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Interim Report of the Working Group on the Value of Coastal Habitats for Exploited Species (WGVHES)

27 June – 1 July 2016

Amsterdam, the Netherlands



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Executive summary

The Working Group on the Value of Coastal Habitats for Exploited Species (WGVHES) met from 27 June to 1 July 2016 in Amsterdam, the Netherlands.

The groups made good progress on three manuscripts; one paper was published. Two new ideas emerged from discussions of which one lead to a new manuscript outline.

One main finding is that for those ICES advice species using the coastal areas 92% is impacted by at least one anthropogenic activity.

Habitat alteration is pervasive and Anthropogenic impacts are documented at local level, but without knowledge of temporal and spatial connectivity upscaling to population level is not possible.

Tools for valuation of coastal habitats need to be developed for maritime spatial planning as more ICES countries recognize the needs to obtain specific information on important coastal fish habitat.

1 Administrative details

Working Group name Working Group on the Value of Coastal Habitats for Exploited Species (WGVHES)
Year of Appointment 2016
Reporting year within current cycle (1, 2 or 3) 1
Chair(s) Josianne Strottrup, DK Rochelle Seitz, USA Karen van de Wolfshaar, NL
Meeting venue Amsterdam, the Netherlands
Meeting dates 27 June – 1 July 2016

2 Terms of Reference a) – z)

- a) Continue synthesizing available information for quantifying the value of coastal habitat for exploited species.
- b) Demonstration of the importance of habitats for exploited species on regional scales using modelling and case study approaches.
- c) Characterising the relation between habitat, individual processes and population responses.
- d) Investigate how habitat considerations can be incorporated into quantitative tools used in the management process.

3 Summary of Work plan

After presentations and updates of ongoing work, the group worked in subgroups. One subgroup made great progress on the review of “Conflicts in the coastal zone: A review of evidence for human pressures impacts on commercially important coastal fish species” (ToR a). The modelling subgroup dealing with “Review of quantitative modelling approaches for integrating habitat quality into population models”, nearly finalized the manuscript (ToR a). A second subgroup also made great progress on the characteristics and function of natural and anthropogenic hard bottom habitats for fish and inverte-

brates in coastal waters (ToR b). The intersessional work on mapping fish habitats in data poor areas was presented as an update ToR c). Some progress was made by the subgroup dealing with “Dynamic Energy Budget model for prey of flatfish such as plaice” (ToR d).

A new subgroup initiated a discussion on the definition of nursery habitat. This discussion will lead to a new manuscript reviewing current definitions and providing a conceptual framework for management (ToRs a) and d)).

The idea was raised to make an overview reviewing different approaches to defining and delimiting important habitats (e.g., nursery areas) – so many different approaches are taken – mapping distribution, genetic or otolith chemistry analyses to map nursery areas and connectivity. Such an overview could help bridge the gap between local studies and upscaling to population level. Due to time limitations this was not started this year.

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

Publications

Van de Wolfshaar KE, Tulp I, Wennhage H & Støttrup JG. Modelling population effects of juvenile offshore fish displacement towards adult habitat. MEPS 540: 193-201. 2015.

Presentations

Støttrup JG, Thomas K. Sørensen, Josefine Egekvist, Elliot E. Brown, Grete, E. Dinesen, Frank I. Hansen and Morten Vinther. Multidisciplinary mapping of fish habitats in the Sound, Denmark for maritime spatial planning. WKCCMSP, Geesthacht, Germany, 8-12 February 2016.

Støttrup JG, Thomas K. Sørensen, Josefine Egekvist, Elliot E. Brown, Grete, E. Dinesen, Frank I. Hansen and Morten Vinther. Multidisciplinary mapping of fish habitats in the Sound, Denmark for maritime spatial planning. HELCOM, Riga, Latvia, 16-18 February, 2016.

5 Progress report on ToRs and workplan

Progress by ToR

- a) One subgroup made great progress on the review of “Conflicts in the coastal zone: A review of evidence for human pressures impacts on commercially important coastal fish species”. The modelling subgroup dealing with “Review of quantitative modelling approaches for integrating habitat quality into population models”, nearly finalized the manuscript.
- b) Second subgroup also made great progress on the characteristics and function of natural and anthropogenic hard bottom habitats for fish and invertebrates in coastal waters.
- c) The intersessional work on mapping fish habitats in data poor areas was presented as an update.
- d) Some progress was made by the subgroup dealing with “Dynamic Energy Budget model for prey of flatfish such as plaice”. A new subgroup initiated a

discussion on the definition of nursery habitat. This discussion led to initiating a new manuscript reviewing current definitions and providing a conceptual framework for management.

Science Highlights

Van de Wolfshaar KE, Tulp I, Wennhage H & Stottrup JG. Modelling population effects of juvenile offshore fish displacement towards adult habitat. MEPS 540: 193-201. 2015.

6 Next meetings

Options for meeting in year 2: Malta, Sweden; proposed week is 26–30 June 2017.

7 Abstract of new sub-group work

A subgroup was formed to (i) define one of the critical coastal habitats (nursery habitat) quantitatively and (ii) produce a framework for incorporating nursery habitat into ICES management decisions and actions. The initial subgroup was comprised of Andreas Dänhardt, Marjolein Post, and Romuald Lipcius, but it is expected that other working group members will participate as well. The objectives of the subgroup during the working group meeting were the following:

- Prepare the structure, specific goals and organization of a report/manuscript dealing with the major goals stated above.
- Decide on model species to be included in the analyses. Blue crab, sole, plaice, and brown shrimp are potential candidates.
- Decide on a timeline, which was selected to be a report by next year's meeting.
- Present the initial organization and details to the working group.

A draft structure, specific goals and organization of the report/manuscript was produced, as follows:

Draft title: "15 years after Beck *et al.*: Linking concepts of nursery habitats to management"

Introduction & objectives:

- 1) Why is it important to be clear about the nursery definition? A clear definition is required to identify nursery areas as the basis for conserving sensitive habitats relevant for closing the life cycles of the focal species.
- 2) The spatial characteristics of habitat patches play an important role in structuring associated animal communities, but typically are not considered in assessments of nursery value, leaving a critical knowledge and conservation gap.
- 3) Brief history of the nursery habitat concept, and examples of the common usage of the concept, such as nursery habitat, seascape nursery, habitat mosaic, and metapopulation. Review and discuss definitions and terms of 'nursery' for fishes and macroinvertebrates to derive a framework that both covers func-

tional aspects from a population point of view and is useful for managers to make informed decisions.

- 4) Establish a link between the juveniles in nursery areas and the adult stock.
- 5) Suggest an approach to set thresholds of juvenile abundance within a nursery (by new definition) not to be crossed (management goal).
- 6) Discuss how both practical applicability and sufficient consideration of complexity and dynamics that can be incorporated into one framework suited to support informed management decision based on best available knowledge.
- 7) Make specific suggestions on needed research to identify quantitative species-habitat relationships and connectivity issues at relevant spatial and temporal scales (ontogenetic migrations, small-scale inter- and intra-habitat movements) to be used periodically to update management with the best available knowledge.
- 8) Extensive literature search (under way).
- 9) Construct recruit-stock-relationships for selected species (blue crab, sole, plaice, brown shrimp), for which there is sufficient data of juvenile and adult abundance. Focus on a few exploited species first, later extend to unexploited species. Case studies on recruit-stock relationship to set the stage for defining threshold levels of juvenile density in nursery habitats.

8 Abstracts of presentations

Marjolein Post, IMARES

The shallow coastal zone is an essential nursery habitat for juvenile flatfish species such as sole (*Solea solea* L.). The increased frequency of shoreface nourishments along the coast is likely to affect this nursery function by altering important habitat conditions, including sediment grain size. Sediment preference of juvenile sole (41–91 mm) was studied in a circular preference chamber in order to understand the relationship between grain size and sole distribution. The preference tests were carried out at 11°C and 20°C to reflect seasonal influences. The juveniles showed a significant preference for finer sediments. This preference was not length dependent (within the length range tested) nor affected by either temperatures. Juvenile sole have a small home range and are not expected to move in response to unfavourable conditions. As a result, habitat alterations may have consequences for juvenile survival and subsequently for recruitment to adult populations. It is therefore important to carefully consider nourishment grain size characteristics to safeguard suitable nursery habitats for juvenile sole.

Karen van de Wolfshaar, IMARES

The fisheries of brown shrimp (*Crangon crangon*) in the south-eastern North Sea are of regional economic importance. Especially the Dutch and German fleet, representing together 2/3 of the total fleet targeting the shrimps in the coastal regions, take over 80% of the catch (ICES Report WKCCM). The shrimp fishery has developed in the past decades to a mature fishery and there are concerns about its sustainability in the future, yet the stock is not managed. The Dutch fleet itself has requested for management advice for the brown shrimp, while catches are still high and in advance of possible decreases in catch-

es, to ensure the future of the population as well as its fishery (ICES Report WKCCM). To that end a mechanistic model was developed to test harvest control rules. The population dynamics of brown shrimp in the North Sea shore area and its fisheries are modelled using a Dynamic Energy Budget approach for individual level processes of shrimp. A second model shell then keeps track of all individuals, their growth, mortality and reproduction, and includes a dynamical resource, while the fishing fleet is modelled agent-based. This approach allows for assumptions at individual shrimp level while population level dynamics and fleet catches are an emergent property of following all individuals and vessels in time. We find that model results comply with individual growth, density and catch data, and that the model provides mechanistic understanding, based on growth overcompensation and resource competition, of the effects of the evaluated harvest control rules.

Olivier Le Pape (from several research steps together with B. Archambault, E. Rivot, M. Savina L. Baulier, Y. Vermard, P. Riou, M. Huret). ESE, Ecology and Ecosystem Health, Agrocampus Ouest, INRA, 35042 Rennes, France. Using a spatially structured life cycle model to assess the influence of multiple stressors on an exploited coastal-nursery-dependent population

Exploited coastal-nursery-dependent fish species are subject to various stressors occurring at specific stages of the life cycle: climate-driven variability in hydrography determines the success of the first eggs/larvae stages; coastal nursery habitat suitability controls juvenile growth and survival; and fisheries target mostly adults. A life cycle approach was used to quantify the relative influence of these stressors on the Eastern English Channel (EEC) population of the common sole (*Solea solea*), a coastal-nursery-dependent flatfish population which sustains important fisheries. The common sole has a complex life cycle: after eggs hatch, larvae spend several weeks drifting in open water. Survivors go on to metamorphose into benthic fish. Juveniles spend the first two years of their life in coastal and estuarine nurseries. Close to maturation, they migrate to deeper areas, where different subpopulations supplied by different nurseries reproduce and are exploited by fisheries. A spatially structured age-and stage-based hierarchical Bayesian model integrating various aspects of ecological knowledge, data sources and expert knowledge was built to quantitatively describe this complex life cycle. This integrated approach combined: (1) outputs of an individual-based model for larval drift and survival that provided yearly estimates of the dispersion and mortality of eggs and larvae, from spawning grounds to settlement in several coastal nurseries; (2) a habitat suitability model, based on juvenile trawl surveys coupled with a geographic information system, to estimate juvenile densities and surface areas of suitable juvenile habitat in each nursery sector; (3) a statistical catch-at-age model for the estimation of the numbers-at-age and the fishing mortality on subadults and adults and (4) expert knowledge on the low connectivity among three subpopulations in the EEC. Scenarios were designed to quantify the effects of interacting stressors on population renewal. Results emphasized the importance of coastal nursery habitat availability and quality for the population renewal. Realistic restoration scenarios of the highly degraded Seine estuary produced a two-third increase in catch potential for the adjacent subpopulation, resulting in a 20% increase at the whole EEC scale. Fisheries, however, remained the main source of population depletion. Setting fishing mortality to the maximum sustainable yield led to substantial increases in biomass (+100%) and catch (+33%) at the EEC scale. The approach also showed how overfishing increased the sensitivity to climate-driven variability. Our results pro-

vided insights into the dynamics of numerous exploited coastal-nursery-dependent species while paving the way toward more robust advice for sustainable management of these resources.

Elliot Brown, Rita Vasconcelos, Håkan Wennhage, Josianne Støttrup, Karen van de Wolfshaar, Olivier Le Pape, Francesco Colloca, Ulf Bergstrom

The literature review undertaken showed that a large proportion of the commercial fish species categorized as coastal were reported to be impacted by habitat degradation related to human pressures. 92% of these ICES advice species were found to be affected by at least one human pressure acting during one of their life stages in the coastal habitats. Coastal areas have experienced substantial increase in human population densities and rapid economic development, increasing the threat to coastal habitats by multiple human impacts. Despite the prevalence of examples linking coastal habitat degradation to critical life stages of commercial fish species, only a few studies have been able to demonstrate habitat availability as a bottleneck for population size. These findings clearly show both the need and importance of studying the state of coastal habitats for many commercial species.

Rochelle Seitz, Virginia Institute of Marine Science. Ecosystem Services of Restored Oyster Reefs in Lower Chesapeake Bay: Oysters, Benthos, Fish

I summarized a recent project on examining ecosystem services on oyster reefs by determining finfish, blue crab, and benthic prey utilization of oyster reefs in relation to reef characteristics, environmental conditions, and geographic location. Study sites were in the Great Wicomico, Piankatank, Lynnhaven, and Lafayette Rivers of the lower western shore of Chesapeake Bay, Virginia, USA. Our specific objectives were to (i) quantify oyster populations at four sampling locations (ii) quantify finfish and blue crab use of differing oyster reefs using baited and unbaited trap surveys and gill-net surveys (iii) quantify benthic prey availability at the reefs using embedded benthic trays, and (iv) characterize the diet of finfish and blue crabs at the reefs. Oyster population densities were high at all locations, generally meeting the target of 50 individuals/m² and 50 g DW/m². Notably, we discovered a relict reef in the Lafayette River with high densities including large individuals and five cohorts within the population. In terms of the ecosystem service of provision of habitat, a total of 61 macrofaunal species were identified among all the benthic tray samples, average macrofaunal density was 6169 individuals m⁻², and average biomass per sample was 68 g AFDW m⁻². Species assemblages differed significantly among rivers (PRIMER analysis). Differences in diversity and species composition seemed to be largely due to variation in salinity, with the higher-salinity rivers (Lafayette and Lynnhaven) having greater species diversity compared to the lower-salinity rivers (Piankatank and Great Wicomico). Importantly, macrofaunal abundance, was strongly correlated with live oyster density (oysters m⁻²) ($r^2 = 0.70$, $p < 0.001$) and volume of live oysters (L) ($r^2 = 0.70$, $p < 0.001$). Catch per unit effort in one high-salinity tributary exceeded that in one low-salinity tributary, but did not vary between sites. Fish abundance varied seasonally with the highest abundances in June and the lowest in October. Diet analysis suggested some distinction between individuals at reef and reference sites, with diet of reef-associated fishes including reef-associated prey items. Understanding the functional value of restored reef habitat is crucial to predicting and evaluating the impacts of large-scale oyster restoration and quantifying changes for exploited species.

Rom Lipcius, Virginia Institute of Marine Science – update model review

The subgroup is finalizing the modelling review begun during the first working group, which focuses on a review of modelling approaches useful in the quantitative valuation of coastal habitats for exploited populations. The subgroup has a working manuscript draft, which will be circulated to all members (co-authors) of the subgroup for their input during the week of 4 July 2016, revised and submitted for publication to Marine Ecology Progress Series by 1 August 2016. The working title of the manuscript is “Modelling quantitative value of coastal habitats for exploited populations” and has as co-authors Romuald N. Lipcius, David B. Eggleston, F. Joel Fodrie, Jaap van der Meer, Kenneth A. Rose, Rita P. Vasconcelos, and Karen E. van de Wolfshaar.

Josianne Støttrup, Danmarks Tekniske Universitet

An example of mapping marine fish habitats in a data poor situation was provided by Denmark. This was used to advise The Danish Nature Agency under the Danish Ministry of Environment and The Danish AgriFish Agency under the Ministry of Food, Agriculture and Fisheries in a situation where there were conflicts between different human activities and interests. The Sound between Denmark and Sweden is a transitional sea between the Baltic and the North Sea with multiple uses such as commercial gillnet fishing, angling and sports diving as well as shipping, the wind energy sector and marine aggregate extraction. Conflicts arose between the fishing sector and marine aggregate sector. A project was therefore carried out in 2014/2015 in the Danish part of the Sound with the aim to collect information from all existing sources. Quantitative information from fishing surveys was lacking and the study relied on general descriptive information providing habitat suitability maps, and interviews with small-scale commercial gillnetters and anglers to map the habitats of ecological importance for selected fish species of commercial value. The information and any data available was collated in GIS layers and integrated in map overlay using also GIS layers with depth, sediment or other environmental information. Habitat maps for seven commercially important fish species were produced and when compiled provided visualization of hot-spot fishery/fish habitat areas, which would be most likely to create conflict between fishery and marine aggregate extraction.

Jaap van der Meer, Royal Netherlands Institute for Sea Research

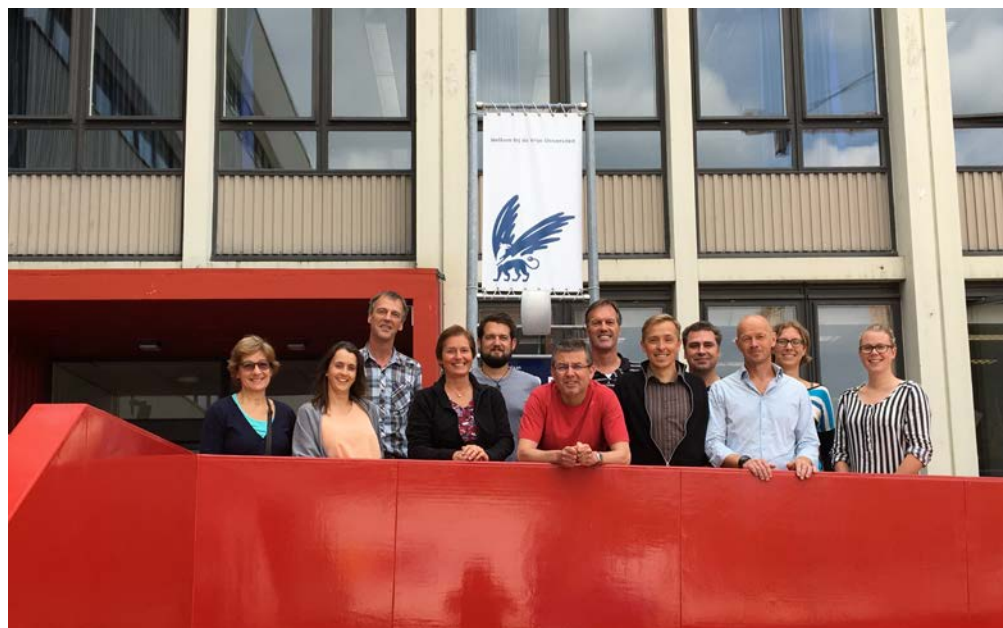
Bivalves belong to the most abundant animal groups in intertidal soft-sediment systems. They provide food for many bird and fish species, as well as for humans. The question whether their productivity is at carrying capacity and limited by food availability during their benthic stage, or whether they are recruitment-limited still causes debate. Intersessionally and during the meeting we explored for five local populations of either the cockle *Cerastoderma edule* or the Baltic tellin *Macoma balthica*, to what extent post-recruitment growth and survival depend on recruitment. We observed that annual variability in secondary production, which is a function of both recruitment and growth and survival (these latter two can be integrated into expected mass at death), is merely a matter of recruitment variability in three out of the five populations. Yet for the other two populations the role of post-recruitment density dependent processes, as reflected in the covariances between recruitment and growth and mortality (and in that between log recruitment and log expected mass at death), could not be ignored

Ulf Bergstrom, Institute of Coastal Research. Economic valuation of coastal fish habitats

The coastal environment generates a large number of ecosystem services. The nearshore zone provides essential habitats for a large part of the economically most important fish species. Also, vegetated areas along the coast bind sediments and nutrients, thus protecting the open sea. Simultaneously, the dense human populations along the coasts put high, and accelerating, pressure on the coastal ecosystem through overexploitation, habitat transformation and pollution, threatening the valuable ecosystem services provided by these shallow-water habitats. In the research project VALUES (<http://www.aquabiota.se/en/projects/values/>), funded by the Swedish EPA, the aim is to develop methods to describe the value and magnitude of these ecosystem services, to enable their integration in political decisions and in the end contribute to a sustainable management of the coastal zone. One case study concerns valuation of fish nursery habitats. In this case study, nursery areas of large predatory fish, such as perch (*Perca fluviatilis*) and pikeperch (*Stizostedion lucioperca*), are mapped for a large archipelago area of the Baltic Sea. These maps are then utilized together with existing functional relationships describing the dependence of adult stocks of the species to the amount of nursery habitat available (Sundblad *et al.* 2014) to produce fish production maps. In a next step, the effects of eutrophication (Bergström *et al.* 2013) and coastal construction (Sundblad & Bergström 2014) on the distribution of nursery habitats is assessed in scenario analyses, whereafter the corresponding effects on fish production and ecosystem services is then evaluated. Several important ecosystem services are associated with these predatory fishes. They provide food and opportunities for recreational fishing, and are important for ecosystem functioning through controlling growth of filamentous algae, thus decreasing eutrophication-related problems (Östman *et al.* 2016). The value of these habitats will be estimated using a suite of methods, from estimates of replacement cost and restoration cost to compensate for lost habitat, to estimates of the food value using the market price method, the recreational value using the travel cost method and the biological control value using the substitute cost method. A central part of the project is to apply the results obtained in real management cases relating to coastal construction to evaluate and refine their utility for management situations.

Annex 1: List of participants

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Participants 2016 of the ICES Working Group on the value of coastal habitats for exploited species in Amsterdam, The Netherlands. Front row: Josianne Støttrup, Rita Vasconcelos, Rochelle Seitz, Olivier Le Pape, Ulf Bergstrom, Håkan Wennhage, Marjolein Post. Back row: Jaap van der Meer , Elliot Brown, Rom Lipcius, Andreas Danhard, Karen van de Wolfshaar.