities. Mapping seabed sediments in a reliable and efficient way is still a challenge, due to the high costs and limited availability of seabed samples. Multi-beam echo-sounders (MBES) allow for the mapping of seabed sediment distributions with a minimum of bed samples. For the Dutch Natura2000 program, MBES data were acquired in the Cleaver Bank area during three surveys carried out in 2013, 2014 and 2015 using two different vessels. The backscatter strengths and bathymetry as measured by the 300-kHz EM3002 MBES have been used for classifying the surface sediments in the area using both a Principal Component Analyses of the backscatter features and the Bayesian approach that discriminates between sediment classes using the backscatter strengths while accounting for the ping-to-ping variability of the backscatter intensity.

The acoustic classification results show a very good agreement with grab samples, demonstrating the reliability of the determined sediment maps. The combination of the classification results of the MBES measurements from the different surveys show a very good consistency indicating both the repeatability of MBES classification and its independency on time scale and research vessel. This observation demonstrates the power of the use of backscatter strength for determining seabed sediment distribution of large areas and achieving a full coverage. Based on the repeatability of the classification results, measurements from individual marine surveys can be used for long-term environmental monitoring, by revealing time-dependent sediment maps, which are of high importance for assessing potential variations in the marine habitats.

Keywords: Benthic habitat mapping; Acoustic classification; Bayseian approach; PCA; Backscatter; Multi-beam echo-sounder

O'Hara Murray Rory (Alejandro Gallego)

Marine Scotland Science

Author(s): Rory O'Hara Murray[1], Michela De Dominicis[2] and Alejandro Gallego[1]

Affiliation(s) : [1] Marine Scotland Science, Marine Laboratory Aberdeen, Scotland (UK); [2] National Oceanography Centre - Liverpool, England (UK)

Modelling the near- and far-field effects on the physical environment of maximizing tidal stream energy extraction in the Pentland Firth, Scottish waters

Scotland's seas contain 25% of Europe's tidal energy resource and the Pentland Firth and Orkney Waters Strategic Area (PFOW) contains the highest tidal stream energy resource in Scotland. To date, six sites in the PFOW area have been licensed to Marine Renewable Energy (MRE) developers for commercial tidal stream energy development, with an overall aspirational energy generating capacity of approximately 1 GW. However, the maximum extractable power in the Pentland Firth has been quoted in the literature as > 4 GW so it is expected that further developments will be planned in the area. However, any single development has the potential to change the flow within the region to an extent, and it is widely expected that the scale of development required to extract most of the available tidal energy may have the potential to cause a "permanent alteration of hydrographical conditions", as defined by Descriptor 7 of the Marine Strategy Framework Directive.

Here we present results based on a high-resolution 3D hydrodynamic model developed from the Finite Volume Community Ocean Model (FVCOM). A number of potential tidal stream energy scenarios are represented within the model to investigate the realistic limits to the maximum tidal stream energy extraction in the region and their potential near- and far-field effects on the physical environment. The output metrics from our work provide the type of quantitative framework that is critically required in order to estimate the threshold values for any potential adverse effects on the marine environment that may threaten Good Environmental Status for Descriptor 7.

Keywords: marine renewables, tidal stream, MSFD, environmental effects

Gimpel Antje

Thünen Institute of Sea Fisheries

Author(s): A. Gimpel[1], V. Stelzenmueller[1], N. Marbà[2], J. Aguilar-Manjarrez[3], L. Arantzamendi[4], L. Asplin[5], K. Black[6], A. Boyd[7], D. Brigolin[8], G. Roca Carceller[2], Ibon Galparsoro[4], Aline Gangnery[9], Jon Grant[10], Matthew Gubbins[11], Anne A. Hageberg[12], Eva Kerepeczki[13], Hui Liu[14], David Miller[15], Arantza Murillas[4], Nafsika Papageorgiou[16], Roberto Pastres[8], Ana Sequeira[17], Øivind Strand[5] and S. Bricker[18]

Affiliation(s) : [1] Thünen Institute (TI), Institute of Sea Fisheries, Hamburg, Germany. E-mail: Antje.Gimpel@thuenen.de ; [2] Spanish National Research Council (CSIC), Madrid, Spain; [3] Food and Agriculture Organization of the United Nations (FAO), Rome, Italy; [4] AZTI-Tecnalia, San Sebastian, Spain; [5] Institute of Marine Research (IMR), Bergen, Norway; [7] The Agri-Food and Biosciences Institute (AFBI), Belfast, Uk; [8] Bluefarm, Venice, Italy; [9] Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), Port en Bessin, France; [10] Dalhousie University (DAL), Silver Spring, USA; [11] Marine Scotland Science (MSS), Aberdeen, Uk; [12] Christian Michelsen Research (CMR), Bergen, Norway; [13] The National Agricultural Research and Innovation Center (NARIC), Szarvas, Hungary; [14] Yellow Sea Fisheries Research Institute (YSFRI), Qingdao, China; [15] The James Hutton Institute (JHI), Aberdeen, Uk; [16] The University of Crete (UOC), Crete, Greece; [17] University of Western Australia (UWA), Crawley, Western Australia; [18] NOAA's National Estuarine Eutrophication Assessment, Silver Spring, US

Tools and methods to support an Ecosystem Approach to Aquaculture (EAA) - a gap analysis

The EU funded project AquaSpace aims to highlight the key issues and practical challenges when integrating aquaculture management in the wider context of marine spatial planning (MSP) processes. Accounting for emerging conflicts and synergies with other sectors or combined impacts in a multi-use environment a science based evaluation of aquaculture planning options is needed which allow for a spatial representation of costs (e.g. risks) and benefits (e.g. food security) of a proposed aquaculture activity at a specific location. This study outlines a targeted review on existing spatial analysis of costs and benefits and a stakeholder consultation process on required assessments to enhance spatial planning with aquaculture. This includes the mapping of a wide variety of tools and methods against constraints identified by the real world of the AquaSpace case studies. This finally allowed conducting a gap analysis on desired tools to facilitate the aquaculture planning process. Results revealed that there are multiple tools assessing environmental factors describing the suitability of a site for aquaculture ventures. Meanwhile a lack of tools assessing costs and benefits related to socio-economic issues was conceivable. Further it can be said that although nearly all functions have been applied in a GIS framework, no practical tool were found which were designed to fully implement environmental, social and economic functions.

Nevertheless, developed further, these tools could fill identified gaps and deliver decision support by providing a holistic view on environmental costs and benefits. Some methodology is taken forward to be part of a GIS add-in which allows such an environmental CBA. Such a toolkit would support the licensing process and facilitate investments.

Keywords: Marine spatial planning, Aquaculture, GIS, Tools

Huysman Steve

Ghent University, Dep. of Veterinary Public Health and Food Safety

Author(s): Huysman, S., Vanryckeghem, F., Van Langenhove, H., Demeestere, K., Vanhaecke, L.

Affiliation(s) : Ghent University, Dep. of Veterinary Public Health and Food Safety and Dep. of Sustainable Organic Chemistry and Technology

Is our North Sea contaminated with endocrine disrupting compounds?

To date, little is known about the presence of endocrine disrupting compounds (EDCs) in the marine environment resulting in few toxicological marine assessments on EDCs. Furthermore, the protection of our coasts and marine waters are a long-standing part of the European Community environmental policy, which is also internationally regulated (a.o. OSPAR, USEPA, etc.). To better evaluate the possible effects of EDCs and to meet international legislative obligations in the marine environment there is a need for monitoring. Therefore, the aim of this study was to develop analytical methods that allow simultaneous monitoring of multiple EDCs in the marine environment. A first method was designed to monitor steroidal EDCs (estrogens, androgens, progestins and corticosteroids). A second method was designed for the detection of xeno-estrogens, in particular phthalates and phenols. Both methods were optimised on an ultra high performance liquid chromatograph (UHPLC) coupled to a hybrid high-resolution mass spectrometer (HRMS). The steroidal EDCs and xeno-estrogens were separated with a water/methanol on a Hypersil Gold column. For both the steroidal EDCs and xeno-estrogens novel extraction procedures were developed using SpeedisksTM for sea water grab samples. The results of grab samples from the North Sea (in three Belgian coastal harbours Ostend, Nieuwpoort and Zeebrugge) in terms of EDC profile will be presented during the conference. A major advantage of our newly developed methods lies in their ability to identify also unknown EDCs in the North Sea, beside the targeted list (55 steroids and 20 xenoestrogens). This work will be an important first step towards environmental assessments, future European legislations and a contribution to the Marine Water Framework Directive.

Keywords: Endocrine disrupting compounds, Speedisks, grab samples, unknown analysis, seawater

Jenkins Chris (Sonia Papili)

University of Colorado Boulder - INSTAAR

Author(s): Chris Jenkins[1] & Thomas Wever[2]

Affiliation(s) :

[1] University of Colorado Boulder (INSTAAR), USA

[2] Wehrtechnische Dienststelle für Schiffe und Marinewaffen, Maritime Technologie und Forschung. Seafloor Research Group, WTD-71, Germany

A Demonstration of the Global Seafloor Substrates system dbSEABED

A demonstration will be given of the seafloor substrates mapping/analysis system dbSEABED.

In addition to holding the usual analysis-based data, it includes the ability to machine parse and transfer word-based descriptions to calibrated quantitative estimates for parameters like coarse fractions, components (especially the unusual or biological), features, colour and consolidation. No manual reclassification of data is required. This facility gives an unbiased view of the seabed materials, for example in coarse, rocky, intensely biological, and coastal settings as well as normal sediments.

There is a focus on physical properties such as geoacoustic properties, consolidation and surface physical roughness. This allows the system to fulfill it's main goal - providing better inputs to numerical models concerned with the seafloor - as recently for acoustics, sediment transport, trawling impacts, fisheries management, hydrodynamic drag. By holding copious (>5 million worldwide) data at sample / observation spatial granularity, special capabilities exist for analysis of spatial variability, i.e. benthic habitat patchiness. A live demonstration will be given, using the North Sea global ocean coverage. The worldwide partners of the project invite further collaborations.

Keywords: seabed mapping

Kromkamp Jacco

Royal Netherlands Institute for Sea Research (NIOZ)

Author(s): Jacco C Kromkamp[1], Thanos Gkritzalis[1], Reinhoud de Blok[1], Catharina J.M. Philippart[1]

Affiliation(s) : [1]Royal Netherlands Institute for Sea Research, Netherlands

[2]Flanders Marine Institute, Belgium

[3]Ghent University, Dep. of Biology, Belgium

A new innovative way for semi-automated measurements of phytoplankton primary production

Phytoplankton primary production forms the basis of marine food webs. Most measurements of marine primary production (PP) are based on the C14-technique, which measures the uptake of radioactive labelled CO2. Unfortunately there is a decrease in the number of primary production measurements all over the world, partly due to health and safety reasons which make it more and more difficult to use radioactive tracers on board ships. This makes it increasingly difficult to assess the functioning of the marine ecosystem and to assess the effects of global changes versus man-induced changes, for which long term time series are a necessity. As phytoplankton biomass is the result of both top-down and bottom up control, and because of the rapid turnover of phytoplankton cells, chlorophyll-a (chla) is a poor proxy for PP and there are several examples in the literature where a decrease in PP is not accompanied by a decrease in chla. In this presentation we will demonstrate that application of semi-automated Fast Repetition Rate Fluorometry (FRRF) can be a good alternative to measure phytoplankton PP. We will show measurements made on ships in the Dutch Delta, the Belgian and Dutch North Sea and discuss how FRRF measurements (which measure photosynthetic electron transport) and CO2-fixation are coupled. In addition we will show measurements of an automated setup on a jetty in the western Wadden Sea (Marsdiep basin) where the photosynthetic activity is measured continuously and this time series reveals a highly regulated diurnal pattern in activity.

Keywords: phytoplankton, primary production, FRRF

Lacroix Genevieve

Royal Belgian Institute of Natural Sciences (RBINS)

Author(s): Lacroix Geneviève[1], Barbut Léo[12], Volckaert Filip A.M.[2]

Affiliation(s) :

[1] Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment, Brussels, Belgium

[2] Laboratory of Biodiversity and Evolutionary Genomics, University of Leuven (KU Leuven), Leuven, Belgium

Will soles be more numerous and more connected in a warmer world?

Connectivity throughout the life cycle of fish remains a poorly charted question, especially during the early life stages. The case of the flatfish sole (Solea solea) is of particular interest because it is a heavily exploited species in the Northeast Atlantic Ocean whose interannual variability in recruitment is high. Effective fishery management requires the understanding of how spawning grounds and nurseries are connected, what processes influence larval retention/dispersal and how climate change will impact dispersal and connectivity patterns in the future. The dispersal pattern of sole larvae from the spawning grounds to the nurseries and larval survival/abundance are driven by hydrodynamic processes and (a)biotic environmental factors. A temperature increase could affect for instance the spawning period, the duration of the pelagic stage, the mortality of eggs and larvae, and the match-mismatch with prey fields. Modifications in the magnitude and direction of the wind regime might affect egg and larval retention and dispersal through changes in the hydrodynamics. Here we use a particle tracking model coupled to a 3D hydrodynamic model (LARVAE&CO) of the English Channel and the North Sea (between 48.5°N-4°W and 57°N-10°E) to investigate the impact of climate change on larval dispersal, connectivity pattern and recruitment at nurseries through a hypothetical increase in sea surface temperature and wind regime. The impact of five scenarios inspired by the 2040 scenario of the Intergovernmental Panel on Climate Change (IPCC) at the scale of the North Sea is discussed and compared with interannual variability over the period 2003-2011.

Montereale Gavazzi Giacomo

Royal Belgian Institute of Natural Sciences and UGent

Author(s): Montereale-Gavazzi G.[1,2], De Bisschop, J.[1,2], Roche, M.[3], Degrendele, K.[3], Baeye, M.[1], Francken, F.[1], Van Lancker, V.[1,2]
Affiliation(s) : [1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment. Brussels, Belgium
[2] Ghent University, Dep. Geology. Renard Centre of Marine Geology, Belgium
[3] Federal Public Service Economy, Continental Shelf Service, Belgium

Can multibeam-derived acoustic backscatter be used to monitor changes in seabed habitats?

Within the Marine Strategy Framework Directive, the benthic habitat is the backbone of many seabed related indicators. To assess its distribution and extent, seabed mapping, and particularly multibeam echosounding (MBES), is increasingly used. However, to monitor the environmental status of the seafloor, evaluations are needed on the precision, sensitivities and repeatability of the acoustic devices; taking into account the factors other than those exclusively related to the seabed that may influence the MBES BS level from one survey to another. This is especially the case for MBES backscatter (BS) since its decibel values' ranges, being a proxy of seabed type, depend on a range of instrumental and environmental parameters that need quantification before individual data products can be compared from one survey to another. Results relate to assessing the effect of suspended particulate matter (SPM) and near-bed sediment load on MBES backscatter, hitherto seldom quantified. During a 13h tidal cycle MBES backscatter was collected in combination with oceanographic data using a benthic lander and a profiler equipped with current and turbidity meters, as well as a particle-sizer and water samples. A strong correlation was found between the intensity of backscattering in the water column and MBES seafloor BS. Around highest current velocities, water column backscattering reached a maximum, with a higher absorption in acoustic energy. Around slack water, MBES BS was most reflective, with moderate water column backscattering. A significant difference of 3 dB was found against the variability given by the manufacturer. The variation in decibel range needs accounting for when evaluating changes in MBES BS, though this will depend on sediment type and dynamics. Our results emphasize the influence of SPM on the MBES seabed BS. Up to now this factor is not considered by the sonar equation itself. Given the temporal variations of SPMs concentration in coastal areas, the real-time measurement of SPM concentration in the water column and its effects on BS measurement remain serious challenges.

Keywords: Backscatter Multibeam Monitoring Seafloor

Papili Sonia (Lopera, O)

Belgian Navy

Author(s): Sonia Papili [1], Olga Lopera [2]

Affiliation(s) :[1]Belgian Navy, Marine Base Zeebrugge, Zeebrugge Belgium, [2]Signal and Image Centre, Royal Military Academy, Brussels Belgium,

High frequency response on seafloor signature: structure for an innovative methodology for modern monitoring.

Demanding a sustainable sea is currently a necessity more than a duty. To satisfy human needs, shallow seas are affected by a constant increment of activities. Next to fishing and transportation, more traditional, installations for energy sources such as windmills are currently the reality and marine constructions for residential or touristic purposes can be the future.

This constant and incrementing human impact requires an efficient monitoring on the ecosystem variability and moreover requires a thorough knowledge of the seafloor. High resolution (HR) sonar systems are frequently used to monitor our seas. They are often used for seabed mapping and, at a smaller scale, for object detection and time series analysis. The advances in the performances of these systems result in images with a detail of few centimeters resolution. Due to the spatial variability and the complexity present on the seafloor, this degree of detail can be misleading if not associated to an adequate understanding of the seafloor dynamics. During our current investigation we try to associate new image processing techniques to seafloor characteristics. This advanced approach and technique is the basic structure for our future project aiming to produce an innovative methodology for modern monitoring.

A test area on the Belgian Continental Shelf, between the Thorton bank and the Goote Bank is selected based on the long term stability of its physical characteristics. Information regarding the sediment granulometry, shell distribution, and biological presence are collected and associated to backscattering strength values recorded by two different AUV-mounted HR sonar systems (Side Scan Sonar REMUS@900/1800kHz, Synthetic Aperture Sonar MUSCLE@300kHz). Results will be presented during the conference.

Keywords: sonar, monitoring, innovative, approach

Phillips Becky

Joint Nature Conservation Committee (JNCC)

Author(s): Phillips, B.[1], Pettit, L.[1], Jesus, A.[1], Vaughan, D. R.[1], Robson, L.[1], Jenkins, C.[2], Lee, J.[3], Judd, A.[2], Stoker, B.[1] & Hawkridge, J. M.[1]

Affiliation(s) : [1]Joint Nature Conservation Committee (JNCC), United Kingdom
[2]Centre for Environment, Fisheries and Aquaculture Science (Cefas), United Kingdom
[3]Leegis Consulting Limited, United Kingdom

Developing innovative tools to improve the quality and efficiency of offshore Marine Protected Area assessments in the UK

Assessments of the state of marine biodiversity are required to deliver national and international reporting obligations and to inform management within Marine Protected Areas (MPAs). Offshore MPAs are difficult and costly to monitor so the availability of direct, observational evidence is currently low. JNCC in partnership with Cefas have been developing innovative tools that draw on best available evidence to assess the likely condition of benthic habitats within MPAs using information on human pressures and indicators of health. These include a Decision Support Tool (DST), and a Cumulative Effects Assessment (CEA) model. The DST is a system that provides an auditable and consistent method of decision making when undertaking an offshore MPA assessment. It consists of a number of discrete decision trees, each of which traces a set of possible options and assessment steps. The DST has the potential to be adapted for use in different assessment types or scales, including in the assessment of plans and projects.

The CEA model provides a systematic procedure of identifying and evaluating the significance of effects from multiple stressors and for providing an estimate on the overall expected impact. It uses a geographical information system model, which incorporates uncertainty. The model output provides a selection of maps, including the results of the cumulative effects assessment, which represents the results spatially across the site. The use of the DST and CEA model can improve the efficiency of undertaking offshore MPA assessments as well as the quality and transparency of the assessments.

Keywords: MPAs, habitat sensitivity, human pressures, cumulative effects assessment, decision support tool

Pirlet Hans

Flanders Marine Institute (VLIZ)

Author(s): Pirlet, Hans[1]; De Hauwere, Nathalie[1]

Affiliation(s) : [1]Flanders Marine Institute (VLIZ), Belgium

Historical maps of the coastal zone of the North Sea

How would our North Sea look like without any human impact? It is a question that is often asked by scientists but also by policymakers who have to set thresholds for legal instruments. This story of shifting baselines is more and more taken on by scientists, especially in the field of fisheries biology and ecology but also in geomorphological and sedimentological studies.

Historical maps of the coastal zone provide a unique view on the coast line of the North Sea with less human activities and may be used to assess the magnitude of the associated impact. However, there is often doubt about the accuracy and in most cases the relevant maps are not digitally available. In this context, Flanders Marine Institute (VLIZ) has started a new initiative - HisGISKust - in which historical maps of the Belgian coastal zone and the adjacent Scheldt Estuary (16th - 19th century) are digitally disclosed (http://www.vliz.be/hisgiskust/). This project was initiated in collaboration with the Cultuurbibliotheek (Brugge) and was funded by the Province of West-Flanders.

The historical maps are georeferenced in QGis and are subsequently disclosed through GeoServer. Furthermore, all georeferenced maps are analysed with regard to their geometric accuracy using MapAnalyst (Jenny and Hurni 2011). The distortion grids and statistical parameters that are produced with this program allow the end users to assess the possibilities for further analysis and avoid over-interpretation. In addition, certain elements of the maps such as the coastline are vectorised as shapefiles. All these products are disclosed with their metadata in open access to other end users. In the future, more historical maps of the coastal zone will be added to this collection and old aerial photos will be included as well.

Keywords: Historical maps, shifting baselines, Belgian part of the North Sea, Scheldt

Reubens Jan

Flanders Marine Institute and Ghent University, Marine Biology Research Group

Author(s): Jan Reubens([1,2]), Pieterjan Verhelst([2]), Klaas Deneudt([1]), Francisco Hernandez([1])

Affiliation(s) :

([1]) Flanders Marine Institute (VLIZ), Belgium

([2]) Ghent University, Dep. Biology, Marine Biology Research Group, Belgium

Acoustic receiver network - the need for range testing

Technology does not stand still and it helps researchers to perform high-quality scientific research. Improving technology allows us to gather continuous information on ocean processes, animal behaviour and environmental variables using automated devices. In Belgium, an acoustic receiver network was established as part of the Belgian LifeWatch observatory. This network allows flexible and cost-efficient spatio-temporal tracking of migratory fish species and is used to support biodiversity research and environmental impact studies.

An important aspect in acoustic telemetry studies is to know the detection range of the acoustic receivers. Therefore, range tests are performed to determine a receiver's ability to decode transmitters at various distances and in varying environmental conditions. The environmental factors affecting detection range (e.g. bottom type, noise, currents and weather conditions) can vary significantly from one location to another and with time at a particular location. Therefore, a range test was performed in the Belgian part of the North Sea to determine: 1) whether the current array design is appropriate and 2) to understand the detection performance and environmental factors influencing this performance. The range test assessed the detectability of tags between 50 and 700m and was run for approximately one month. Results will be discussed during the conference.

Keywords: acoustic telemetry, range test, fish, receiver

Savina Esther

DTU Aqua

Author(s): Esther Savina[1], Ludvig Ahm Krag[1], Niels Madsen[12]

Affiliation(s) :

[1]Technical University of Denmark, National Institute of Aquatic Resources, North Sea Science Park, Hirtshals, Denmark

[2]Present address: Section of Biology and Environmental Science, Department of Chemistry and Bioscience, Aalborg University, Aalborg, Denmark

Ecosystem Approach: fishing gear technical contributions and challenges for passive gears in the North Sea

Fishing can affect other components than targeted species, with for example physical damage to habitats or discards. In the case of bottom set nets, effects on habitat may be well below those associated with natural disturbance, but if located in areas of high biological importance, the effects on ecosystem functions could be larger. Gillnets are known to be size selective, but they can catch various species. From a conservation perspective, minimizing unwanted catch helps maintain biodiversity and community structure and function. Gear technological considerations are therefore necessary to fully implement an Ecosystem Approach to Fisheries, and hence participate in an ecosystem-based management of the North Sea.

There is limited knowledge about the ecosystem impacts of passive gears in the North Sea, partly due to historical focus on active gears, but also because data collection and analysis calls for the development of appropriate innovative assessment methodologies. We will present how experimental data gathered in commercial conditions can help assess the 3D movements of gillnet on the seabed, and better understand discarding practices in passive gear fisheries.

The consideration of the gear level in an ecosystem-based approach participate in better understanding of fishing pressures, and can have management implications at a broader scale for example when considering Marine Spatial Planning in sensitive areas.

Keywords: Ecosystem-based approach, fishing gear technology, habitat damage, discard, gillnet

van der Zande Dimitry

Royal Belgian Institute of Natural Sciences

Author(s): Dimitry Van der Zande, Kevin Ruddick

Affiliation(s) : Royal Belgian Institute of Natural Sciences/OD Nature

Space-borne ocean colour observations: a valuable tool for monitoring the water quality in the North Sea

International initiatives such as the Water Framework Directive (WFD) and Marine Strategy Framework Directive (MSFD) aim at maintaining a 'good environmental status' of marine waters. Operational monitoring is an essential part of the implementation of these directives to evaluate the effects of measures taken to improve situations like the eutrophication state of the Belgian coastal waters. While traditional seaborne observations are still considered as the main monitoring tool, optical remote sensing is a valuable supporting instrument to achieve the monitoring requirements in a time of severe resource constraints of ship time and man power. Over the last decade, mature services for marine monitoring and management have emerged using data from mainstream ocean colour sensors such as ENVISAT-MERIS and MODIS-AQUA and the recently launched Sentinel3-OLCI. These sensors typically deliver daily reflectance data used to estimate water quality parameters such as the concentrations of chlorophyll a (CHL) and total suspended matter (SPM) with a spatial resolution of 300m. Additionally, there is a growing interest in exploiting data from high-resolution sensors on polar-orbiters originally designed for land applications, such as Landsat-8/OLI giving 30m spatial resolution, Sentinel-2/MSI (10-60m) and Pleiades (2m) as they enable new types of applications (e.g. monitoring of harbors, environmental impact assessment, etc). Within running projects (i.e. FP7-HIGHROC, FP7-INFORM, STEREO-PONDER), RBINS is developing algorithms and software to turn raw Earth Observation data from satellite sensors into value for the end users. This presentation will show the state of the art of ocean colour services currently provided in Belgium, in particular in support of MSFD and WFD reporting.

Keywords: ocean colour, eutrophication, MSFD, WFD

Van Hoey Gert

Institute for Agricultural and Fisheries Research (ILVO)

Author(s): Van Hoey Gert

Affiliation(s) : Institute for Agricultural and Fisheries Research (ILVO)

Ecosystem status assessment: one step at a time!

The goal of the Marine Strategy Framework Directive is an integrated, regional ecosystem status assessment. That is a major challenge with a large number of hurdles. In this contribution, I want to illustrate the essential steps in this process, with the North Sea benthic ecosystem as an example. The first step is to determine appropriate strata (units) for the status assessment and related monitoring within a region. The units are ideally based on the environmental drivers triggering the co-occurrence and habitat demarcation of different ecosystem components (cf. North Sea ATLANTIS model). The second step is the regional data gathering, which should be collected in an efficient way. Therefore, the effort should be distributed across the strata, taking into account the variance of the benthic characteristics and the size of the strata. Such a sampling program can 'harvest' from existing or adapted national and environmental impact assessment monitoring programs. In a third step, a set of indicators with complementary properties (structural and functional) has to be chosen to effectively assess the ecosystem and to support the decision-making process. Although a wide variety of benthic related indicators already exist, picking the right ones is still a major challenge. Since there are so many possible configurations, harmonization and intercalibration is unavoidable. Additionally, setting an appropriate threshold against major pressures is an equally complicated business. Finally, this assessment should lead to an appropriate management plan for the region. So there are different steps and each step faces its own challenges. To reach this, further strengthening of the regional coordination is needed.

Keywords: MSFD, Indicatoren, assessment

Vanhellemont Quinten

Royal Belgian Institute of Natural Sciences

Author(s): Quinten Vanhellemont and Kevin Ruddick

Affiliation(s) : Royal Belgian Institute of Natural Sciences

Aquatic applications of (very) high resolution satellite imagery

In the last few years, novel applications of high spatial resolution satellite imagery in coastal and inland waters have emerged. The main drivers for this evolution are the availability of data for free from the space agencies or at reasonable cost from private companies, as well as the improvement of the imaging sensors themselves. In contrast to the traditional ocean colour missions with pixel sizes of 250 m to 1 km, high resolution missions with pixel sizes from <1 m to 100 m, can be used for monitoring turbidity and algal blooms in smaller water bodies, estuaries, and in the near-shore coastal zone. Studies have also shown the use of this type of imagery for monitoring of offshore constructions such as wind farms, regular dredging activities, and even the detection of shipwrecks. Here we present some applications and the processing of high resolution satellite imagery, with a focus on the Pléiades mission and its complementarity to the Landsat and Sentinel-2 missions. Pléiades is a constellation of two identical satellites, which have on board a five band imager with four spectral bands (blue, green, red, and near-infrared) at 2.8 m spatial resolution, and a panchromatic band across a part of the visible and near-infrared at 70 cm resolution. The mission allows for turbidity mapping within ports and estuaries and can aid in understanding of small scale sediment dynamics and dredging efforts. Pléiades shows potential for detection of algal blooms, and in waters dominated by phytoplankton, the concentration of chlorophyll a may even be retrieved. A fourfold improvement of the spatial resolution can be achieved using the panchromatic channel, allowing for the mapping of sub-metre scale structures.

Keywords: water quality, turbidity, dredging, sediment transport, chlorophyll a concentration, remote sensing, ocean colour

Willsteed Edward

Cranfield University/Cefas

Author(s): Edward Willsteed [1,2], Andrew Gill [1], Silvana Birchenough [2], Simon Jude [1]

Affiliation(s) :

[1] School of Water, Energy and Environment, Cranfield University, Cranfield, U.K.

[2] Cefas, Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, U.K.

Assessing the cumulative environmental effects of marine renewable energy developments

Assessing and managing the cumulative impacts of human activities on the environment remains a major challenge to sustainable development. This challenge is highlighted by the worldwide expansion of marine renewable energy developments (MREDs) in areas already subject to multiple activities and climate change. Cumulative effects assessments in theory provide decision makers with adequate information about how the environment will respond to the incremental effects of licensed activities and are a legal requirement in many nations. In practise, however, such assessments are beset by uncertainties resulting in substantial delays during the licensing process that reduce MRED investor confidence and limit progress towards meeting climate change targets. Our research to date has reviewed the origins and evolution of cumulative effects assessments, key considerations and challenges, and how these translate into uncertainties with respect to assessing the cumulative effects of MREDs. A second component of the research has been a critical evaluation of MRED cumulative effects assessments to identify how effective practical assessments are at meeting the information needs of marine managers tasked with protecting and conserving the structure and function of marine ecosystems. Here we present the outputs of the critical evaluation and of the review and propose common ground from which to coordinate future assessments to better support marine management objectives.

Keywords: Cumulative effects assessment; marine renewable energy; cumulative effects; environmental impact assessment; marine management

Posters

Theme 2:

A new era in environmental monitoring and assessment: what is at stake?

Artigas Luis Felipe (Arnaud Louchart)

LOG CNRS - Université du Littoral Côte d'Opale

Author(s): L.F. Artigas[1] , A. Louchart[1], A. Budria[1,2], M. Duflos[2], I. Rombouts[2], A. Aubert[2], A. McQuatters-Gollop[3], C. Ostle[3], R. de Blok[4], V. Créach[5], A. Lefebvre[6], F. Lizon[7], M. Rijkeboer[8], L. Tyberghein[9], M. Thyssen[10], G. Waquet[1], A. Veen[8]

Affiliation(s) : [1]LOG-CNRS UMR 8187, ULCO, MREN, Wimereux, France.; [2]Museum National d'Histoire Naturelle (CRESCO), Dinard, France.; [3]University of Plymouth, Plymouth, U.K.; [4]U Gent, Ghent, Belgium; [5]Cefas, Lowestoft, U.K.; [6]LER/BL, IFREMER Boulogne sur Mer, France; [7]LOG-CNRS UMR 8187, Université de Lille 1, SMW, Wimereux, France. ; [8]RWS, Lelystad, Netherlands; [9]VLIZ, Ostende, Belgium; [10]MIO-CNRS UMR 235, Marseille, France

On the use of automated approaches for addressing Pelagic Habitats Indicators for the Marine Framework Directive (MSFD)

In order to make European marine ecosystems reach a Good Environmental Status, European countries have defined monitoring and management strategies with reference to descriptors of the Marine Strategy Framework Directive (MSFD). For addressing biodiversity state in pelagic habitats in the North-East Atlantic region, three common diversity indicators were elaborated, based on plankton life-forms, biomass/abundance and community composition, in the frame of an Ecosystem Approach for Regional Habitat Assessmeents (EcApRHA) project. In order to calculate these indicators, phytoplankton monitoring is being implemented, which is based mainly based on discrete sampling and reference laboratory methods as microscopic identification and counts, as well as pigment analysis. However, sampling frequency (fortnightly to monthly and mainly in coastal stations) is not fitted to follow phytoplankton dynamics. In order to increase both the spatial and temporal resolution and to gather useful complementary information for calculating indicators, automated approaches are currenty being applied to monitoring in the North Sea-Channel region, in the framework of both DYMAPHY (2010-2014) and JERICO-Next (2015-2019) European projects, coupled with observing systems and environmental monitoring platforms. There is an increasing need to improve their operability as well as their discrimination of phytoplankton groups.

Keywords : Marine Strategy Framework Directive – Pelagic Habitat Indicators – Phytoplankton - Automated techniques

Baetens Katrijn

Royal Belgian Institute of Natural Sciences

Author(s): Katrijn Baetens[1], Stefano Salon[2], Gianpiero Cossarini[2], Henning Wehde[3], Sébastien Legrand[1], Ray Mahdon[4] and Jan Maksymczuk[4]
Affiliation(s) : [1]Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium
[2]Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - Ogs di Trieste, Italy
[3]Institute of Marine Research, Norway
[4]MetOffice, UK

Quantifying and visualizing the skill of biogeochemistry models in reproducing satellite chlorophyll patterns with binary metrics: a validation study.

Validation tasks are a routine part of research activities in ocean modelling, and aim to verify that the models are scientifically robust and provide numerical results that match. This work presents a technique for biogeochemistry models validated with satellite data that makes use of binary metrics. It is tested on three different area's (Southern Bight of the North Sea, Kattegat/Skagerrak and Mediterranean Sea) and three different models. The aim is not to compare the performance of the three biogeochemistry models, but to check the usefulness of the binary validation techniques. The binary technique checks if model and satellite data pass a threshold value at the same position on the map. This approach gives a rather robust validation of biogeochemical model data but recognizes a match in modelled and observed plankton patterns in space or time. The pattern match is quantified by different discriminants such as the Hanssen-Kuipers discriminant and visualized in colour coded maps. Flexibility in pixel match is introduced by allowing a match between an observed result at a position of interest and a modelled result in the neighbourhood of that position, a known methodology (neighboring method) is used.

The techniques are successfully tested for three different areas (the Southern bight of the North Sea, the Baltic and the Mediterranean Sea).

Categorical metrics in existing studies are usually not combined with neighboring methods and usually there is a focus on the spatial dimension. This work illustrates the temporal dimension. The validation technique is a fast way of detecting structural biases between model and observations. The new visualization presentation is useful for fast model skill assessment.

Keywords: Validation technique, biogeochemistry models, satellite data, neighbouring methods, binary methods, pattern validation

Beauchard Olivier

Netherlands Institute for Sea Research (NIOZ)

Author(s): Olivier Beauchard

Affiliation(s) : Netherlands Institute for Sea Research (NIOZ), The Netherlands

Life-history strategies of North Sea benthic macroinvertebrates: typology and indication of beam-trawl fishing impact

The need of ecological indicators as part of marine directives and conservation programmes has promoted the use of multiple traits for indicator development, but in a questionable context regarding the state of fundamental developments in marine community ecology. In the Dutch exclusive economic zone, benthic macroinvetebrate communities have been intensively studied over more than twenty-five years. This sector of the North Sea is now richly documented in terms of species autoecology and distributions. At the community level, clear correspondences between species assemblages and habitat features have been evidenced. However, the mechanistic explanations behind have been critically lacking.

In this work, life-history strategy is evidenced to be a central element to understand why some benthic communities occur in some habitats and not in some others. Adaptations to habitat temporal variabilities determine either the resistance, the resilience or the sensitivity of benthic communities to physical constraints. In order to derive indicator development, these theoretical outcomes were combined to beam-trawl fishing. The results clearly suggest that beam trawling intensity mimics natural habitat variabilities which have conditioned evolutionary adaptations of the benthic fauna. Macroinvertebrate typological groups of specific life-history strategies are shown to be relevant synthetic indicator of sea-floor integrity.

Keywords: biological traits; life-history strategy; ecological indicators

Beermann Jan

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

Author(s): Jan Beermann, Karin Heyer, Jan Holstein, Jennifer Dannheim

Affiliation(s) : Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

Large-scale information systems - valuable tools for the assessment of the ecological quality status for MSFD purposes in the North Sea

In order to meet the demands of the European Marine Strategy Framework Directive (MSFD) there is a need for a standardized and consistent way to assess the ecological quality of the North Sea. Although this has repeatedly been a matter of debate, a uniform guideline is still missing and several different indices are currently in use. Large-scale highly resolved datasets may be a convenient and valuable basis to disentangle contradictions and to distinguish between natural variability and anthropogenic disturbance. Here, we used a compiled dataset which covered almost the entire German Bight (North Sea) with a high spatial resolution and continuous information available in some regions for a timespan of nearly 50 years. Ecological Quality Ratios (EQR) were calculated for predefined areas using both commonly employed EU Water Framework Directive (WFD) indices (e.g. M-AMBI, BQI, BEQI2, DKI) and assessment indices that are currently under discussion by OSPAR (e.g. Margalef, FIBI, ITI). The outcomes for respective benthic communities were correlated to different natural and anthropogenic stressors to assess each indicator's applicability for the realistic depiction of the ecological water quality. Furthermore, the influence of different sampling strategies for the analyses is demonstrated and the advantage of huge datasets is discussed in this context.

Keywords: large-scale datasets; Marine Strategy Framework Directive; ecological quality assessment; ecological indicators

Bekaert Karen

Institute of Agricultural and Fisheries Research (ILVO)

Author(s): Karen Bekaert[1], Marielle Adam[2], Karien Decauwer[2], Ruth Lagring[2], Bavo Dewitte[1]

Affiliation(s) :

[1] Institute of Agricultural and Fisheries Research (ILVO), Belgium

[2] Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment, Belgium

Determination of the best normalizing parameter for heavy metals in sediments of the Belgian Part of the North Sea (BPNS)

In order to determine temporal or spatial changes in heavy metals in sediments, a correction is needed for the grain size effect. Coarse components in sediments, which normally have low levels of heavy metals and organic pollutants, produce a downward shift of the concentration in the total sample. Since sediments of different origin vary in grain size composition, this shift is non-uniform between locations. Therefore, pollutant concentrations should be standardized by using a normalizing parameter for extrapolating the results towards a "standard seafloor". An important condition for normalizing is that equally polluted samples should show a linear relationship between the concentration of the contaminant and the normalizing parameter. To find the best normalizer, sediments of nine locations of the Belgian Part of the North Sea were taken with a Van Veen grab in March 2015 and sieved into nine different fractions in order to artificially make equally polluted samples. Each fraction was analyzed for heavy metals and possible normalizing parameters (Fe, Al and Total Organic Carbon (TOC)). The best normalizer was determined to be TOC, as this gave the best linear relationship with most heavy metals based on the correlation coefficient. However TOC values are not always available, therefore Fe will be used as second best normalizer for comparing the results of four decades of heavy metal monitoring in the BPNS in the frame of the project "4 decades of Belgian marine monitoring: Uplifting historical data to today's needs" (4DEMON).

Keywords: heavy metals, sediments, normalization

Cheng Chiu

Royal Netherlands Institute for Sea Research (NIOZ)

Author(s): Chiu Cheng[1], Bas Borsje[2] and Karline Soetaert[1]

Affiliation(s) :

[1] Royal Netherlands Institute for Sea Research (NIOZ), The Netherlands

[2] University of Twente, The Netherlands

Feedback of benthic organisms to bedforms in the North Sea

Many studies in the North Sea show significant relationships between benthic macrofauna and their surrounding environment. In particular, they illustrate how specific groups of benthos effectively function as ecosystem engineers, modifying the seabed stability and landscape. Disturbances to the seabed, from anthropogenic activities such as sand mining, not only physically alter seabed morphology, but can also impact macrofauna community structure and densities. This could have cascading effects on local sediment dynamics, biodiversity or other ecosystem function and exchange processes. This project will study the interactions between the benthic organisms and seabed features, through processes such as ripple formation, erosion and incorporation of fines into the sediment. Benthic biodiversity and its relationship with geomorphology will be investigated through field campaigns as well as laboratory experiments using racetrack and annular flumes. The research aims to facilitate the development of design rules for smart and sustainable use of the sandy seabed.

Keywords: Geomorphology, benthos, ecosystem engineer, sand mining, benthic, North Sea

Desmit Xavier

Royal Belgian Institute of Natural Sciences

Author(s): X. Desmit, D. Van der Zande, G. Lacroix

Affiliation(s) : Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environments, Brussels, Belgium

Spatial patterns of chlorophyll a variability in the North East Atlantic

The North East Atlantic (NEA) comprises a high diversity of marine systems within a relatively small geographical area: shallow and well-mixed systems, stratified systems, coastal upwelling systems, continental shelf and deep ocean. Across these systems, different seasonal and interannual patterns of chlorophyll *a* (Chl) variability may be observed. Characteristic features of the Chl dynamics are used to identify typical areas across the NEA, in a way similar to Longhurst provincies classification. Remote sensing observation of Chl (ENVISAT-MERIS, 2nd reprocessing, full mission) offers a comprehensive picture of the spatial dynamic of surface phytoplankton biomass over almost a decade (2003-2011). An existing multiplicative method of Chl signal decomposition was applied to every pixel separating the Chl signal into four components: 1) the grand mean, 2) the interannual, 3) the seasonal and 4) the residual components for the considered 9-years period. In this way, the method assumes no trend over the considered period where the standard deviations of each component are compared in a relative fashion to describe the local dynamics of Chl. The pixel-wise calculated components are represented in individual maps to depict the spatial patterns of chlorophyll *a* variability and outline areas of high or low seasonal and interannual variability. Subsequently the decomposed Chl signal is used in a K-means cluster analysis to classify the NEA region into different categories of Chl dynamics for the considered period 2003-2011 providing a governance tool for policy makers.

De Borger Emil

Ghent University & NIOZ

Author(s): Emil De Borger[1,2], Jan Vanaverbeke[1,3], Ulrike Braeckman[1], Marilaure Grégoire[4], Karline Soetaert[2]

Affiliation(s) :

[1]Ghent University. Dep. Biology. Marine Biology Research Group, Belgium
[2]Netherlands Institute for Sea Research (NIOZ), The Netherlands
[3]Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium
[4]Université de Liège, Belgium

Upscaling small-scale environmental studies of the Southern Bight of the North Sea by biogeochemical modelling.

The FaCE-It project (Functional biodiversity in a Changing sedimentary Environment: Implications for biogeochemistry and food webs in a managerial setting) aims at understanding the impact of sediment fining and artificial hard substrates on the benthic biogeochemical cycle and food webs in the Southern Bight of the North Sea (SBNS). We will develop mechanistic model descriptions of sediment biogeochemistry and food webs to help upscaling experimental results, performed at the local scale (see poster by Toussaint et al., and Mavraki et al.), to the entire area, by providing descriptions that can be coupled to the hydrodynamic model developed for this area (see poster by Ivanov et al.). Here we present initial results of an early diagenetic model, implemented to investigate the impact of bio-irrigating benthic animals on the nitrogen and phosphorus cycle. The model is applied in muddy and porous sandy sediments, showing the different effects of animal activity in these sediment environments. Bio-irrigation is a crucial but understudied activity of benthic organisms. It will change if benthic communities are altered due to fining of the sediment, which is what we observe in the SBNS. Via our models, we want to relate density of bio-irrigating animals to the effect of sediment biogeochemistry, so as to ultimately predict how biotic changes will affect ecosystem functioning.

Keywords: SBNS, sediment biogeochemistry, diagenetic modelling, bio-irrigation,

De Cauwer Karien

Royal Belgian Institute of Natural Sciences - MUMM

Author(s): De Cauwer K.[1], De Witte B.[2], Desmit X.[1], Lauwaert B.[1], Parmentier K.[1], Van der Zande D.[1] & Van Hoey G.[2]

Affiliation(s):

[1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Brussels, Belgium
[2] Institute for Agricultural and Fisheries Research (ILVO), Oostende, Belgium

Evaluation of the Belgian coastal waters in the frame of the EU Water Framework Directive

According to the Water Framework Directive (2000/60/EC), the river basin management plan needs to be updated every six years. This includes a presentation of the monitoring results of the considered water bodies. Within the river basin management plan for the Belgian coastal waters, the ecological status is evaluated in the 1 nautical mile zone while the chemical status is evaluated in the 12 nautical miles zone. Monitoring results gathered during the period 2009-2014 are presented in the current revision of the first river basin management plan. Different priority substances as well as Scheldt specific pollutants (agreed in the frame of the International Scheldt Treaty) have been evaluated. Priority substances that exceed the environmental quality standard belong to the persistent, bio-accumulating and toxic substances that stay present for a long time in the aquatic environment, even after drastic measures or a total ban. In general, an evolution of decreasing trends can be noticed. The ecological status is evaluated as moderate: benthic invertebrate fauna score moderate with an Ecological Quality Ratio close to the defined threshold and chlorophyll *a* exceeds the threshold concentration (moderate). The assessment includes an evolution over time of nutrient concentrations and refers to the importance of cross-border inputs to the Belgian coastal waters, indicating that the achievement of good water status will depend upon international collaboration.

Keywords: WFD, chemical status, ecological status, Belgian coastal waters

De Tender Caroline

Institute for Agricultural and Fisheries Research (ILVO)

Author(s): De Tender Caroline[1,2], Devriese Lisa[1], Haegeman Annelies[1], Maes Sara[1], Ruttink Tom[1], Dawyndt Peter[2]

Affiliation(s) :[1]. Institute of Agriculture and Fisheries Research, Merelbeke, Belgium

[2]. Department of applied mathematics and computer sciences, Ghent University, Ghent, Belgium

The dynamic bacterial colonization on plastic: an exposure experiment at sea

Plastic debris is widespread in our marine ecosystem. For some marine organisms, e.g. fish and seabirds, its presence could be harmful as they could be entangled by plastic debris or ingest microplastics. However, other organisms, especially micro-organisms, may take advantage of the plastic pollution in the seas, as they can use plastic as habitat or even as food source.

We previously showed using 16S rDNA metabarcoding, that bacteria are able to colonise plastic items in the North Sea. The composition of the bacterial community on these items was different from that of seawater and sediment. This indicates that the plastic surface represents a specific environmental niche for bacteria, and suggests that plastic could act as transport vector for microbial organisms. Also between the plastic items, variation in bacterial community composition was observed which could be associated to three main factors: plastic-related factors (e.g. pigments), environmental factors (e.g. seawater temperature, salinity) and the stage of biofilm formation.

To study the dynamics of the bacterial colonisation of plastic, we exposed two different types of polyethylene (sheet vs. dolly rope) to the marine environment on two different locations (harbour vs. offshore). Plastic was sampled on a monthly interval during six months. Biofilm formation could be observed visually after six months of exposure. Using 16S rDNA metabarcoding, the temporal dynamics of bacterial community composition and diversity will be studied with the aim to study the early processes of marine plastic debris colonization

Keywords: Plastic debris, Bacteria, Metabarcoding

Jauniaux Thierry

University of Liège

Author(s): Jauniaux Thierry

Affiliation(s) : University of Liege, Dept of Veterinary Pathology, Belgium

Causes of death of harbour porpoises (Phocoena phocoena) stranded on the Belgian coastline (1990-2015)

Since the end of the 1990s, a significant rise of harbor porpoise (Phocoena phocoena) stranding occurred in the southern North Sea and the density of stranding on its continental coastline (Netherlands, Belgium and northern France) is among the highest in Europe. The aim of the study is to present the main lesions and causes of death of porpoises stranded on the Belgian coastline and their evolution between 1990 and 2015. Porpoises were selected for necropsy and sampling (histopathology, toxicology, microbiology) following a standard procedure. Frequent observations included net marks on the skin, sub-cutaneous and muscular bruises, emaciation, pulmonary (blood vessels and airways) and gastric parasitism, acute pneumonia, and pulmonary congestion and edema. The two main causes of death were by caught in fishing nets and infectious diseases. By-catch in fishing nets was mainly observed in animals stranded in March and April and appeared to be more frequent (from 20% to 35%). Infectious diseases (40%), mainly acute pneumonia associated with severe parasites infestation, occurred throughout the year. The infection by Brucella ceti is reported on 8% of stranded porpoises. Two other causes of death are emerging: severe emaciation with lung edema in absence of other lesions and grey seal attacks with typical lacerations of the skin and the blubber. The two main reasons for the recent porpoises stranding rise on the continental coastline of the southern North Sea are linked (1) with the southward shift of the population within the North Sea and (2) with the characteristics of winds, tides and currents pushing carcasses towards the coast.

Keywords: Harbour porpoise

Kint Lars

Royal Belgian Institute of Natural Sciences

Author(s): Lars Kint[1], Sytze Van Heteren[2], Ruth Lagring[1], Vera Van Lancker[1]

Affiliation(s) : [1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium
[2] TNO, Geological Survey of the Netherlands, The Netherlands

Versatility of marine geological databases in view of MSFD related assessments

To ensure harmonised seabed mapping over large areas and to facilitate the exchange of information, a common geological knowledge base is being developed for the southern part of the North Sea. Data, sustaining this marine geological database, originate from a variety of sources, including the industry.

Related to the seabed and its subsurface, two main databases are being compiled: one comprising all available lithological descriptions and one with all numerical grain-size information. To enable standardisation of the data and make them easily queryable, non-numerical descriptions are being coded to an international standard (EU FP7 Geo-Seas), of which the Udden-Wentworth scale is the main classifier. Several other parameters were derived, such as percentages mud, sand, gravel, shells and organic material. For the second database, cumulative grain-size distribution curves were compiled, enabling calculations of any desired granulometry parameter, such as percentages of the grain-size fractions (fine, medium, coarse sand) and percentiles that are relevant in seabed-habitat mapping or sediment-transport modelling (D35, D50, D84). To quantify data uncertainty in the derived data products, metadata on sampling and coring techniques, analytical methods, horizontal and vertical positioning accuracy and the exact timing of data acquisition were included. These metadata fields are also crucial in the quantification of habitat changes, a key issue in the assessment of good environmental status within Europe's Marine Strategy Framework Directive.

The newly developed database and its associated data products contribute to the objectives of the projects TILES (Belspo Brain-be), EMODnet-Geology (EU DG MARE), and ZAGRI (private revenues from the marine-aggregate industry).

Keywords: geological resources, data management, seabed mapping, Marine Strategy Framework Directive, North Sea

Lagring Ruth

[1]Royal Belgian Institute of Natural Sciences

Author(s): Ruth Lagring[1], Marielle Adam[1], Annelies Goffin[2], Yvan Stojanov[1], Lennert Tyberghein[2], Thomas Vandenberghe[1]

Affiliation(s) : [1]Royal Belgian Institute of Natural Sciences, OD-Nature

The implementation of a data management plan to uplift historical data: long-term change detection in the Belgian Continental Shelf

The amount of marine data collected during research and monitoring programs is increasing continuously. Based on these data, long-term changes have been reported in all measured indicators defining an ecosystem status. Over the years not only the climate is changing, also the know-how has undergone an immense evolution. First of all, methods for data collection and analyses have improved, and secondly means for data handling and storage have been upgraded. As in the past a lot of data were stored locally, today more than ever there is a need for integrated quality-checked, intercalibrated and integrated datasets. The project "4 Decades of Belgian Marine MONitoring: uplifting historical data to today's needs" (4DEMON) has the challenge of integrating data on contamination, eutrophication and ocean acidification gathered in the past with recent data from the Belgian Continental Shelf (BCS). This both safeguards the historic data and uplifts its value.

To streamline the resuscitation process a data management plan was implemented. At the base is a workflow with all data management tasks, the latest processes and tools. This involves a secure online file sharing system (MDA), a Data Inventory and Tracking system (DITS), the import process in large integrated databases (IDOD and IMERS) and international dissemination via projects like OBIS and EMODNet by the National Oceanographic Data Centres (VLIZ and BMDC).

The intermediate results are very promising: thanks to the inventorisation of over 1000 datasources an immense amount of data could be resuscitated. As a result, the project could already indicate shifts in species, test standardization methods and relate trends to reduction policies. The adequate data management plan can be applied in many projects.

Keywords: climate change, long-term data sets, historic data, data management plan

Lopera Olga

Belgian Navy

Author(s): Olga Lopera [2], Sonia Papili [1]

Affiliation(s) : [1]Belgian Navy, Marine Base Zeebrugge, Zeebrugge Belgium, [2]Signal and Image Centre, Royal Military Academy, Brussels Belgium,

New methodology for modern monitoring

Currently, our project aims to use high resolution (HR) acoustic images to associate seafloor characteristics to zones in the image with similar statistical representation. Based on that, further work will be directed towards the development of a new methodology to improve monitoring procedures and new ways for acoustic images quality assessment. The resulting methodology will be helpful for both decision makers and operators in determine which areas need further control/monitoring. This new approach could be applied in different areas such as automatic recognition of seafloor characteristics, sea waste monitoring and collection.

This challenging new project aims to enhance the efficiency in operation and investigation at sea and to improve ecosystems conservation.

Madgett Alethea

Marine Scotland Science and Robert Gordon University

Author(s): Alethea Madgett, Kyari Yates, Lynda Webster, Colin Moffat

Affiliation(s) : Marine Scotland Science and Robert Gordon University

Bioaccumulation of Persistent Organic Pollutants and Trace Metals in North Sea Food Webs and their Relationship with Trophic Level and Fatty Acid Signatures

The concentration of persistent organic pollutants (POPs) and trace metals will be determined in a variety of targeted species at different trophic levels across the marine food web of the northern North Sea. Fatty acid signatures will be determined by gas chromatography-mass spectrometry (GC-MS). Stable isotope ratios (15N/14N and 13C/12C) determined by CN Isotope Ratio Mass Spectrometry (IRMS) will be used, together with the fatty acid signatures, to identify the feeding pattern of organisms and accurately determine their trophic position. Samples have been collected from 5 areas around Scotland covering from trophic level 1 (primary producers) to level 4 (whiting and dogfish). The relationship between the trophic position and contaminant concentrations will be assessed. The Water Framework Directive (WFD) has introduced Environmental Quality Standards (EQS) for a number of contaminants in biota while other processes have also produced assessment criteria including Background Assessment Concentrations (BACs) and Environmental Assessment Criteria (EACs).In order to undertake marine assessments using data from across the foodweb, the data sets need to be normalised to trophic level 4 (species that can most easily be obtained in sufficient numbers on a regular basis). Trophic magnification factors (TMFs) will be calculated and applied to the concentrations of POPs and trace metals to investigate the effect this has on the assessment of the data against the relevant assessment criteria and ultimately establish whether this methodology can be used to assess environmental status. The presentation will primarily focus on the identification of fatty acid signatures and stable isotope ratio analysis to establish the feeding patterns and trophic position of aquatic species.

Keywords: Fatty Acids, Stable Isotopes, Persistent Organic Pollutants, Trophic Level, Background Assessment, Environmental Status

Missiaen Tine

Ghent University, Dep. Geology

Author(s): Tine Missiaen[1] & Wim Versteeg[2]

Affiliation(s) :

[1] Ghent University, Dep. Geology, Renard Centre of Marine Geology, Ghent, Belgium

[2] Flanders Marine Institute (Vlaams Instituut voor de Zee - VLIZ), Ostend, Belgium

Innovative acoustic technique for 3D prospection of intertidal areas

Acoustic studies of very shallow and/or intertidal areas along the North Sea coast pose major technological challenges due to the water depth (causing strong multiples), fierce wave action, strong currents, large tidal range, and the presence of biogenic gas in the shallow sediments. As a result these areas on the land-sea boundary are rarely investigated in a structured way. Recently, innovative acoustic investigations have been carried out at Ostend and Raversijde for archaeological and environmental prospection of the sub-seafloor. The beach area of Raversijde is known for its artefacts and structures dating from Neolithic, Roman and medieval times, including old coastal defence structures (e.g. dykes), remnants of drowned fishing villages, and intensive peat exploitation. Due to sand suppletion works in the '70ies all the remains are now covered by a few m of sand. Using a multitransducer echosounder system (containing an array of 4 synchronized parametrical transducers with a total spread of 1 meter) a 3D sub-seafloor volume could be obtained with a grid cell size as small as 25x25x1 cm (x/y/z). This allowed to map the peat and salt excavation pattern at Raversijde in the highest detail (cm/dm resolution). The observed features match perfectly with the old aerial photographs of the area (before the sand accretion). At the test site in the harbour of Ostend a number of small buried objects could be identified within the thick layer of fluid mud sediments. The data also allowed a detailed image of the 3D topography and internal stratification of the mud layer. This opens new perspectives for detailed prospection of the sub-seafloor in nearshore areas.

Keywords: 3D imaging, sub-seafloor, innovative

Missiaen Tine

Ghent University, Dep. Geology

Author(s): Tine Missiaen[1], Oscar Zurita Hurtado[1], Pauline Kruiver[2], Marco De Kleine[2]

Affiliation(s) :

[1] Ghent University, Dep. Geology, Renard Centre of Marine Geology, Ghent, Belgium

[2] Deltares, Dep. Geology, Utrecht, The Netherlands

Development of an efficient survey methodology for the prospection of buried palaeolandscapes and archaeology in the southern North Sea

Within the framework of the SeArch project (www.sea-arch.be) an efficient, generic survey methodology was developed for the prospection of buried palaeolandscapes and archaeological features in the southern North Sea. Standard geophysical techniques, such as marine seismic reflection, are mainly used on an ad hoc basis (if at all) and these techniques are often not well adapted for archaeological investigations. Detailed acoustic imaging is often hindered by the (hard) sandy seafloor which induces strong echo's that obscure the image, and the presence of large sand banks which absorb the sound waves. Moreover the widespread occurrence of shallow (biogenic) gas limits the acoustic penetration, especially in the nearshore area. For this study a wide range of seismic sources and receivers were tested over the past 3-4 years, including different multichannel configurations. Where possible, different sources and receivers were used simultaneously in so-called 'one-sweep' surveys. The results show that sparker sources generally provide the best trade-off between image resolution and penetration depth. Surprisingly, multichannel recording significantly improved the image resolution already for shallow target depths. Special attention was also paid to acoustic imaging in gassy areas, using not only conventional (P-)waves but also non-conventional surface waves and refracted waves. This highly unique test involved the simultaneous use of 2 research vessels (RV Belgica and RV Simon Stevin). The preliminary results indicate that relevant sub-bottom information can be obtained in gassy areas using a 'smart' acquisition and processing design. This opens important perspectives for the prospection of nearshore areas with regard to engineering and environmental projects.

Keywords: buried palaeolandscapes, seismic imaging, non-conventional techniques

Noble-James Tammy (Laura Robson)

Joint Nature Conservation Committee

Author(s): Tammy Noble-James

Affiliation: Joint Nature Conservation Committe (JNCC), United Kingdom

Combining Vessel Monitoring System (VMS) and benthic habitat data to investigate pressure-state relationships in offshore MPAs

Benthic habitats and communities within UK waters are considered to be at high risk of damage from abrasion pressures associated with demersal mobile gears. The relationship between abrasion pressure and habitat condition (the pressure-state relationship) is well understood for some habitats, whilst further research is required for many. Investigation of pressure-state relationships requires an understanding of the pressure distribution within the habitats of interest. In contrast to many other anthropogenic pressures, such information is accessible for abrasion pressure in the offshore region due to Vessel Monitoring Systems (VMS) onboard commercial fishing vessels, which relay positional 'ping' data at two hour intervals. The Joint Nature Conservation Committee (JNCC) and the Centre for Environment, Fisheries and Aquaculture Science (Cefas) have used VMS data to produce abrasion pressure maps at an ecologically meaningful scale. JNCC is responsible for monitoring benthic habitats within UK offshore MPAs, and is conducting R&D studies to investigate relationships between designated habitat condition and abrasion pressure (where these are not already established). VMS mapping products provide a significant resource for sampling design, being used in combination with habitat maps to identify pressure gradients within MPAs. This poster will explore various aspects of abrasion pressure-state studies, including: the advantages and limitations of using VMS data for sampling design; the combined use of VMS ping data, abrasion pressure maps and habitat maps to assess study feasibility and design sampling strategies, with examples from UK MPAs; and the potential use of VMS products for indirect monitoring where pressure-state relationships are sufficiently understood.

O'Flynn Sarah

Royal Netherlands Institute for Sea Research (NIOZ)

Author(s): Koop, L., van der Reijden, K. J. & O'Flynn, S. J.

Affiliation(s) : Royal Netherlands Institute for Sea Research (NIOZ), The Netherlands

Distribution, structure and functioning of low-resilience benthic communities and habitats of the Dutch North Sea (DISCLOSE)

Under the EU Marine Strategy Framework Directive, Member States have a responsibility to implement marine strategies for their territorial waters to protect marine biodiversity, with the aim of attaining 'Good Environmental Status' by 2020 (2008 56/EC). Within the Dutch sector of the North Sea there is a need for a more thorough understanding of the variation in seabed habitats and species present, as well the influence of anthropogenic activity on seabed communities. The primary objective of the DISCLOSE project (Distribution, structure and functioning of low-resilience benthic communities and habitats of the Dutch North Sea), supported by the Gieskes-Strijbis Fonds, is to improve the quality of seabed habitat mapping of sensitive habitats and species. An integrated approach will be implemented, combining acoustic remote sensing with video imaging data and standard seabed sampling techniques, thereby allowing detailed examination of the biotic and abiotic characteristics of the seabed. Biological traits analysis will be used to examine possible relationships between the biology, ecologically significant abiotic characteristics and anthropogenic influences on the benthic assemblages. Interpretation of new and existing datasets will be used to produce broad scale, high resolution benthic habitat maps, to contribute to the development of policy and legislation for the protection of sensitive habitats and species within Dutch marine waters.

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance), 2008 L 164/19. Available online at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056 [Accessed 14 October 2016].

Keywords: biodiversity; anthropogenic activity; remote sensing; video imaging; seabed sampling; biological traits analysis

Rambo Henrike

Thünen-Institute of Sea Fisheries

Author(s):Henrike Rambo [1], Vanessa Stelzenmüller [1], Rabea Diekmann [2] & Christian Möllmann [3]

Affiliation(s) : [1] Johann Heinrich von Thünen-Institute of Sea Fisheries, Hamburg, Germany

[2] Johann Heinrich von Thünen-Institute of Fisheries Ecology, Hamburg, Germany

[3] Institute of Hydrobiology and Fisheries Sciences, Center for Earth System Research and Sustainability, University of Hamburg, Hamburg, Germany

Disentangling habitat from fishing effects on spatial patterns of fish community sensitivity to fishing

Understanding the relationship between spatial patterns of fish biodiversity and fishing pressure is a prerequisite of most indicator-based management schemes and pressure-state-response relationships are state-of the art in integrated marine assessments in Europe. However, opinions diverge whether such a complex relationship can be entangled from other environmental factors. Also, specifically at the community-level effects of fishing on fish biodiversity have never been fully understood. A contributing factor is that most established taxonomic biodiversity indices are not specifically coupled to a specific pressure. We developed a functional traits-based indicator, the community sensitivity index (CSI) to fishing which is derived from traits that are known to render a species particularly sensitive to additional fishing mortality. We used a correlative approach to test the spatial relationship of demersal fish in German waters of the North Sea with fishing effort interpolated from Vessel Monitoring System data of the international bottom trawl fleet. To disentangle habitat from fishing effects we combined variance partitioning and generalized additive models. Relationships were highly fleet- and habitat-specific. The CSI showed anticipated pressure-state patterns (a decrease of index value with increase in fishing effort) for the beam trawl but not the otter trawl fleet and was most influenced by depth. While the results stress the importance of a direct ecological link between pressure and state indicators and to include habitat variables in the analysis, a clear univariate response to fishing could not be found. The CSI proofed to be a valid surveillance indicator but its full operationalisation towards a pressure-state indicator for management requires carefully designed experimental studies on its responsiveness to fishing. Further, we suggest a more general assessment using environmental risk-based approaches that can quantify effects and impacts of management scenarios and address uncertainties.

Keywords: Biodiversity indicators, sensitivity to fishing, VMS, pressure-state relationship, spatial statistics, traits-based indicator, fishing effort, German North Sea EEZ

Rybicki Sandra

Institute for Hydrobiology and Fisheries Science (IHF), University of Hamburg

Author(s): Sandra Rybicki[1], Anne F. Sell[2] & Clive J. Fox[3]

Affiliation(s) : [1] Institute for Hydrobiology and Fisheries Science (IHF), University of Hamburg, Germany
[2] Thünen-Institute for Sea Fisheries, Germany
[3] Scottish Marine Institute, UK

Comparison of the diversity of groundfish assemblages at different spatial scales in the North Sea – Implications for future monitoring programmes

Biodiversity indices are quantitative estimates of biological variety used in order to compare biological units in time and space, but these measures can be scale-dependent. Two aspects, species evenness and richness, have been widely used to assess the status of diversity. This study analysed potential differences in these diversity indices for North Sea fish in relation to spatial scale by comparing the German Small-scale Bottom Trawl Survey (GSBTS) with the International Bottom Trawl Survey (IBTS). For both, data of 18 GOV hauls were used in order to gain reliable indices estimates. In four areas of the North Sea the two chosen scales of 16 ICES rectangles (120x120nm; 4,9391km2) and the respective GSBTS box (10x10nm; 343km2) produced an overall similarity of biodiversity patterns, both in richness and evenness, over a time-period of 15 years (1998-2013). However, a fifth area produced different patterns: The German Bight showed significant differences in Hill's N0, N1, N2 and the Simpson's diversity indices, which are likely to be caused by consistently higher catches of dab (Limanda limanda) in the GSBTS. Dab is regularly the most abundant species in this GSBTS box but not in the aggregated IBTS rectangles. Although the general patterns of the indices developed similarly over time, the effects of sampling intensity and coverage of differing habitat types influenced the values at both scales differently. Hence data were assigned to habitat type for a reference analysis. The results will help with designing future monitoring for fish diversity by identifying areas of the North Sea where finer spatial resolution in sampling may be required for biodiversity monitoring under policy actions, such as the European Marine Strategy Framework Directive.

Keywords: Groundfish diversity North Sea Spatial scales Ecology

Tyberghein Lennert

Flanders Marine Institute

Author(s): Lennert Tyberghein[1], Simon Claus[1], Peter Herman[2], Olivier Beauchard[2], Jean Marie Beckers[3], and Francisco Hernandez[1]

Affiliation(s) :

[1] Flanders Marine Institute (VLIZ), Oostende, Belgium

[2] Nederlands Instituut voor Onderzoek van de Zee (NIOZ), Yerzeker, Netherlands

[3] Universite de Liege, Geohydronmics and environment research (GHER), Liege, Belgium

EMODnet gridded abundance products: a tool to facilitate ecosystem assessments

The European Marine Observation and Data Network is a network of organisations supported by the EU's integrated maritime policy. These organisations work together to observe the sea, process the data according to international standards and make that information freely available as interoperable data products. Within the EMODnet Biology project a set of gridded map layers is being produced showing the average abundance of different species of different trophic levels for different time windows using geospatial modelling. The spatial modelling tool used to calculate the gridded abundance maps is based on DIVA. DIVA (Data-Interpolating Variational Analysis) is a tool to create gridded data sets from discrete point measurements of the ocean. It was decided to select a number of well-known and published cases from diverse data sources to test the methodology. The selection was based on data availability within the EurOBIS database, reference to existing literature and relevance to the project. Currently data products are available for species from the North Sea, Baltic Sea and North East Atlantic. The products are currently made for different species groups, such as benthos, zoo- and phytoplankton, birds, fish and mammals. The availability of zeroes (i.e. explicit knowledge of the sites where a species was looked for but was absent) is essential for the gridding procedure using DIVA. Since most databases only record presences, the reconstruction of zeroes is a requirement for the mapping. These gridded map layers showing the abundance for copepod species most frequently recorded from the North Atlantic CPR dataset are delivered as operational oceanographic products and services (OOPS), to support the integrated ecosystem assessments (IEAs), recently undertaken by ICES.

Van den Eynde Dries

Royal Belgian Institute of Natural Sciences

Author(s): Dries Van den Eynde[1], Matthias Baeye[1], Michael Fettweis[1], Frederic Francken[1] and Vera Van Lancker[1]
Affiliation(s) : [1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium

Effect of aggregate extraction on MSFD descriptor 7 (hydrographic condition) in the Hinder Banks area (Belgian Continental Shelf)

Bottom shear stress, determining sediment resuspension and erosion, deposition and bottom morphology, is proposed as an indicator for descriptor 7 (hydrographic conditions) in the Belgian MSFD implementation to evaluate human-induced changes. An impact asks consideration if the mean bottom shear stress, calculated by a validated mathematical model over a spring-neap tidal cycle, increases by more than 10%. Furthermore, it is stated that the impact should remain in a distance less than the square root of the surface occupied by this activity, taken from its external limit.

Near-bed current profiles, measured with bottom mounted Acoustic Doppler Current Profilers, have been used to calculate bottom shear stress and associated error ranges at two stations along an offshore sandbank subdued to aggregate extraction (-20 to -30m depth).

Currents were modeled using the 3D COHERENS model, waves using the WAM model. Bottom shear stress was calculated under the combined influence of currents and waves. Results of currents and waves showed good results along a linear part of the sandbank, but were less well modeled where complex bed forms occurred, implying stronger tide-topography interactions. Model results for a mean bottom shear stress of around 0.7 Pa had a bias less than -0.09 Pa and a root-mean-square error less than 0.26 Pa along the linear part, being acceptable.

To assess the impact of aggregate extraction, three different extraction scenarios were simulated. In the zone of extraction, the mean bottom shear stress, over a spring-neap tidal cycle, changed considerably, from -39% to +14%. The impact outside the zone was less than 6%. One can conclude that in these relatively deep waters, aggregate extraction does not lead to major changes in hydrographic conditions.

Keywords: bottom shear stress, aggregate extraction, Marine Strategy Framework Directive, Belgian Continental Shelf

Van Lancker Vera

Royal Belgian Institute of Natural Sciences

Author(s): Van Lancker, V.R.M.[1], Baeye, M.[1], Evangelinos, D.[1,2], Montereale-Gavazzi, G.[1,2], Terseleer, N.[1] & Van den Eynde, D.[1]
Affiliation(s) : [1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment. Gulledelle 100, B-1200 Brussels, Belgium
[2] Ghent University, Dep. Geology. Renard Centre of Marine Geology, Belgium

MSFD-compliant investigative monitoring of the effects of intensive aggregate extraction on a far offshore sandbank, Belgian part of the North Sea

In 2012, unprecedented sand extraction activities started on a far offshore sandbank in the Belgian part of the North Sea, just north of a Habitat Directive area. The Flemish Authorities, being in demand of large volumes of sand for coastal safety, agreed on a dedicated follow-up of the effects of extraction (MOZ4 project). In synergy with the long-term monitoring, paid from the revenues of extraction activities (ZAGRI programme), investigative monitoring was set-up, with focus on assessing changes in seafloor integrity and hydrographic conditions, two descriptors that define Good Environmental Status within Europe's Marine Strategy Framework Directive (MSFD). Results relate to: (1) quantification of natural variability of currents and turbidity; (2) sediment plume formation and deposition, differentiating between small and large trailing suction hopper dredgers; (3) far–field impacts, with focus on the gravel beds within the Habitat Directive area, and (4) improvement of models that predict the impact of extraction activities. New insights were revealed on the four levels. Striking was an increase in sand, as well as an enrichment of fine sediments in the coarse permeable sands in the gravel area, though no direct relationship could yet be made with the intensive extractions. Further monitoring is required, since favourable colonization and growth of epifauna on the gravel beds is critical for the maintenance and increase of biodiversity in the Belgian part of the North Sea. Recommendations were formulated for the exploitation of the sandbanks.

Keywords: Aggregates, Sand, Gravel, Habitat, Seafloor Integrity, Marine Strategy Framework Directive, Uncertainty, Resource Suitability, 3D Voxel Modelling; 4D Impact Assessment, North Sea, Belgium, Netherlands

Winter Christian

MARUM Center for Marine Environmental Sciences, Bremen University

Author(s): WInter, Christian

Affiliation(s) : MARUM Center for Marine Environmental Sciences, Bremen University, Germany

The project WIMO: Scientific Monitoring Concepts for the German Bight

The state and development of coastal marine systems and an understanding of the interaction of organisms, sea floor, water column, and biochemical and physical processes can only be obtained by a combination of long-term monitoring and model approaches of different complexity. The need for the development and evaluation of monitoring strategies has been established in the framework of different European and German regulations. The research project WIMO 'Scientific Monitoring Concepts for the German Bight' has developed concepts and methods that aim at a fundamental scientific understanding of marine systems and also meet monitoring requirements of European legislation and regulations like the EU Marine Strategy Framework Directive. Common descriptors of ecosystem state like the seabed integrity, eutrophication, and biodiversity are discussed. It has been assessed to what extent established measuring procedures used to survey the characteristics of the sea floor, and newly developed technologies are eligible for governmental monitoring. The significance of integrative modelling for linking and visualising results of measurements and models is illustrated. It is shown how new concepts have been implemented into governmental monitoring in the form of web based data sheets. These insights enable continuous analysis and developing of methods in the future.

Keywords: MSRL, monitoring, implementation, modelling, remote sensing

Oral Presentation

Theme 3:

Sustainability:
one for all, all for one?

Andrusaitis Andris

BONUS, the joint Baltic Sea research and development programme

Author(s): Andris Andrusaitis[1], David Cox[2], Maurice Heral[3], Kaisa Kononen[1], Fritz Köster[4], Maija Sirola[1], Josef Staufer[5]

Affiliation(s) : [1]BONUS, The joint Baltic Sea research and developemtn programme, Finland; [2]Belgian Science Policy Office, North Sea Programme, Belgium; [3]National Research Agency, France; [4]National Institute for Aquatic Resources DTU-Aqua, Denmark; [5]Netherland's Organisation for Scientific Research, Earth and Life Sciences, The Netherlands

Building a joint research and innovation programme for northern European regional seas: Towards sustainable blue economy in the North Sea and the Baltic Sea regions

This contribution will introduce a proposal submitted by 11 EU member states to the European Commission in November 2015 with an aim to create a joint North Sea and Baltic Sea research and innovation programme. As an integral part of the EU research and innovation framework, the new programme will be co-funded by the participating states and the EU. Its focus will be on those challenges where a collaborative sea-basin ap¬proach can bring better, faster and more cost-effective results compared to either the broader EU or narrower national-level approaches. The new programme will build on rich experience accumulated and mechanisms tested within the ongoing joint Baltic Sea research and development programme BONUS.

Today the blue economies of the Baltic Sea and the North Sea account for around EUR 50 billion annual turnover and sustain at least 1.5 mil¬lion work places. This enormous body of economy is directly and critically dependent on the quality and extent of the ecosystem services provided by the two regional seas and their coasts. Nevertheless serious challenges are posed by fragmentation, on nation and sector level, gaps in interdisciplinary knowledge, inadequate information on potential synergies and trade-offs, and insufficient exchange of knowledge among scientists, industries and policy makers. At the same time both seas face interlinked challenges caused by climate and sea level change and are influenced by runoff from large, densely populated and heavily exploited catchment areas resulting in loading with nutrients and contaminants. Both seas are forced by the same weather patterns and dependent of water exchange with the North Atlantic. The full outline is available at http://www.bonusportal.org/files/4699/BONUS_Publication_No_15.pdf .

Keywords: joint research programming, science support for better policy, the North Sea, the Baltic Sea

Blanz Benjamin

Universität Hamburg

Author(s): Benjamin Blanz, Hermann Held

Affiliation(s): University of Hamburg, Germany

Modelling ecosystem economy interaction dynamics

Anthropogenic pressures are a key determinant of the ecosystem status in the North Sea. However these drivers are themselves dynamic and dependent on many factors. In order to predict the ecosystem status, it is necessary to also predict the anthropogenic dynamics. As part of the NOAH project (http://www.noah-project.de/) we have developed an integrated ecosystem-economy model of the coastal fisheries in the German EEZ, in which these drivers as well as their impact on the ecosystem are modeled. Human drivers in this model depend on the ecosystem state, behavior of consumers of harvested ecosystem services and decisions of harvesters. The base configuration of the model represents unconstrained optimizing economic actors. Optimal management is implemented as a benchmark for other management rules. The interaction of these two dynamic systems, ecosystem and economy, create dynamics different from those of the individual systems, introducing extinction thresholds and interdependencies of ecosystem stocks, that are not an intrinsic property of the ecosystem. Extinction thresholds are stock levels below which the combined system moves to extinction through over-harvesting, independent of minimum viable populations. When conducting management of such an ecosystem it is not enough to understand the ecosystem dynamics. Species that are independent of each other from a biological perspective still require an integrated management approach, as human behaviour may link their dynamics. Disregarding these issues can lead to stock collapse of unmanaged species. Understanding the interconnections between ecosystem and economy can help differentiate between human induced and ecosystem dynamics in observed data.

Keywords: Anthropogenic Pressures, Ecosystem Management, Sustainability, Threshold-Effects

Cormont Anouk (Peter Verweij)

Wageningen University & Research

Author(s): Anouk Cormont[1], John Cowley[2], Gerry Sutton[3], Peter Verweij[1], Michiel van Eupen[1], Theo van der Sluis[1], Marta Pérez-Soba[1]

Affiliation(s) :

[1]Wageningen Environmental Research, Wageningen University & Research, the Netherlands
[2] Mineral & Resources Planning Associates Ltd, United Kingdom
[3] University College Cork, National University of Ireland, Cork, Ireland

Constraints in the common pool of the continental shelf: fixed mineral resources in a dynamic environment

The exploitation of minerals in Europe is an indispensable activity to ensure that the present and future needs of the European society can be met. This means that sufficient access is required, without compromising the needs of current or future generations. Accordingly, the potential of exploitable mineral deposits needs to be evaluated in relation to other land use and environmental objectives. The deliberation between mineral exploitation and other land use objectives is a challenging arena, especially if the showground is the dynamic environment of the sea, shared by several countries. For the Celtic and Irish Sea we have mapped constrained and unconstrained aggregate resources using QUICKScan, an approach and software tool to explore spatial policy options in participatory settings. We took the position and permit status of wind turbine farms, marine nature conservation areas and main fishery interest areas into consideration and indicated the relative amount of interactions between mineral resources and these other types of 'land use' (or: sea use). For the UK, we could say that constraints due to fishing grounds are highest, while for the Irish waters, nature conservation areas put most spatial constraints to mineral resources. The marine system may be more dynamic than land systems in both the value of cropping (fish catch) and the location of that crop. There may be major (cyclical) changes in size of catch in particular locations. Besides, the extent, grade or quality of minerals cannot be changed by human action. Constraints on minerals can therefore increase in area or value, especially offshore.

Keywords: mineral deposits, sustainability, land use constraints, mapping, Celtic and Irish Sea, QUICKScan

de Jong Maarten

Building with Nature and De Jong EcoLogical Consultancy

Author(s): Maarten de Jong[1], Martin Baptist[2], Bas Borsje[3], Daan Rijks[4]

Affiliation(s):

[1] Building with Nature and De Jong EcoLogical Consultancy, The Netherlands

[2] Wageningen Marine Research, The Netherlands

[3] Deltares en University of Twente, The Netherlands

[4] Boskalis, The Netherlands

The ecological effects of deep sand extraction and implications for the future

On the Dutch continental shelf, approximately 26 million m3 of marine sand is extracted each year which may increase up to 40 to 85 million m3 to counteract sea-level rise. For Maasvlakte 2 (MV2), a seaward harbor extension of the Port of Rotterdam, 220 million m3 of sand was used. The Dutch authorities permitted sand extraction up to 20 m below the seabed instead of the common 2 m to decrease the surface area of direct impact.

The effects of deep sand extraction (20 m) were and compared with Dutch case studies with shallow and intermediate extraction depths. Significant changes in faunal species composition and sediment characteristics were observed in the deep areas of the MV2 borrow pit. Biomass of macrozoobenthos, organisms living in and on the seabed, increased 7-12 fold. The biomass of demersal fish increased 20-fold in the deep areas. Macrozoobenthos and demersal fish correlated with sediment and hydrodynamic characteristics and time after cessation of sand extraction.

Ecological and hydrodynamic data were combined and transformed into Ecosystem-Based Design (EBD) rules which can be used in the design phases of future borrow pits in order to simultaneously maximise the sand yield and decrease the surface area of direct impact.

Keywords: sand extraction, benthos, demersal fish, ecosystem-based design rules

Degrendele Koen

FPS Economy - Continental Shelf

Author(s): Koen Degrendele, Marc Roche, Patrik Schotte and Helga Vandenreyken

Affiliation(s): FPS Economy, S.M.E.s, Self-Employed and Energy, Directorate-General Quality and Safety, Continental Shelf, Belgium

What is the role of the economy in marine management, i.c. sand extraction?

The extraction on the Belgian part of the North Sea is an example of a well-organized, closely monitored and intensely studied activity. The Continental Shelf Department is responsible for the management and organization of the licenses, and monitors the activities from all extraction vessels with a electronic monitoring system, organized by BMM Oostende. The ecological impact on the benthos is studied by ILVO since many years and the impact of the overall sand extraction on the seabed is monitored by the Continental Shelf department with multibeam echosounders since 1999. The long time series of detailed terrain models have revealed and established the non-sustainable character, the linear relation between the extracted volumes and the change in topography, and the local impact on the seafloor. Up to now, the national legislation limits the extraction to an arbitrary depth of 5 meters under the seabed model defined in 2005. The department is currently defining a new reference surface, based on the nature of the seabed, the geological structure and marine ecology. This new surface aims to further limit the negative impact of the extraction on the marine ecosystem. But, with the growing ecological constraints (Marine protected areas – MSFD), the future of the aggregate extraction on the Belgian part of the North Sea seems very unsure. Since more than a decade, the available volume of sand is rapidly decreasing, much more due to environmental regulation and pressure from other users of the marine space, than the extraction itself. This trend greatly limits the prospects of this economic sector. To secure a limited available resource in the future, a more balanced management policy is required that takes in consideration the economic and social importance of the sector.

Keywords: Sand extraction, management, monitoring

Hartley John

Hartley Anderson Ltd

Author(s): JP Hartley[1], S Marappan[2], DM Borthwick[1] & SK Hartley[1]

Affiliation(s) : [1] Hartley Anderson Ltd, Aberdeen UK; [2] UK Department of Business, Energy and Industrial Strategy, United Kingdom

The role of Strategic Environmental Assessment in delivering sustainability - a long term North Sea case history

A case history of the application of Strategic Environmental Assessment (SEA) to plans for UK marine oil & gas, renewable energy and carbon storage development spanning 17 years is presented. The SEA programme has covered all UK waters including the North Sea and has involved significant research effort to address gaps in ecological and industrial effects understanding identified through the assessment process and extensive stakeholder input. The advent of major renewable energy developments across the North Sea has raised several issues (from seabird key foraging areas, non-breeding distribution, migration routes, and flight heights and avoidance behaviour) on which the information base on which to base site selection and effects predictions was weak. This has important consequences for effective marine spatial planning and sustainability of marine energy developments, at both national and international scales. The major remaining information needs and the collaborative efforts to address them are summarised, together with perspectives on their relevance to effective management of the North Sea and the attainment/demonstration of Good Environmental Status.

Keywords: SEA, North Sea, marine energy, sustainability, adaptive management

Lonsdale Jemma

Cefas / University of Hull

Author(s): Jemma Lonsdale

Affiliation(s) : Centre for Environment, Fisheries and Aquaculture science, Lowestoft, UK/ Institute of Estuarine and Coastal Studies, University of Hull, UK.

Developing an estuarine planning support system: a case study for the Humber Estuary, Eastern England

Estuaries are important because of their multiple uses and users, making management challenging to strike a balance between the needs of users, their ecological and economic value and the context of multiple legislative drivers. To facilitate integrated, sustainable and successful management we have developed an Estuarine Planning Support System (EPSS) framework using the Humber Estuary, Eastern England, as a case study, integrating the current legislation tools and concepts. This integrated EPSS framework has been developed as a GIS based interactive tool, which improves previous approaches for assessing cumulative impacts as it takes into account legislative drivers, management tools and details of plans/ projects specific to the estuary. This accessible tool enables users to assess and address both the current state and the way in which a new development could impact an estuary. Although developed for the Humber Estuary, the EPSS is sufficiently generic to be modified to incorporate other site-specific requirements and legislation. Increasing and changing pressures to estuaries and coastal areas require adaptable and accessible management plans for management. The EPSS allows this by giving a structured process but with sufficient flexibility to allow for regional priorities and project specific information as well as being applicable to other European and international estuaries, and into coastal and open seas for management and planning. The EPSS framework allows for and incorporates the vertical governance structure, horizontal integration of stakeholders, merging of risk assessment and risk management, incorporation of ecosystem services and societal benefits, and fulfilling the Ecosystem Approach

Keywords: Ecosystem goods and services, Estuarine Planning Framework, Estuary, Humber

Pecceu Ellen

Institute for Agricultural and Fisheries Research (ILVO)

Author(s): Ellen Pecceu[1], Ibon Galparsoro[2], Tomas Vega Fernandez[3], Irida Maina[4], Genoveva Gonzalez-Mirelis[5], Paraskevi Karachle[4], Kris Hostens[1]

Affiliation(s) : [1] Institute for Agricultural and Fisheries Research (ILVO), Aquatic Environment and Quality, Bio-environmental research group, Oostende, Belgium

[2] Fundación AZTI, Spain

[3] Istituto per l'Ambiente Marino e Costiero-Oristano (CNR-IAMC), Italy

[4] Hellenic Centre for Marine Research (HCMR), Greece

[5] The institute of Marine Research (IMR), Norway

Using a systematic conservation planning approach to enhance the marine spatial planning process in Europe

The overall aim of this study was to test the usefulness of the Systematic Conservation Planning (SCP) software MARXAN, to underpin and enhance the Marine Spatial Planning process (MSP) in Europe. The idea stems from the EU-FP7 MESMA project (Monitoring & Evaluation of Spatially Managed Areas) in which tools were tested, a framework was developed and governance analyses were executed within nine case studies (http://www.mesma.org/). MARXAN is freely available and has been successfully used in more than 60 countries to support mainly terrestrial but also maritime spatial planning. Although MSP is relatively well established in Europe, and MARXAN is regarded as one of the most widely used decision support tools worldwide, its utilization in Europe is rather scanty. The core of this research is the use and evaluation of MARXAN within the marine spatial (and conservation) planning process in five European case studies: the Bay of Biscay (Spain), the Skagerrak (Norway), the Strait of Sicily (Italy), the Ionian Sea (Greece) and the Belgian part of the North Sea (Belgium). All case studies differ in scale, complexity, data availability and number of human uses, and each case study tackles a specific spatially-oriented research question. However, all cases focused on nature conservation and fisheries, which allowed us to perform cross-comparisons and to find an answer on how the different circumstances of each case study influence the use and usefulness of MARXAN. Or, in other words, can SCP in general, and more specifically MARXAN, help us to overcome some of the challenges related to the implementation of MSP at the local and regional levels?

Keywords: Marine spatial planning, systematic conservation, MARXAN, Europe

Rambo Henrike

Thünen-Institute of Sea Fisheries

Author(s): Henrike Rambo[1], Vanessa Stelzenmüller[1] & Roland Cormier[2]

Affiliation(s) : [1] Johann Heinrich von Thünen-Institute of Sea Fisheries, Hamburg, Germany

[2] Helmholtz-Zenstrum Geestacht, Centre for Materials and Coastal Research, Geesthacht, Germany

Assessing the effects of cumulative pressure management using spatial Bayesian Modelling - a case study from the German EEZ of the North Sea

Maritime Spatial Planning (MSP) in Germany is mandated to facilitate Blue growth sustainably. To implement this challenging task spatial management assessments are essential to identify and weigh potential risks of planning decisions on the environment. A key responsibility of the German MSP process is the approval and regulation of offshore wind farms (OWF) which are then closed to fishing, along with the allocation of other activities to specific areas. Currently not even 2% of the German EEZ of the North Sea is being developed with OWFs but this could amount to more than 20% and in combination with certain fleet exclusions in Natura 2000 sites, fishing effort redistribution could be significant. As a case study, we examine the generic pressures abrasion and selective extraction of the seafloor system caused by bottom trawling, aggregate mining, anchoring and gas extractions and how well spatial management (including effectiveness and compliance) performs to reduce the overall cumulative pressure as well as the impact on a suite of ecological indicators. We propose an approach of structuring a Bayesian Belief Network (BN) using the Bow-tie method and combined the model with a Geographical Information System to spatially quantify the ecological risks of a baseline and future scenario. Here, we simulated implementing fishing restrictions in Nature 2000 sites as well as the continued development of offshore wind farms in the German EEZ of the North Sea. The BN model was able to predict the proportion of the area where ecological indicators and the cumulative pressure would be likely to change. It also allowed us to account for the considerable uncertainty in the system. In conclusion, MSP processes should incorporate spatial management assessments which allow for the integration and the quantification of related risks as well as uncertainties at a common spatial scale.

Keywords: Risk assessment, management scenarios, management performance, Marine Spatial Planning, Bayesian Belief Networks, bow-tie, fishing restrictions, Nature 2000, offshore wind farms

Reach Ian

MarineSpace Ltd

Author(s): Ian Reach[1], Dafydd Lloyd Jones[1], Rob Langman[1], Caroline Chambers[2], Iain Warner[1], Mark Russell[3]

Affiliation(s) :

[1] MarineSpace Ltd, United Kingdom
[2] Csalt, United Kingdom
[3] British Marine Aggregate Producers Association

Identifying North Sea herring Clupea harengus spawning habitat, assessing environmental effects from UK dredging areas and adaptive environmental management

Review of recent UK marine aggregate licence applications identified that the regulator specifically required detailed environmental impact assessment of North Sea herring Clupea harengus spawning habitat; upon advice from the International Council for the Exploration of the Seas (ICES) herring assessment working group (HAWG). The authors developed a 2 stage methodology to strategically assess potential impacts between UK dredging areas and defined spawning habitat. Stage 1 screened receptor-exposure-effect pathways between dredging direct and indirect impact zones, and seabed areas likely to support herring spawning (using: areas of 'preferred' spawning seabed sediment type; UK fish spawning data; interpolated ICES international herring larval spawning data; fishing vessel monitoring system data; and Fisheries Authority data). A confidence score based on five parameters (method, vintage, positioning, resolution, quality standards) was applied, with higher scores indicating higher confidence of data layers representing spawning locations. Using GIS, the data were mapped, and the greater the number of overlapping data layers the greater the 'heat' mapped, and the higher the confidence that the seabed may be suitable for spawning. Aggregate area effect footprints overlapping the 'heat' map proceeded to Stage 2 assessment: cumulative impact assessment at a regional scale. The methodology resulted in robust assessment of magnitude of effects. All licences were renewed/licensed without spawning season dredging bans. The results were presented to ICES in December 2014, and in 2015, ICES HAWG adapted its environmental management advice, stating that if "…activities have been assessed and shown not to be detrimental…" they may proceed in areas of spawning habitat.

Keywords: North Sea, herring, Clupea harengus, spawning area, aggregate dredging, gravel beds, geography, data, knowledge, information, environmental impact, adaptive management

Rumes Bob

Royal Belgian Institute of Natural Sciences

Author(s): Bob Rumes[1] & Steven Degraer[1]

Affiliation(s) :

[1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium

Scraping the bottom of the barrel - Assessing the impact of bottom trawling fisheries on ecosystem functioning and ecosystem services in a Habitats Directive area

In 2014 the Belgian government approved a new maritime spatial plan for the Belgian Part of the North Sea by Royal Decree. In this plan, seabed -disturbing fishing techniques i.e. bottom trawling fisheries were excluded from parts of the Flemish Banks Habitats Directive area in order to preserve the sea bottom integrity and achieve favourable conservation status. The exclusion areas were specifically defined to conserve two ecologically valuable and protected types of habitat: naturally occurring gravel beds and shallow sand banks with high densities of sand mason worms (Lanice conchilega). Here we compare the current status of biodiversity in the Habitats Directive area with a historic baseline and discuss how ecosystem functioning and ecosystem services may have changed as a result. We focus on the impact of abrasion, reducing habitat heterogeneity in gravel beds, and removal of non-target species, impacting bioturbation in soft sediments both in relation to (the exclusion of) bottom trawling. This work is conducted in the framework of the AQUACROSS (Knowledge, Assessment, and Management for AQUAtic Biodiversity and Ecosystem Services aCROSS EU policies) project.

Keywords: Marine ecosystem services, AQUACROSS

Terseleer Nathan

Royal Belgian Institute of Natural Sciences

Author(s): N. Terseleer[1] , M. Roche[2], K. Degrendele[2], D. Van den Eynde[1] , V.R.M. Van Lancker[1]
Affiliation(s) : [1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium
[2] Federal Public Service Economy, Continental Shelf Department, Belgium

Towards sustainable use of seabed resources using a combined monitoring-modelling approach, Belgian part of the North Sea

Marine aggregates are a valuable and evermore consumed geological resource. In the Belgian part of the North Sea, their extraction has been increasing since the 1970s, raising questions about the sustainability of this activity. Here, we address these questions through the analysis of combined monitoring and modelling approaches. Since the early 1990s, high resolution depth recordings, as well as vessel monitoring datasets are available in areas with high extraction activities. For the monitoring areas in the Flemish Banks, their detailed analysis allows the estimation of depletion and regeneration rates and of the effect of the extraction activity on these. In the most heavily extracted area, a local reorganization of sediments is observed with an accretional trend in the extraction pit and an erosive pattern over the surrounding very-large dunes. This points to a general flattening of the area and suggests that the extraction activity can locally affect the seabed stability and, consequently, its recovery potential. In parallel to the analysis of monitoring data, the behaviour of the seabed is simulated. Innovatively, a 3D geological 'voxel' model of the seabed (based on cores, seismic profiles, sediment size distributions) is here coupled to a hydro- and sediment dynamics model. This provides a modelling framework at an unprecedented level of realism for the initialization and parameterization of the numerical model suite. It further allows exploring the evolution of the seabed, and morphodynamics feedback loops, under various extraction scenarios. From this, recommendations can be provided for a sustainable extraction activity within the context of the European Marine Strategy Framework Directive.

Keywords: sustainable use of resources, monitoring, modelling, management plan, Marine Strategy Framework Directive

Van Hoey Gert (Michael Fettweis)

Institute for Agricultural and Fisheries Research (ILVO)

Author(s): Van Hoey, Gert[1], Devriese, Lisa[1], De Witte, Bavo[1], Fettweis, Michael[2], Lauwaert, Brigitte[2], Parmentier, Koen[2], Vanlede, Joris[4], Martens, Chantal[3]
Affiliation(s) : [1] Institute for Agricultural and Fisheries Research (ILVO), Bio-Environmental Research group and Chemical monitoring and Product Technology, Belgium
[2] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium
[3]Maritime Access Division, Flemish Government, Belgium
[4] Flanders Hydraulics Research, Department of Mobility and Public Works, Flemish Government.

Environmental impact assessment in line with the EU Nature Directives

The debate on a sustainable performance of human activities impacting the marine environment needs to be more objectively structured and scrutinized. For this, the assessment criteria developed under the EU Nature Directives (Marine Strategy Framework Directive (MSFD), Habitat Directive (HD, Water Framework Directive WFD)) can form the basis for a scientifically, more uniform environmental impact assessment (EIA). The list of criteria, funded by operational indicators allow a more objective assessment of the degree of impact on the marine ecosystem across human activities. A major obstacle is the variety of criteria between EU Directives, which is likely to be harmonized for Belgian waters. The alliance of the EU Directive requirements and the assessment of pressures on the ecosystem is illustrated by the evaluation of the activity of disposal of dredged material at designated areas on the Belgian Part of the North Sea. The disposal of dredged material has effects on the water surface, in the water column and on the seabed. These effects are followed up in a joint monitoring program and a periodical integrated assessment is made, which is now put in line with the MSFD requirements. 10 MSFD criteria/indicators out of the list of 50 used in Belgium have a clear relevance to this activity. Those relevant indicators are related to evaluation of the characteristics of the bottom fauna, chemical pollution and physical changes of the disposal areas. An integrated assessment of those indicators is made and easily visualized by means of a star diagram. Based on this information, the effect of the activity itself can be evaluated, monitoring optimized and appropriate management measures be taken in relation to the requirements of the EU Directives.

Poster

Theme 3:

Sustainability:
one for all, all for one?

Bonne Wendy

JPI Oceans

Author(s): JPI Oceans Secretariat ; Willem De Moor, Wendy Bonne, John Hanus, Anastasios Lekkas, Tom Redd, Angel Muniz-Piniella, Jacky Wood and Kathrine Angell-Hansen

Affiliation(s) : JPI Oceans Secretariat, Brussels

Joint Programming Initiative Healthy and Productive Seas and Oceans

The Joint Programming Initiative Healthy and Productive Seas and Oceans is an intergovernmental coordinating and integrating platform, open to EU Member States and Associated Countries who invest in marine and maritime research. Participation of international partners happens on a case by case basis.

JPI Oceans focuses on making more efficient use of national research budgets, which represent 88% of the marine-maritime funding within Europe. How: countries are expected to coordinate national research activities in the broadest sense, group resources, benefit from complementarities and develop common research and innovation agendas as a basis for long-term cooperation, in which countries can be involved on a voluntary basis. Participating countries also decide what contribution to make: this may include institutional, project-related or new funding.

Bringing together the interested countries JPI Oceans aims to add value by: avoiding fragmentation and unnecessary duplication planning common and flexible initiatives facilitating cooperation and foresighting establishing efficient mechanisms for interaction and knowledge transfer between the scientific community, industry and policy makers at high level to solve societal challenges in seas and oceans on initiatives which go beyond the capacity of a single country.

JPI oceans has implemented 4 pilot actions:

Joint funding for the intercalibration in WFD coastal and transitional waters in the North-East; Atlantic Multi-use of Infrastructures for Monitoring in the North Sea; Ecological Aspects of micro-plastics in the marine environment; Ecological Aspects of deep-sea mining.

Currently joint actions are developing on technology, coastal and marine planning and management, GES (ecosystem goods & services, new pollutants, cumulative effects of human disturbances), climate change and the bioeconomy.

Keywords: Joint Programming Initiative, Seas, Oceans

Deprez Tim

Ghent University, Marine Biology Research Group

Author(s): Tim Deprez[1], Tom Artois[2], Peter Bossier[3], André Cattrijsse[4], Koen Chiers[5], Olivier De Clerck[6], Annemie Decostere[5], Klaas Deneudt[4], Marleen De Troch, Francisco Hernandez[4], Thibaud Mascart[1], Tom Moens[1], Aäron Plovie[1], Tim tkint[1], Gilbert Van Stappen[3], Tim Verstraeten[1], Anne Willems[7], Ann Vanreusel[1]

Affiliation(s) :
[1] Ghent University, Marine Biology Research Group, Campus Sterre S8, Gent, Belgium; [2] Universiteit Hasselt, Research group Zoology: Biodiversity and Toxicology, Diepenbeek, Belgium; [3] Ghent University, Laboratory of Aquaculture and Artemia Reference Center, Gent, Belgium; [4] Vlaams Instituut voor de Zee, InnovOcean site, Oostende, Belgium; [5] Ghent University, Pathology, Bacteriology and Poultry Diseases, Merelbeke, Belgium
[6] Ghent University, Phycology Research Group, Gent, Belgium; [7] Ghent University, Laboratory of Microbiology, Gent, Belgium

EMBRC.be – The Belgian node of the European Marine Biological Resource Centre

The European Marine Biological Resource Centre (EMBRC) is a pan-European research infrastructure providing a strategic delivery mechanism for excellent and large-scale marine science in Europe. EMBRC interconnects European marine research communities by upgrading and harmonizing their current infrastructures and services. It supports both fundamental and applied research based on marine bio-resources and marine ecosystems and as such encourages the development of blue biotechnologies. EMBRC provides the suitable research environment for a variety of users from both academia and industry.

Presently, EMBRC has nine European and associated countries as full members. EMBRC strives to establish a legal structure as a European Research Infrastructure Consortium (ERIC) by the end of 2016, which will also lead to a restructuring of the organization of the Belgian node of EMBRC (EMBRC.be) with potential new partners. EMBRC.be is at date represented by Ghent University, University of Hasselt and the Flanders Marine Institute.

EMBRC builds on existing and expanding marine biological facilities, equipment and human capital. It aims for long-term collaboration, development of common strategies and standards, and sharing of best practices related to the use of marine biological resources. Services, tailored to users from academia, industry and governments, include access provision to European marine ecosystems and biodiversity, marine model organisms, culture collections, technology platforms, e-infrastructure services and training facilities.

For more information: www.embrc.eu/belgium

Keywords: research infrastucture, Europe, marine biological resources, blue biotechnology

Deprez Tim

Ghent University, Marine Biology Research Group

Author(s): Marleen Roelofs, Katherine Brownlie, Aäron Plovie, Tim tkint, Tim Deprez

Affiliation(s) : Ghent University, Marine Biology Research Group, Gent, Belgium

MBRSea – The upcoming International Master in Marine Biological Resources

The International Master in Marine Biological Resources (IMBRSea), will be a joint master programme organized by eight European universities renowned in marine sciences (Ghent University, University of Pierre and Marie Curie, University of the Algarve, University of Oviedo, Galway-Mayo Institute of Technology, University of the Basque Country, Polytechnic University of Marche, and University of Bergen), supported by the European Marine Biological Resource Centre (EMBRC).

The programme consists of the acquisition of a profound knowledge on fundamental marine biology during the first semester, hands-on experience during a six week Professional Practice (internship), and a Joint School bringing all students together for training in a European marine station. Moreover, during the second and third semester the students follow two Thematic Modules, leading to one of the five Specialization Tracks defined according to the EU Horizon2020 Blue Growth innovation challenges:

- Marine food production
- Management of living marine resources
- Applied marine ecology and conservation
- Marine environment health
- Global ocean change

The programme is finished by a 30 ECTS credits Master Dissertation during the fourth semester.

IMBRSea merges two scientific fields -marine biology from genes to population levels, and marine environmental sciences- within a single programme, emphasizing the link between what occurs at the molecular level and in the physical world. For Europe to realize a sustainable blue bio-economy, skilled marine graduates are required with a specialized knowledge on marine systems. IMBRSea will integrate academia, industry and societal stakeholders to produce specialists able to extensively understand and manage the potential of marine resources.

Grehan Anthony

National University of Ireland

Anthony Grehan[1], Murray Roberts[2] & the ATLAS Consortium

Affiliation(s) : [1]Earth and Ocean Sciences, School of Natural Sciences, National University of Ireland, Galway, Ireland

[2]School of Geosciences, University of Edinburgh, Scotland

A Trans-Atlantic assessment and deep-water ecosystem-based spatial management plan for Europe 'ATLAS'

The ATLAS EU Horizon 2020 project, that runs from 2016 to 2020, has created a dynamic new partnership to assess the Atlantic's deep-sea ecosystems and Marine Genetic Resources to create the integrated and adaptive planning products needed for sustainable Blue Growth. ATLAS will gather diverse new information on sensitive Atlantic ecosystems (including Vulnerable Marine Ecosystems (VMEs) and Ecologically or Biologically Sensitive Areas (EBSAs)) to produce a step-change in our understanding of their connectivity, functioning and responses to future changes in human use and ocean climate. Fully integrated spatial planning products built on basin and regional scales are needed to allow stakeholders to explore, and respond to, alternate scenarios of ocean dynamics and cross-sectoral Blue Growth. The EU FP7 MESMA (Monitoring and Evaluation of Spatially Managed Areas) framework will be applied in Case Studies spanning the deep waters of the EU, US, Canada and ABNJs (NAFO and NEAFC regulatory areas) against the backdrop of potential climate change, to develop marine spatial planning scenarios to support basin scale ecosystem based management.

Keywords: Spatial planning

Hitchin Becky

Joint Nature Conservation Committee

Author(s): Becky Hitchin, Becky Phillips

Affiliation(s): Joint Nature Conservation Committee (JNCC), UK

Novel methods to assess the impacts of oil and gas decommissioning within Special Areas of Conservation

There is a lack of understanding of the impact that rock dumping activities associated with decommissioning will have on the conservation objectives and site integrity of Special Areas of Conservation (SACs) designated for sediment habitats. Improved understanding is needed to reduce some of the levels of scientific uncertainty currently inherent in consenting decisions for industry and in European and national site assessments. The deposition of gravel, pebbles and cobbles onto the sea floor is common in most industrial marine operations to stabilise jack-up rigs and to prevent scour. In SACs with sediment features, rock dumping represents a potential permanent decline in extent, structure, functions and associated environmental processes. This has the potential to restrict the ability of those habitats to meet their conservation objectives – especially if the objective is to restore to favourable condition. Within the UK, innovative methods for assessments are currently being developed, using North Norfolk Sandbanks and Saturn Reef cSAC/SCI (NNSSR), a large North Sea sandbank site containing numerous gas platforms, as a pilot site. An automated spatial analysis tool is providing clearer understanding of overall impact of decommissioning on the site through cumulative effects modelling, driving the condition assessment of Annex I seabed habitats. Understanding how pressures impact on the different conservation objective attributes of the sediment features and thus a site's ability to meet its conservation objectives provides another important tool for assessment of decommissioning operations and impact on a protected site. Insights from these techniques will therefore allow consent decisions to be considered with significant improvements in both evidence and process.

Keywords: conservation status, assessment, innovative tools, decommissioning, conservation objectives, cumulative effect, oil and gas, North Norfolk Sandbanks, SAC

Kafas Andronikos

Marine Scotland Science

Author(s): Kafas, A., Davies I, Gubbins, M. et al.

Affiliation(s) : Marine Scotland Science, United Kingdom

Overview of offshore energy planning efforts in the North Sea – The NorthSEE project

The North Sea is one of the busiest seas for maritime industries in the world and its shared resources represent a crucial asset but also a shared territorial challenge to North Sea Region (NSR) countries. Various sectors, such as offshore energy, play a major part in generating economic value and employment; many are set to expand in line with smart blue growth. Appropriate management is essential to ensure maritime sectors develop sustainably in line with the carrying capacity of the marine environment. Marine Spatial Planning has been identified as a main tool for implementing the EU Integrated Maritime Policy and central approach to give effect to the EU's Blue Growth Strategy, while at the same time contributing to the achievement of Good Environmental Status in line with the Marine Strategy Framework Directive (MSFD). The recently adopted EU MSP Directive requires all Member States to implement marine spatial plans by 2021. Although MSP is a national competency, the Directive calls for national plans to be coherent across sea basins. Given the transnational nature of offshore energy activities and the transnational character of most marine ecosystems, facilitating greater transnational coherence and cooperation in MSP for the benefit of the North Sea environment and space represents a key shared challenge the European-funded NorthSEE project aims to tackle. In this study we present an overview of the state-of-the-art knowledge and planning solutions for offshore energy sectoral planning from North Sea member states. Furthermore, we share lessons-learnt in marine management within the North Sea and present the framework developed to compare international offshore energy planning efforts as part of the NorthSEE project based on ICES MSP Quality Management System, UNESCO's MSP guidelines, and the EU MSP Directive.

Mascart Thibaud

Ghent University - Marine Biology Research Group

Author(s): [1] Thibaud Mascart, [1] Tim Deprez, [1] Tim tkint, [2] Karolien Deprez, [2] Wim Vyverman, [1] Ann Vanreusel

Affiliation(s) :
[1] Ghent University, Marine Biology Research Group, Gent, Belgium
[2] Ghent University, Protistology and aquatic ecology, Gent, Belgium

EMBRIC – The European Blue Bio-Economy cluster for aquaculture and biotechnology innovations

EMBRIC - The European Marine Biological Research Infrastructure Cluster - is designed to accelerate the pace of scientific discovery and innovation derived from natural marine Bio-Resources. The novelty of EMBRIC lies in clustering 6 existing European Research Infrastructures (EMBRC, MIRRI, EU-OPENSCREEN, ELIXIR, AQUAEXCEL and RISIS) and 27 interdisciplinary partners from Academia, Research institutes, non-for-profit organizations and industry. Together, these will create new pipelines and novel applications in diverse fields, such as, drug discovery, aquaculture selective breeding, bioremediation, cosmetics and bioenergy.

One of EMBRIC's academic partners, Ghent University, dedicated two research groups to the cluster:

- The marine biology research group is in charge of training and exchange of best practice, by building an integrated training platform for the Blue economy industry and academia.
- The laboratory of protistology and aquatic ecology is in charge of proof of concept that genetically engineered microalgae can produce strains with improved performances in commercial applications.

Moreover, by interconnecting science, industry and policy, EMBRIC will defragment regional research, development and innovation policies. Hence, facilitating technology transfer, knowledge transfer and transnational access by developing best practices and integrated training programs. Furthermore, the industry will have access to newly available resources, novel techniques and up-to-date industry standards to directly integrate results and protocols in commercial processes, putting forward Europe's Marine Blue Bio-economy innovation in the fields of aquaculture and biotechnology. www.embric.eu

Keywords: Blue Growth, Biotechnology, Aquaculture, Innovation, Interdisciplinary, Marine bio-resources

Mascart Thibaud

Ghent University - Marine Biology Research Group

Author(s): Thibaud Mascart, Tim tkint, Marleen Roelofs, Ann Vanreusel, Tim Deprez

Affiliation(s) : Ghent University, Marine Biology Research Group, Gent, Belgium

The Blue training online one-stop-shop platform: MarineTraining.eu

Are you having problems finding the adequate marine or maritime course? Do you want to outsource the time consuming administrative burden of establishing a training? Do you have a Blue training initiative you want to disseminate at a European scale?

The Marine Training Platform is the partner you were looking for!

Our services include a free insights into a comprehensive database focused on higher education institutes (both universities and university colleges) and a free access to the collected data from all existing European blue training initiatives for each country, ranging from master and doctoral programmes, to expert trainings and specialist courses. In addition, our services include organizational aspects of creating and running a training in a straightforward and fast way. We support advertising possibilities, supply administrative services to trainees and training organizers (application, registration & certification) and create marine and maritime dedicated e-learning initiatives. Moreover, in the framework of the Belgian node of EMBRC (European Marine Biological Resource Centre - a distributed Research Infrastructure (RI), of which Belgium is an associate partner through Ghent University, University of Hasselt, Flanders Marine Institute and future partners, and via involvement in other European Blue Growth projects and networks, we are gradually expanding, including non-accredited training initiatives (for instance, research institutes and industries).

The Marine Training Platform is your online one-stop-shop for Blue Training in Europe

www.marinetraining.eu

Keywords: Blue Growth, Marine Training Platform, EMBRC, Marinisation, Education, Support

Moreau Kelle (Els Torreele)

Institute of Agricultural and Fisheries Research (ILVO)

Author(s): Kelle Moreau[1] & Els Torreele[1]

Affiliation(s) :

[1]Institute of Agricultural and Fisheries Research (ILVO), Belgium

Survey-based stock assessments versus sustainability assessments : interpretation and communication problems.

Stock assessments resulting in fishery advice traditionally rely on time series of catch and biological data originating from both active fisheries and fishery-independent surveys. Time series of spawning stock biomass, fishing mortality and recruitment are typical products of data-rich modelling, and reference points are known for most of these stocks. However, the number of stocks for which policy makers request fishery advice has increased substantially in recent years, and the necessary datasets to allow for a similar approach is usually not available. Therefore, the stock dynamics and response to changes in fishing pressure remain poorly understood, and reference points for these stocks have not been defined. Scientific surveys have nevertheless often collected certain types of information on these species, that allow to fill this knowledge gap. The results of such 'survey-based assessments' (a category of data-limited assessments) have been used in recent years to formulate fishing advice for the corresponding fish stocks. In parallel, an increased societal demand for sustainability information has characterized the past years, and scoring stock status forms an important part of this type of assessments. The accepted methodologies however, are focused on data-rich stocks, and don't accommodate for detailed scoring of the ecological sustainability of data-limited stocks. This could result in negative scores following a precautionary approach. Simultaneously, unambiguous communication of sustainability results for these stocks to a wide audience, is often tricky. Problems and pitfalls of scoring the stock status of data-limited stocks in a sustainability assessment and regarding popular advice (such as traffic light systems) are highlighted in this contribution.

Keywords: survey-based stock assessments, sustainability assessments, data-limited stocks, communication.

Noack Thomas (Esther Savina)

Technical University of Denmark, National Institute of Aquatic Resources

Author(s): Thomas Noack[1], Niels Madsen[1,2], Kai Wieland[1], Esther Savina[1], Ludvig Krag[1],

Affiliation(s) : [1]DTU Aqua, Technical University of Denmark, North Sea Science Park, Hirtshals, Denmark

[2]Section of Biology and Environmental Science, Department of Chemistry and Bioscience, Aalborg University, Aalborg, Denmark

Danish seine – Ecosystem effects of fishing

Requests for CO2 emission reduction and a growing interest in sustainable fisheries products by consumers are both facts that support fishing with Danish anchor seines. Danish seining is an efficient, fuel saving fishing method with expected low impacts on the environment. The scientific knowledge on the gear is, however, rather low. Therefore, aim of the current study "Danish seine – Ecosystem effects of fishing" is to increase this knowledge. Besides an analysis of catch profiles (based on data from an observer program), two sets of sea trials have been conducted. The purpose of one set has been a scientific description of the fishing process, a description of fish behavior and an initial evaluation of impacts the gear has on the seabed. The other set of sea trials aimed at estimating the level of direct impacts Danish seines have on the benthic and demersal fauna. Besides attaching small mesh collecting bags to the gear, a modified codend cover has been applied to the gear in order to estimate selectivity characteristics of a commercial Danish anchor seine. Overall, results of this study increase the knowledge on Danish seining and its potential impacts on the environment. These information are of great importance for future discussions in relation to ecosystem effects of fishing, spatial planning and fisheries management like setting new technical regulations.

Keywords: Alternative gears, Danish seine, Ecosystem effects, Selectivity

Reach Ian

MarineSpace Ltd

Author(s): Ian Reach[1], Dafydd Lloyd Jones[1], Andrew Bellamy[2], Joseph Holcroft[3], Nigel Griffiths[4], Rob Langman[1]

Affiliation(s) :

[1] MarineSpace Ltd, United Kingdom

[2] Tarmac Marine Ltd, United Kingdom

[3] CEMEX Marine Ltd, United Kingdom

[4] Hanson Aggregates Marine Ltd, United Kingdom

The use of marine aggregate sector environmental data to enable robust Marine Protected Area designation in the UK

UK Government is committed to implementing an ecologically coherent network of Marine Protected Areas (MPAs) within territorial waters by 2020. A 'blue belt' comprised of international designations e.g. Natura 2000, and domestic Marine Conservation Zones, to deliver obligations under the Convention on Biological Diversity, Habitats Directive, the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) etc. UK aggregate operators have consistently engaged in the MPA process in a co-ordinated, unified, and strategic manner. The sector has provided extensive time-series acoustic and benthic datasets to the statutory bodies, which are frequently the highest quality and resolution of any data informing the designation process. Many UK MPAs have been designated for features originally identified from aggregate characterisation and monitoring surveys. Notable are MPAs in English southern North Sea waters for: Ross worm Sabellaria spinulosa biogenic reefs, using high resolution sidescan sonar and drop-down video data; and extensive sites with subtidal sandbank habitat, where sub-bottom profiling data have been used to investigate subtidal sandbank thickness, and clearly differentiate bank toes from surrounding sandwave fields. The sector's data have also been used to revise the mapping and delineation of features already identified within MPAs. It is critical that designated features are correctly identified and mapped to achieve/deliver conservation objectives and avoid over-protection of non-feature areas, preventing unnecessary restriction of activities. UK experience shows that win-wins are possible, with industry engagement delivering robust MPA designation, whilst allowing operations to continue at most locations.

Van Lancker Vera

Royal Belgian Institute of Natural Sciences

Author(s): Van Lancker, V.[1,4], Francken, F.[1], Kint, L.[1], Terseleer, N.[1], Van den Eynde, D.[1], De Mol, L.[2], De Tré, G.[3], De Mol, R.[3], Missiaen, T.[4], Chademenos, V.[4], Bakker, M.[5], Maljers, D.[5], Stafleu, J.[5] & van Heteren, S.[5]

Affiliation(s) : [1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment. Brussels, Belgium

[2] Federal Public Service Economy, Continental Shelf Service, Belgium

[3] Ghent University, Dep. Telecommunications and Information Processing. Database - Document and Content Management, Belgium

[4] Ghent University, Dep. Geology. Renard Centre of Marine Geology, Belgium

[5] TNO - Geological Survey of the Netherlands, The Netherlands

Building a 4D Voxel-Based Decision Support System for a Sustainable Management of Marine Geological Resources

For sustainable management of marine geological resources, a geological knowledge base is being built for the Belgian and southern Netherlands part of the North Sea. Voxel models of the subsurface are used for predictions on sand and gravel quantities and qualities, to ensure long-term resource use. The voxels are filled with geological data from boreholes and seismic lines, but other information can be added also. The geology provides boundary conditions needed to run environmental impact models that calculate resource depletion and regeneration under various scenarios of aggregate extraction. Such analyses are important in monitoring progress towards good environmental status, as outlined in the Marine Strategy Framework Directive. By including uncertainty, data products can be generated with confidence limits, which is critical for assessing the significance of changes in the habitat or in any other resource-relevant parameter. All of the information is integrated into a cross-domain, multi-criteria decision support system optimised for user-friendliness and online visualisation.

Keywords: Aggregates, Sand, Gravel, Habitat, Seafloor Integrity, Marine Strategy Framework Directive, Uncertainty, Resource Suitability, 3D Voxel Modelling; 4D Impact Assessment, North Sea, Belgium, Netherlands

Vandendriessche Sofie

Institute for Agricultural and Fisheries Research (ILVO)

Author(s): Sofie Vandendriessche[1], Kilian Persoon, Els Torreele[1], Jan Reubens[2], Kris Hostens[1]

Affiliation(s) :

[1] *Institute for Agricultural and Fisheries Research (ILVO), Oostende, Belgium*

[2] *Flanders Marine Institute, Oostende, Belgium*

"A wind of change" in recreational fisheries? Recreational fishermen and wind farms: current use and perception

Offshore wind farms create opportunities for recreational fishermen in Belgium, since the presence of hard substrates and the closure for trawling create a favorable habitat for fish. After the construction in 2008, a concentration of anglers was observed in the vicinity of the first wind farm during monitoring. In the following years, however, the interest of anglers for the wind farms seemed to disappear. To elucidate the evolution in the relation between recreational angling intensity and wind farms, this study aimed to assess how Belgian recreational fishermen perceive wind farms, how often they visit them and why, and which fish species they (expect to) catch. Data were derived from the annual DCF survey for recreational fishermen. Less than 2% of the sea anglers reported to go fishing in the larger wind farm area, even when 30 to 40 percent of the respondents either expected more fish, bigger fish or other fish species. The main reasons to stay away from wind farms is because entering the wind farms is not allowed, because the distance to the wind farms is relatively large, because charter vessels do not offer fish trips to wind farms, and because wind farms are protection zones and nursery areas for fish. 40% of the respondents would consider fishing inside wind farms if it were allowed, mainly because they expect more or other fish. This is a clear indication that the enforcement of wind farm closure for fisheries and shipping is vital when aiming at the creation and/or restoration of nursing grounds in the area. However, the large distance to the wind farms will probably continue to limit fishing pressure, even if wind farms would (partly) be opened for recreational fisheries.

Keywords: wind farms, recreational fisheries, questionnaire survey

Dekker Evelien (presenter Valérie Dulière)

Utrecht University

Author(s): Evelien Dekker[1,2,3], Valérie Dulière[3], Lodewijk van Walraven[2], Geneviève Lacroix[3]

Affiliations:

[1] Utrecht University, The Netherlands

[2] Royal Netherlands Institute for Sea Research (NIOZ), The Netherlands

[3] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Belgium

How vertical swimming behavior affects a jellyfish journey?

The globally observed increase in jellyfish is a major concern due to the negative impacts on commercial activities (such as aquaculture and tourism) and their potential to disturb the trophic balance in marine ecosystems. In order to predict how, when and where massive jellyfish blooms develop, a better understanding of their population dynamics and dispersal is required. The jellies drift is driven by hydrodynamic processes such as currents, tides and waves. However, their trajectories can be affected by swimming behavior. Jellyfish might perform complex swimming behaviours to increase their chance of survival, to search for prey, to prevent stranding and enhance bloom maintenance. Moreover, jellyfish are often observed to perform vertical excursions in the water column and sometimes tend to avoid highly turbulent regions in the surface water. Biophysical models are good tools to help assessing the transport of living organisms during their pelagic phase and to test the impact of swimming behavior. Here, the OSERIT drift model was expanded by including different kinds of vertical swimming behaviours and used to assess the resulting spreading of jellyfish in the southern North Sea. In 2013, a mass stranding of Aurelia aurita occurred at the beaches of Belgium and The Netherlands. Backtracking trajectories have been computed starting from these beaching events. Four hypothetical vertical swimming behaviours have been designed on the basis of literature and the model has been used to test the sensitivity of the modeled jellyfish trajectories to these behaviors. The estimation of the Aurelia aurita trajectories was very sensitive to including vertical swimming behavior or not.

Keywords: jellyfish, polyps particle tracking model, swimming behaviour, spreading, polyps

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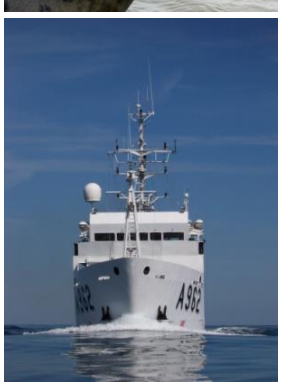

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