

Table of Contents

1 Programme	3
2 Introduction, aims and structure of the conference	4
3 Presentations	5
3.1 Aiming for the Fish Targets	5
3.2 The bigger picture - <i>Supplementing established monitoring surveys with habitat-specific occurrence of fish in the Wadden Sea</i>	6
3.3 On fish, food webs and freely available data	6
3.4 How to include fishermen's knowledge in management	7
3.5 Fishing effort in the Wadden Sea - <i>Difficult estimates in dendritic landscapes</i>	8
3.6 Trends in fish in the Wadden Sea and coastal waters	8
3.7 Demersal Young Fish Survey in German waters	9
3.8 Population status and management of salmon, sea-trout and North Sea houting in the Danish Wadden Sea rivers - <i>Management and challenges</i>	9
3.9 Fisheries, climate and marine mammals conspire to challenge the paradigm of non-management of brown shrimp	10
3.10 Fish Migration River Afsluitdijk - <i>An innovative solution for upstream fish passage between the Wadden Sea and lake IJsselmeer</i>	10
4 Posters	11
4.1 Evaluation of habitat quality of German salt marsh creeks for fish	11
4.2 UFOs in the North Sea	11
4.3 Comparative spatial analysis of vessels landing shrimp in German harbors 2007-2013	12
4.4 Cooperative Fishery Research in the German Wadden Sea, the Brown Shrimp fishery as a case study	12
4.5 A temporal point of view on three-spined stickleback (<i>Gasterosteus aculeatus</i>) in the Dutch Wadden Sea	13
5 Group work	14
5.1 Stocks (& populations): status and trends; drivers	14
5.2 Habitat: diversity; relationship fish habitat	16
5.3 Nursery areas: a question of availability or changes in fish behaviour?	18
5.4 Fish migration: trends in species distribution and pathways of migration	20
6 Plenary discussion and wrap up of the fish workshop	22
7 Main findings and recommendation	23

1 Programme

On January 8th and 9th in 2015, the Programme towards a Rich Wadden Sea (PRW), the Thünen Institute of Sea Fisheries (TI) and the Common Wadden Sea Secretariat (CWSS) organized a workshop focusing on the **Conservation Management of Fish Populations in the Wadden Sea**. The programme of the workshop was announced in advance of the meeting and was carried out without major changes, as listed in Annex 1. The list of participants of both days is presented in Annex 2.

57 participants from various sectors (science & research, policy, authorities and fisheries) spent two fruitful days at the Thünen Institute for Sea Fisheries in Hamburg discussing the options for the implementation of the trilateral fish targets. The Chair of the conference, **Anne Sell** (TI), opened the meeting at 9:00 hours on Thursday, 8 January 2015, on behalf of the co-organisers (PRW and CWSS). She briefly introduced the background and scope of the two-day workshop on conservation management of fish populations in the Wadden Sea (for details, see Introduction, aims and structure of the workshop).

The opening word was followed by welcome addresses by the representatives of the organising institutions: Gerd Kraus (TI), Kees van Es (PRW), and Folkert de Jong (CWSS).



Gerd Kraus, Director of the TI of Sea Fisheries, sketched the history of the founding of the Thünen Institute, resulting from concerns on the developments in pollution and (over)fishing in the Elbe estuary around 1900. He also explained that the Thünen Institute is named after an outstanding scientist, although not in the field of fishery research, but in agriculture and economy, where he developed methods that are relevant across disciplines. Gerd Kraus expressed his positive attitude towards the trilateral cooperation.

Kees van Es, Programme Manager of PRW, introduced the aim and background of the "Programma naar een Rijke Waddenzee" (PRW), which is a programme for nature conservation and sustainable use of the Wadden Sea in the Netherlands. He gave examples of processes that have been facilitated by PRW, e.g. the transition of the Dutch mussel- and shrimp fishery towards a more sustainable use. Less attention has been given to fish stocks in the Wadden Sea in the past. However, last August 2014 a call for action expressed by the NGO's raised questions even in the Dutch parliament. As a first step, the two Dutch institutions NIOZ and IMARES were asked to provide an overview on the development of fish populations in the Wadden Sea. PRW also commissioned one of the static gear fisher(wo)men in the Wadden Sea, to give an impression of how fishermen's knowledge can be used in management.

Folkert de Jong, Deputy Secretary of the CWSS, referred to the first Wadden Sea Quality Status Report (QSR), about 25 years ago. Although there has been significant progress since then, there is still a lot of potential for improving monitoring and research. The QSR of 1994 was the first issue with some information on fish. For many years, the fish information was not updated because of a lack of data and expertise. The initial trilateral targets did not include fish. The QSR of 2004 contained the first broader chapter on fish, and gave recommendations for further action. Subsequently, an ad hoc Fish Expert Group was formed and made good progress and as a result the QSR 2009 contained a comprehensive overview on the status of Wadden Sea Fish plus a detailed proposal on trilateral fish targets. These were adopted at the 2010 Trilateral Wadden

Sea Conference on Sylt. Unfortunately, little progress has been made since except that within the Ministerial Declaration from Tønder in February 2014, the further implementation of the fish targets is requested. It is therefore timely to work on the preparation of the 2018 Trilateral Ministers Conference, also in the framework of the preparation of the QSR 2016.

2 Introduction, aims and structure of the conference

The shallow coastal waters of the Wadden Sea and its tributary estuaries and rivers provide indispensable ecological functions for fish, such as reproduction and feeding, but also serve as an acclimatisation area and transit route for long-distance diadromous fish. The Wadden Sea ecosystem is also connected with, and influenced by, the North Sea. Marine juveniles and marine seasonal species form an important constituent of the Wadden Sea fish fauna, which has a total of approximately 150 species of fish, including 13 freshwater species.

The Wadden Sea is protected by international policy agreements such as the Habitats Directive Natura 2000, the Water Framework Directive and the Marine Strategy Framework Directive. However, there are few direct management measures for fish species other than the diadromous fish such as twaite shad, river lamprey and sea lamprey, also sturgeon, houting and salmon. In order to ensure the development of a healthy fish community, the three Wadden Sea countries - Denmark, Germany and the Netherlands - have developed a series of targets for fish which will be implemented through the Wadden Sea Plan (WSP, 2010).

The two-day event was structured along 4 themes (stocks, habitat, nursery areas, fish migration) originating to some extent from the trilateral fish targets, as formulated in the WSP:

- Viable stocks of populations and a natural reproduction of typical Wadden Sea fish species.
- Occurrence and abundance of fish species according to the natural dynamics in (a)biotic conditions.
- Favourable living conditions for endangered fish species.
- Maintenance of the diversity of natural habitats to provide substratum for spawning and nursery functions for juvenile fish.
- Maintaining and restoring the possibilities for the passage of migrating fish between the Wadden Sea and inland waters

The aim of the workshop was, to focus on main requirements for implementing these targets by identifying (our understanding of) the current status of fish populations, main pressures, gaps in data and knowledge. Furthermore suitable indicators were envisaged to be discussed, which might be the basis for the formulation of recommendations for research, monitoring, conservation and management of Wadden Sea fish populations, also with reference to the forthcoming 2016 Wadden Sea Quality Status Report. To achieve this, there were sessions with presentations by delegates from the three Wadden Sea countries on the relevant subjects (see chapter 4, Presentations).

Furthermore, there were parallel group work sessions in which the different themes were discussed (stocks and habitats on day 1, nursery area and fish migration on day 2). The group work was structured around a matrix with three main questions to be elaborated per theme:

1. what is our understanding of underlying processes?
2. what are available data and data gaps?
3. what are the options for cooperation?

In preparation of the group discussions of the second day, some guiding questions were formulated by the organising committee (indicated in grey in the matrix). The results of the group sessions were reported back by group representatives and were discussed in plenary sessions on both days. As an extra session at the end of day one, there was a poster reception, which was kicked off by a two minutes poster pitch by the poster authors.

At the end of the second day, the Chair provided a wrap up of the outcome of the fish workshop.

3 Presentations

The abstracts of the different presentations (all sessions combined) are presented below as submitted by the authors. After each presentation there was limited time for some short questions.

3.1 Aiming for the Fish Targets

Paddy Walker (Programma naar een Rijke Waddenzee)

There are signs that the fish community in the Wadden Sea has changed radically in the past decennia. Young fish, but also large predatory fish, seem to have declined in numbers; the nursery area function appears to be changed due to the decrease of the relevant species and a decline in the average fish length. However, despite the annual surveys, we do not have a complete overview of the fish community. The abundance and distribution of pelagic fish and the use of salt marshes by fish are just two gaps in our knowledge.

Despite the intentions described in policy directives little headway has been made in the improvement of fish stocks, or even to gain a better insight into the status of the fish community. This is primarily due to the highly abstract level of objectives in policy and the inability to translate these into management measures.

The lack of coherency in policy is also a bottleneck to lasting improvement in fish communities and implementation of management and measurable targets. There is a real need to coordinate and harmonise the policy objectives as apply to fish in the Wadden Sea and North Sea coastal area, both nationally and in a trilateral perspective.

A new strategy is needed in order to implement policy, develop a research agenda and to strengthen and harmonise current monitoring programmes, both in the Netherlands as well as in the Trilateral Wadden Sea and to close the policy cycle. The Trilateral Fish Targets, which were included in the 2014 Trilateral Ministers Declaration, provide a way to harmonise policy objectives. This presentation will explore a new strategy that is currently being developed by the Dutch nature conservation programme – Towards a Rich Wadden Sea.



Impressions of the workshop

3.2 The bigger picture - *Supplementing established monitoring surveys with habitat-specific occurrence of fish in the Wadden Sea*

Andreas Dänhardt (IHF Universität Hamburg)

For implementing most of the trilateral fish targets, we lack a cause-and-effect understanding. Ship-based surveys with active and passive gear are the main source of observation to monitor progress towards reaching the trilateral targets on fish, and they yield valuable information on relative abundance change. Using seasonal and spatially resolved data on fish abundance from stow net catches and information on the occurrence of fish on an intertidal Pacific oyster reef and in intertidal salt-marsh creeks I argue that the Wadden Sea is a seasonal and highly structured environment, requiring multiple methods and integrated analyses to measure the state of fish populations and that focused research on causal relationships is needed to identify options to mitigate adverse human impacts. Interannual trends of the same species measured both in two different areas and in one area in different months did not correspond, indicating the need for considering spatial and seasonal aspects when interpreting abundance trends. Habitat-specific patterns of fish species composition and abundance suggest that habitat affinity plays an important part in structuring the Wadden Sea fish fauna which needs to be considered when evaluating progress towards achieving the trilateral fish targets.

3.3 On fish, food webs and freely available data

Katja Philippart (NIOZ), Martin Baptist (IMARES), Henk van der Veer (NIOZ)

The decline in riverine nutrient loading and fish landings in the Wadden Sea since the mid-1980s led to a public outcry of local fishermen in the harbour of Oudeschild (Texel) if the observed decline in fish was resulting from the reduction of phosphate loads. Correlations between nutrient loadings and fish landings have been observed in other coastal waters of the world, so it is worthwhile to examine if this applies to the Wadden Sea as well. In order to do so, long-term and consistent field observations on all relevant parameters are required. For the Dutch Wadden Sea, the WaLTER website (www.walterwaddenmonitor.nl) gives an overview of monitoring programs (.../tools/eva) and the WaLTER dataportal (.../tools/dataportaal) supplies free access to most of these data as collected by a suite of research institutes and organisations. One of the time series on fish fauna is an ongoing daily sampling programme of NIOZ in the most western part of the Dutch Wadden Sea using a fyke net. Recent min/max auto-correlation factor analyses of the data for the years 1960-2011 showed two major trends in spring and autumn species biomass time series (Van der Veer et al., 2015). The first axis represented a decrease from the 1960s followed by stabilization from the mid-1990s. The second trend showed an increase with a maximum around 1980 followed by a steady decrease in spring and a decrease and stabilization from 2000 in autumn. It is argued that the most likely explanatory variables are a combination of external factors: increased water temperature, habitat destruction in the coastal zone (sand dredging and beach nourishment, fishing) and increased predation by top predators for the first trend, and large-scale hydrodynamic circulation for the second trend. From this statistical analyses of long-term field observations on fyke catches and environmental conditions, change in phosphate loading appears not to be the most likely cause of change in fish stocks in the (western) Wadden Sea. * Van der Veer HW et al. (2015) Changes over 50 years in fish fauna of a temperate coastal sea: degradation of trophic structure and nursery function. *Estuarine, Coastal and Shelf Science* (in press).



Impressions of the workshop

3.4 How to include fishermen's knowledge in management

Barbara Rodenburg (Goede Vissers)

Fishermen know where fishes want to be. But will they tell? Fishermen in the Wadden Sea can never be sure if they will be allowed to fish the next year. But they depend on the fish for their livelihood. To make a more open sharing of knowledge and insights possible it is necessary to first create the right conditions.

Condition 1: Find common ground

Can we agree on a common starting point? For instance: conservation for nature and people, fish production as one of the management targets, and fishery as part of the heritage we wish to conserve. These points add up to an inclusive conservation strategy that takes coastal communities into account. Fishermen generally see nature as something unpredictable that cannot be controlled, even though our actions can effect nature. Conservationists emphasize the huge impact we can have on ecosystems, and for them the concept of nature management is completely accepted. It should be possible to combine these two different attitudes towards nature into a shared starting point, such as: "Although human impact on ecosystems can be huge, our capability to control nature is very much limited". This can then lead to the notion that we don't manage fish stocks, and we don't manage nature. Instead, we can change conditions in ecosystems and we can manage human activities.

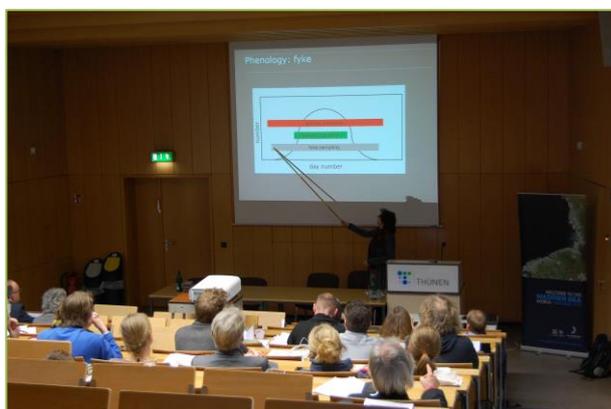
Condition 2: Create a safe space

Everyone involved should first acknowledge the vulnerable position of fishermen and should understand that for a more open sharing of knowledge it is necessary to create a safe space. Details provided by fishermen can be taken out of their context and be used against them. When fishermen don't feel safe, important information may not be shared, whereas sharing may lead to more effective policies and legislation, also in the interest of fishermen. Start with a (small) group of dedicated people: fishermen, scientists, conservationists and policy makers. As some of these people will speak "Swahili" and others "Chinese" it is important to include one or more "interpreters". The fundamental need to share information and insights should be acknowledged by everyone in the group, but still there will be occasions when not every last detail comes out. Safety also means that the others can accept that. It is useless to press anyone, because pressure may very well be counterproductive in the whole process. There can be no obligation to share all information. However, as soon as there are results it is good to share it with the world outside the group, to show what this approach can achieve, and (hopefully) to get other people interested.

3.5 Fishing effort in the Wadden Sea - *Difficult estimates in dendritic landscapes*

Torsten Schulze & Katharina Schulte (Thünen Institute of Sea Fisheries)

As pings are transmitted on a 2-hourly basis, effects of future closures on the distribution of fishing effort are usually estimated using a spatial grid of 0.05° c- squares or larger, incorporating the uncertainty of the information. However, especially in dendritic landscapes as the Wadden Sea, this resolution might be too coarse for some of the arising questions, such as the evaluation of small scale spatial conflicts between fisheries and several objects of protection in the Wadden Sea. These are much smaller than e.g. large windfarm or Natura 2000 areas in the EEZ which were evaluated in the past using a 1.5 x 3 nm grid. We will show high resolution maps displaying summarized raw pings of German fishing effort in 2010 to illustrate the use of the Wadden Sea before and behind the islands, provide the possibility to zoom in in areas of interest and discuss alternative concepts to evaluate the outcome of spatial management options in the Wadden Sea.



Impressions of the workshop

3.6 Trends in fish in the Wadden Sea and coastal waters

Ingrid Tulp (IMARES) & Henk van der Veer (NIOZ)

Two long-term monitoring programs are available to study trends of fish in the Dutch part of the Wadden Sea. The Demersal Fish survey is carried out annually in late summer and covers the Dutch part of the Wadden Sea and the coastal waters from The Netherlands along the German Bight to Denmark. It is a ship based survey using a shrimp trawl and has run since 1970. The fyke at Texel is operated by NIOZ since 1966 and is emptied daily in spring and autumn. Both programs sample different parts of the fish fauna. The DFS covers a large area but is only carried once every year, while the fyke has a strong resolution in time, but none in space.

In this contribution we present long-term developments using both sets concentrating on the questions:

- What is the species composition and has it changed?
- Do species belonging to different guilds show different developments?
- Has timing changed in response to climate change?
- Has size structure changed?

3.7 Demersal Young Fish Survey in German waters

Holger Haslob (Thünen Institute of Sea Fisheries)

The coastal areas in the south eastern North Sea, and especially the Wadden Sea, serve as important nursery areas for several fish species. The Thünen Institute of Sea Fisheries performs the Demersal Young Fish Survey in the German Wadden Sea area since the mid of the 1970s. This survey which is part of an internationally coordinated survey campaign is mainly dedicated to estimate a relative abundance index of the youngest age groups of plaice and sole which is used in the assessment of these commercially and ecologically highly important flat fish species. The gear in use is a 3m beam trawl which is deployed during daytime from chartered commercial vessels on randomly selected stations covering different depth strata. The survey is conducted during the third quarter, mainly in September. Today, the investigation area includes five different areas along the German coast line. Since 2012, this pseudo random station grid is complemented by the German research vessel “Clupea” which covers a station grid seaward to the island chain. The data obtained by the German DYFS from 1974 to 2014 comprises a valuable time series, not only for plaice and sole but also for other important fish and invertebrate species (e.g. *Crangon crangon*) in the Wadden Sea area. However, in order to obtain the best information out of it the time series should be evaluated and revised due to some changes in methodology over time. Further, the survey design should be evaluated with regard to efficiency and effectiveness.



Impressions of the workshop

3.8 Population status and management of salmon, sea-trout and North Sea houting in the Danish Wadden Sea rivers - *Management and challenges*

Niels Jepsen (DTU Aqua)

The Danish rivers flowing into the Wadden Sea, i.e. rivers from south of Esbjerg to the German border, all have populations of anadromous fish. In the major systems, Varde Å, Ribe Å, Brede Å, Kongeå and Vidå, there are now self-sustaining populations of Atlantic salmon (*Salmo salar*) and sea-trout (*Salmo trutta*). In Vidå, the last healthy stock of the critically endangered North Sea houting (*Coregonus oxyrinchus*) is found. These three valuable/threatened species are protected by strict fisheries regulations in the rivers and in the sea, where all gillnets have been banned since 2008. Additionally, habitat restorations and removal of barriers in the rivers have been carried out at a large scale during the last 20 years. An EU- supported project to protect the houting spent almost 20 million Euro on removal of migration barriers in the Wadden Sea rivers. Thus, habitat restoration, stocking and fisheries regulations are the three main management measures applied, that has led to significant increase in the populations of salmon and to a lesser degree those of sea-trout. For the houting, however, a positive effect has not (yet) been seen. This species remains critically endangered. The main problem for the three anadromous species discussed here, now seems to be the high predation pressure from cormorants, in the rivers and in the sea. This presentation provides a brief overview of the history, status and management of the important migrating fish species in the Wadden Sea.

3.9 Fisheries, climate and marine mammals conspire to challenge the paradigm of non-management of brown shrimp

Axel Temming & Marc Hufnagl (IHF Universität Hamburg)

The North Sea brown shrimp fishery is currently neither regulated with quotas nor with effort management. The current paradigm of non-management was based on an analysis of the total predation by cod and whiting in relation to commercial catches for the period 1970 – 1995 and the estimated total dominance of natural mortality. However, since this period the North Sea ecosystem has undergone pronounced changes with overfishing and climate change causing a substantial decline in predator stocks, namely cod and whiting. In addition both predators have shifted their range of distribution causing a reduced overlap with brown shrimp. Here we extend the previous assessment of brown shrimp predation for the years 1996 – 2011 using updated stock assessment and predator distribution data. For the first time, predation estimates are used together with commercial landings to partition independent estimates of total mortality into fishing and predation mortality.

We demonstrate that the decline of key predators of brown shrimp in combination with a shift in the distributional range of the predators have caused a new situation, in which the fishery has become the main mortality source of adult brown shrimp (>50 mm). Fishing mortality in recent years is estimated to be equal to natural mortality or up to 6 times higher.

Average landings since 2000 have been about 40% higher than in the 1980s and 1990s indicating that humans have at least partly taken over the share previously taken by juvenile whiting and cod. We discuss that this situation is likely to continue, because three marine mammal species have built up a combined population of over 80000 individuals, which hunt for potential brown shrimp predators mainly in the distribution area of brown shrimp. The application of two yields per recruit models of different complexity indicates potential growth overfishing of brown shrimp and reopens the discussion of management.



Impressions of the workshop

3.10 Fish Migration River Afsluitdijk - An innovative solution for upstream fish passage between the Wadden Sea and lake IJsselmeer

Herman Wanningen (PRW/World Fish Migration Foundation)

Migratory fish have problems passing the Afsluitdijk, the dam that separates the Wadden Sea from Lake IJsselmeer and the rivers upstream. To re-establish the connectivity and thereby allow migratory fish to pass, there is an initiative to build a fishway, the Fish Migration River (FMR), at the Kornwerderzand sluice complex. This project will include the construction of a tidal river with a length of 5 km, which is unique in the world. Dutch NGO's, regional governments and the fishery sector are working together with an international advice team on the design and monitoring of this innovative fishway. The construction will start in 2017 and it is expected to be working in 2019.

More than 10 migratory fish species use the Wadden Sea as a part of their life cycle and also depend on the habitat quality and connectivity in the Dutch, Danish and German rivers upstream. Due to intensive damming of the rivers and estuaries essential spawning habitat are lost and can't be reached anymore. The impacts of these barriers are severe. Most species (salmon, sturgeon, shad, houting, sea lamprey, river lamprey) are endangered and under pressure. Migratory fish stocks in the Wadden Sea region have dropped dramatically due to all human impacts in the past. The status of these fish in the Wadden Sea itself and the role they play in the food web are rather unknown. To improve the situation, policies and management strategies for migratory fish need to be optimised. An international **Swimway** project is proposed to turn the tide. The idea is to:

- Develop a shared vision and strategy for migratory fish in the Wadden Sea region. Setting the priorities as a base for future water management, fishery and nature policies
- Develop a long lasting framework and program for cooperation in the Wadden Sea region on sharing knowledge, experiences, measures and management
- Develop an international Wadden Sea monitoring program to identify and evaluate international migration routes and the main barriers (telemetry, genetic studies)
- Create a status reports (6 years) on migratory fish in the Wadden Sea region
- To start an effective communication and knowledge exchange program

4 Posters

4.1 Evaluation of habitat quality of German salt marsh creeks for fish

Julia Friese (IHF Universität Hamburg)

Intertidal salt-marsh creeks are thought to provide good growth conditions for fish due to a favorable interplay between water temperature and food supply [1, 2]. Together with low predation pressure, salt-marsh creeks meet all requirements for fishes to grow quickly [2, 3], which, in turn, enhances their chance to fulfill their most fundamental life-history objective: survive to reproduce. However, desiccation, temperature and oxygen levels could also be negative factors in this environment [2]. Anthropogenic impacts, such as grazing, might also affect the utility and value of salt-marsh creeks for fishes as the abundance of terrestrial prey items (e.g. marsh arthropods) might be reduced in grazed marshes [4]. High habitat quality would result in positive energy budgets for the considered organisms. Positive energy budgets would be reflected in a good nutritional condition. The individual body condition of fish can be analyzed (1) by gut contents as a short-term index, (2) by the length-weight-relationship as a medium-term index and (3) as a long-term index by growth rates which are back-calculated from otolith microstructures. The presented PhD-study is part of the INTERFACE project. The study is split up into two parts. In the first part, the value of German salt-marsh creeks compared to other habitats for fish will be analyzed. The second part focuses then on the comparison of the value of intertidal creeks in grazed and ungrazed marshes for fish. For both parts the habitat quality should be determined - considering seasonal dynamics - by (a) species composition, size distribution and abundance, (b) the three aforementioned condition indices and (c) the biotic and abiotic environmental conditions of the habitats. Finally based on the findings German salt-marsh creeks should be classified into "profitable" and "less profitable" fish habitats to provide information for management decisions.

4.2 UFOs in the North Sea

Sven Hammann, Florian Krau, Boris Cisewski, Joachim Gröger (Thünen Institute of Sea Fisheries)

Climate change, fisheries, and other anthropogenic factors like the offshore energy production are already affecting marine ecosystems in various degrees. The investigation of those impacts demands a long-term monitoring of the relevant physical, chemical and biological variables in the key areas of the ocean. However, conventional marine monitoring and sampling strategies are extremely expensive and highly invasive. Moreover, common vessel-based research cruises enable only quasi-synoptic snapshots. To overcome these sampling problems, we have developed

an autonomous, non-invasive underwater fish observatory (UFO). Based on a combination of a high-sensitive stereo camera and high-frequency sonar, these data enable an identification of species and measurements of size, weight and other biological features of passing individuals. In order to investigate and monitor other relevant environmental parameters that might exert a control on the distribution and abundance of zooplankton and nekton, the optic- and acoustic data are synchronized with abiotic data derived from ADCP, CTD, turbidity and oxygen sensors to get a complete picture of the environment. It creates rather a detailed movie than a rough snapshot of the habitat it is placed in.

The UFO system enables a new environmental sustainable long-term monitoring of marine (coastal) ecosystems in their physical and chemical environment. This new system can also be installed in areas and habitats difficult or impossible to reach for research vessels like protected areas, wind farms or shallow waters, all of them occurring in the North Sea and the Baltic Sea.

4.3 Comparative spatial analysis of vessels landing shrimp in German harbors 2007-2013

Viola Liebich & Hans-Ulrich Rösner (WWF)

The Wadden Sea and the adjacent North Sea areas comprise the main fishing grounds for brown shrimp *Crangon crangon*. However, up to now even basic information such as the spatial distribution of the fishery, including the question how much of it takes place within the protected areas, was missing for the German part of the Wadden Sea. For a “natural and sustainable ecosystem in which natural processes proceed in an undisturbed way” such as the Wadden Sea and in order to achieve its protection goals, this is not a good precondition for an appropriate management.

Thus, WWF prepares an analysis to provide a solid base for discussion. Analysing the number of VMS points indicating fishing activities, according to the vessel’s speed, gives an indication about the distribution of the shrimp fishery within and among the protected areas and other sea areas. For example, in 2012 there were on average 14 VMS points (2,0-3,8kn) per 1km² in the Wadden Sea National Park of Schleswig-Holstein, 2 in the National Park Hamburg and 13 in the National Park Niedersachsen.

4.4 Cooperative Fishery Research in the German Wadden Sea, the Brown Shrimp fishery as a case study

Kai Wätjen (Alfred-Wegener-Institut)

Brown shrimp fisheries in Germany often consist on day trips of small and old fishing vessels within the vicinity of home ports. Fishing close to their own front door requires or encourages a higher engagement and awareness about sustainable and environmental issues, rather than fishing in areas further out. The cooperative research was established, among other goals, to learn on fishermen’s experience and expertise about the recent fish fauna of the Wadden Sea. That is done within a scientific framework to support the already existing monitoring system, which can be applied in the Marine Strategy Framework Directive. The monitoring is restricted to rare species: migratory species protected under the Habitat’s Directive, southerly distributed species and IUCN Red List fishes or generally endangered species like cartilaginous fishes. Cooperative research has a number of dilemmas. Identifying and dealing with such dilemmas is one of the main tasks in cooperative fishery research. The two main tools used to improving the accuracy of the data gotten from self-sampling programs are confidence-building measures and mutual learning events.

4.5 A temporal point of view on three spined stickleback (*Gasterosteus aculeatus*) in the Dutch Wadden Sea

Jeroen Huisman, R. van Gemert, L. Nagelkerke (VHL University of Applied Sciences/Wageningen University)

This poster describes a project that is carried out to explore the migration of diadromous three-spined stickleback in the Dutch Wadden Sea. Objectives of the study were to investigate:

- The relationship between the use of tidal flow by three-spined sticklebacks and the performance of intertidal fish passes
- Which spatial-temporal opportunities are offered to migratory fish at intertidal barriers and what is the subsequent relationship between tidal flow and fish pass efficiency
- Role (biomass and timing) of three-spined stickleback in Wadden Sea ecosystem

Data were collected at 12 locations along the Wadden Sea coast regarding:

- Amount and timing of migrating three-spined stickleback
- Length and weight of three-spined stickleback
- Inter-species variation in migration and migratory behaviour of three-spined stickleback
- Amount of flow, temperature and other environmental variables at each location

On one of the locations information was gathered on the migratory behaviour of individual sticklebacks at fish passes. This was achieved by the use of pit telemetry. The migration of individual three spined-sticklebacks was measured at an intertidal fish pass using an antenna set-up attached to the four openings of the of the fish pass. As such, in March 2014, 6 batches of stickleback were pit tagged, in total 1200 three-spined sticklebacks. Length and weight of each individual stickleback was determined. Of all pit tagged sticklebacks, on average nearly 19% (10-29% per individual batch) was detected by the antennas. The detections gave detailed information on the timing of appearance of individual sticklebacks, trying to enter the fresh water.

The preliminary results indicate that using pit tag telemetry on three spined sticklebacks seems to be a viable option for monitoring its migration. Weight and length of individual fish seem to increase during the monitoring period.

Migratory activity occurred mainly during day and at upcoming tide. A limited amount of tagged fish was detected in the four openings of the fish pass.

It is recommended to look further into the role of three-spined stickleback in the ecosystem. For this, research on the variation in biomass and timing of the stickleback migration in the Wadden Sea and more locations across the Wadden Sea are needed.

5 Group work

The group work took place in two parallel sessions. On the first day, the focus was on "stocks" and "habitats"; on the second day two groups discussed "nursery areas" and "fish migration". The group composition can be found in the participants list in Annex 2. Each group started with a short introduction round. The discussions were structured by completing a matrix (rows: trilateral fish targets/themes; columns: understanding of underlying processes, data availability, collaborations). Per theme, the matrix is presented and the corresponding discussion is summarised.

5.1 Stocks & populations: status, trends and drivers

The trilateral fish targets that are the most relevant for the discussion in Group 1 are:

- Viable stocks of populations and a natural reproduction of typical Wadden Sea fish species.
- Occurrence and abundance of fish species according to the natural dynamics in (a)biotic conditions.

Matrix

Chair & group representative: Holger Haslob; Rapporteur: Zwanette Jager

Underlying process (candidates)	Data availability	Cooperation within scientific community and stakeholders
<p>Key processes affecting fish communities in the Wadden Sea:</p> <ul style="list-style-type: none"> • Change in habitat availability, e.g. through dredging, abrasion by fishing gears, anthropogenic landscape modifications • Predation (by marine mammals and sea birds) • Changes in temperature regimes due to climate change • Short- and mid-term fluctuations in temperature • Fishing mortality (mostly due to by-catch) • Eutrophication <p>Examples for 5 CWSS guilds:</p> <ul style="list-style-type: none"> • Estuarine residents: Eel pout -> <ol style="list-style-type: none"> 1. Temperature (climate change) 2. Predation (by seal and harbour porpoise?) • Marine juveniles: plaice • Migratory species: river lamprey • Marine adventitious species: mullet • Marine seasonal migrant: cod • Extirpated species: sturgeon 	<p>Available:</p> <ul style="list-style-type: none"> • Time series of fish abundances (DYFS, DFS, NIOZ, Senckenberg Survey, Stownet surveys of LS and SH, Tagging data by BfN, WFD fish monitoring in transitional waters) • Various project data (inventory) • Possible use of landings data <p>Gaps:</p> <ul style="list-style-type: none"> • Extension of WaLTER ->compile project data base • Information on food web relationships (connections, consumption or predation rates) • Influence of eutrophication on food availability • Knowledge on vertical and horizontal distribution and the influence on catchability and survey design 	<ul style="list-style-type: none"> • Self-sampling programs by fisheries (similar to cooperation between shrimp fisheries and IMARES, IMR Fisheries dynamics group, cooperation between German fisheries and AWI) -> possible funding through EMFF • International coordination of self-sampling programs (again funding maybe through EMFF) • Establish permanent contact persons within projects • Life-stage dependent use of different habitats • Investigate the impact of no-take zones by comparing fished and non-fished areas within a trilateral cooperation • Trilateral ECOPATH, ENA, modelling approach for Wadden Sea • Improve VMS resolution to estimate swept area by fisheries. • Stimulate the development of innovative monitoring techniques

Discussion

After spending some time to familiarize with the matrix and its aim, the group started to deliver input on how to target the theme “stocks”. Not only commercial stocks should be considered, but also non-commercial species. It may be helpful to group species by ecological guilds (marine juvenile, diadromous and estuarine resident species). What are typical Wadden Sea fish species? One definition is that these species should depend on the Wadden Sea, or the Wadden Sea should have importance at some life stage of this species. It should also include species that were typical in the past, but are no longer present in the area (e.g. sturgeon). The 14 identified species described in the QSR 2009 could be considered as a basic list that could be extended.

As a next step the group tried to identify representative fish species for different ecological guilds.

The discussion evolved about our **common understanding** of the development of stock abundances. The necessity of a separation of natural and anthropogenic influences was raised. Further issues were targeted during the session: habitat degradation (dredging and beach nourishment, based on the analysis presented by NIOZ); changes in natural habitats, (sea grass meadows, mussel beds and salt marsh creeks) and predation issues (increased populations of marine mammals or seabirds feeding on fish). Temperature was considered as the most important driving force for fish in the Wadden Sea. If temperatures rise too high (>23 °C), fish move to deeper waters; respectively in winter at low temperatures (<1 °C for shrimp).

There are **uncertainties/knowledge gaps**, e.g. the influence of eutrophication and potential food limitations, and the general suitability of the current monitoring to provide a realistic picture of the fish stocks: the International Beam Trawl Survey (North Sea) seems to identify trends in whiting better than the more coast bound Demersal Fish Survey. There are gaps in knowledge on the catchability of gears in different environmental conditions, on the vertical position of fish in the water column and also on the behaviour and distribution of fish (species).

Concerning monitoring there are opportunities for **cooperation** and dialog with the fishery communities.

There is a scope for improvement of existing, and development of innovative monitoring techniques. More knowledge on species distribution and behaviour, not only their abundance, should be gained. The removal of fish by scientific monitoring is thought to have rather low impact, compared to the amounts that are taken by fishery, and can therefore be neglected. However, in case there is a need to close some areas for commercial fisheries, the application of non-invasive monitoring techniques would be recommended.

Initiatives on further development of innovative technologies and encourage further exploration of possibilities are in place. Video monitoring may not be suitable in the turbid waters of the Wadden Sea. It was pointed at existing efforts to improve the LPUE (Landings Per Unit Effort) data by including VMS (Vessel Monitoring through Satellite) data, exemplified by an EMFF (European Marine Fisheries Fund) project, including cooperation between fishermen and local government. Fishermen stressed in this regard to make better use of their expertise. A combination of scientific monitoring and commercial fishing activity could help resolving problems in seasonal and spatial sampling resolution. Feasible examples are a by-catch project carried out by IMARES together with shrimp fishermen, or the Gap-2 project in which a self-sampling for endangered species is performed.

To create a trusted and effective cooperation between scientist and fishermen, some suggestions were made: IMARES sometimes performs control sampling to compare their own result with the self-sampling of the fishermen. However, the fishermen could be (further) involved in the planning of projects. At the IMR Norway, one scientist closely cooperates with 5 fishermen for a longer period, which has resulted in a trusted relationship.



Group discussion at the workshop

5.2 Habitat: diversity; relationship fish habitat

The trilateral fish targets that are the most relevant for the discussion in group 2 are:

- Favourable living conditions for endangered fish species.
- Maintenance of the diversity of natural habitats to provide substratum for spawning and nursery functions for juvenile fish.

Matrix

Chair: Paddy Walker; Group representative: Jeroen Huisman; Rapporteur: Sascha Klöpper

Understanding of underlying process (candidates)	Data availability	Cooperation within scientific community and stakeholders
<p>Habitat definition</p> <ul style="list-style-type: none"> • Parameters such as temperature, salinity, turbidity, noise, electromagnetic fields (cables) are also part of the habitat • Influence of natural processes <p>Connectivity between habitats and impact of fragmentation</p> <ul style="list-style-type: none"> • Heterogeneity of habitats <p>Habitat restoration: rocks vs closed areas; mitigation</p> <ul style="list-style-type: none"> • Species angle • Essential fish habitat (producing surviving offspring) • Quality of habitat • Habitat mapping – oysterbeds etc • Make targets testable – we cannot hit a moving target! <p><i>Wadden Sea as essential feeding habitat</i></p>	<ul style="list-style-type: none"> • Extended literature research starting with the QSR's to derive hypotheses • Involve fishermen • New data from Dutch shrimp (VISWAD) and fixed gear research projects • 1990-1995 SWAP: exchange processes; ecosystem approach incl. fish • Monitoring programmes: mussel beds and oyster reefs, seagrass beds, green algae, sediment composition (maps) • Fish monitoring programmes: correlate with habitat data (per tidal basin) • Maps: tidal flats, water depth, nautical charts analysis per tidal basin • Special volume: Helgoland Marine Research on Human transformations of the Wadden Sea system over time • Inventory of habitat changes in Ems and Weser estuaries (see also the Interreg HARBASINS-project) 	<ul style="list-style-type: none"> • Inventory of historical habitats: <i>Sabellaria</i> reefs, mussel beds, peat, stony rocks, creeks and gullies, clay, shells – take the Afsluitdijk and other infrastructural works into consideration • Correlation of fish and habitat data to generate hypotheses • Dedicated research fish and habitats to get general principles • Essential nursery habitat 'proven' for dab, plaice and sole in the Wadden Sea • Develop new monitoring methods (hydroacoustics) – see poster! • Enclosure experiments • Organise subsequent meetings • Work with ornithologists and learn from feeding observations

Discussion

The session was opened with the question: "Do we know enough about habitats?" The discussion started by outlining a definition of Wadden Sea habitats, and what does it mean for certain species (groups) or life stages.

Concerning the **common understanding**, it was mentioned that although fish monitoring is area related, it does often not distinguish between habitats. Fish also migrate between areas since they are e.g. tide dependent, except species like the sand goby. A suggestion regarding the WSP fish targets is, to look through the species list and check to see what we know about the habitat requirements and which habitats are crucial, or not for the life-cycle. If not, there may be no need for further action; however, it is recommended to create an inventory on the subject of distribution of habitats and fish and then to formulate corresponding hypotheses. It was generally stated that knowledge on species-habitat relationship should be enhanced. Fish could also be a suitable indicator for habitat conditions, with the limitation "that correlation is not necessarily the same as causality".

Furthermore, discussion evolved on the option of creating artificial habitats to either reconstruct lost habitats (e.g. by fishing activities) or to provide artificial structures as e.g. spawning substrate. But question was raised, how any artificial influences are rated by the National Park Administrations as they are aiming for undisturbed conditions,

There are **knowledge gaps** on the former distribution and condition of different habitats (e.g. *Sabellaria*) and on how habitats are connected. Further information gaps were identified, such as the consequences of climate change and predation (e.g. cormorants). As a result a habitat inventory and habitat mapping were identified as targets for future work.

Spawning behaviour of herring was used as an example of habitat dependence and the acceptance of alternative habitats. Herring are hardly spawning since sea grass disappeared. There are local stocks of herring in Denmark that use different sea grass types and habitats, while the contribution to total stocks is still unclear. Alien species (e.g. *Sargassum*) are providing new habitat, for the re-introduction of species (e.g. sea stickleback).

Concerning **data availability**, there is a lot of information available from habitat monitoring: mussel beds, sea grass and sediment maps. In this context, participants welcomed the tidal basin approach, but also pointed to the necessity to correlate between the different basins. A **data gap** could be the historical development of habitats (there has been habitat loss, but unknown how much and where).

During the fruitful discussion, several topics for **collaboration** were identified (see matrix above), with the overall agreement that the fish targets need to be further specified and tested.



Group discussion at the workshop

5.3 Nursery areas: a question of availability or changes in fish behaviour?

The trilateral fish targets that are the most relevant for the discussion in group 3 are:

- Maintenance of the diversity of natural habitats to provide substratum for spawning and nursery functions for juvenile fish.

Matrix

Chair: Paddy Walker; Group representative: Holger Haslob; Rapporteur: Sascha Klöpper

Understanding of underlying process (candidates)	Data availability	Cooperation within scientific community and stakeholders
Do abundance and distribution of adult spawning stock and dispersion of early life stages influence the numbers of juveniles in the Wadden Sea?	<ul style="list-style-type: none"> • Is information on all relevant species available – not only flatfish? • We need information on pelagics and use of Wadden Sea as nursery, also as predators • Herring (8-12cm)? • Creeks in saltmarshes as habitats – Twait shad & herring – full stomachs (Axel) also spring spawners – cohorts follow each other using otoliths Channel stock becomes more important in German WS larvae reaching 	<ul style="list-style-type: none"> • Sampling together with fishermen because survey misses the stamps • Seasonal closure during mass movement of flatfish e.g. summer months • Improve mechanical sorting process to increase discard of viable young flatfish • Develop projects for collaborative research fishermen and scientists – observatories • Sea bass: priority; Brackish tidal areas juvenile sea bass
<p><i>Is there enough habitat diversity?</i></p> <ul style="list-style-type: none"> • Effects of turbidity due to layers of sediment from river management (gully deepening inner and outer), infrastructural works and dump sites in estuaries. Ems is the worst, then Elbe and Weser • Most seaward part of Ems there are still cod (Barbara and Gerrit) but smelt in trouble in Ems • Coastal squeeze: sea-level rise and coastal protection • Pacific Oyster beds as habitats (Axel) Master thesis – including 	<ul style="list-style-type: none"> • What spatial information on diversity and quality of habitats is available? • What do we know of temporal variability of habitat quality? • Information on fishing activities on Pacific oysters (SH 2 licences); Denmark 	<ul style="list-style-type: none"> • Brackish tidal zones missing – important for anchovies, sea bass, spring spawning herring, sticklebacks etc. • This needs more space than in FMR • Biogenic structures • Annual variability in recruitment – data on benthic communities in Dutch Wadden Sea (SIBES) – explore interannual variation of fish recruitment
<p><i>Does temperature play a role?</i></p>	<ul style="list-style-type: none"> • Measurement of temperature in habitats – e.g. in creeks as trigger to leave Wadden Sea • Small red mullet caught with beach seine • Temperatures > 30 degrees on tidal flats in summer high enough for mortality • Temp can be up to 10 degrees more • Oxygen? Last 12 years not observed • Research from Oldenburg on black spots • Ice winters can be especially detrimental for long living species such as eelpout .. and shellfish (sedentary) • Survey data on jelly fish; no dedicated jelly fish monitoring – get idea of ‘succession’ and invasions 	<ul style="list-style-type: none"> • Relate occurrence and abundance to ambient temperatures • Gather old data on black spots from institutes as reference (nutrients) • Changing land use and agricultural practices that might influence nutrient loading • Temperature tolerance per species • Check old times series for correlation temp and abundance • Food web dynamics: competition for food between <i>Mnemiopsis</i> (jelly fish) and larvae • Is there food limitation in the system? E.g. shrimp not on good condition. What sort of density-dependent competition is there?
<p><i>Do we know enough about by-catch of young fish?</i></p>	<ul style="list-style-type: none"> • Fisheries by-catch programmes 	<ul style="list-style-type: none"> • Set up monitoring with fishermen – seasonal monitoring – not only by-catch; EU data collection – increase frequency

Discussion

The session was opened by introducing the pre-formulated questions (grey text in matrix). Concerning the **understanding** of the role of the Wadden Sea as a nursery for flatfish, fishermen stated that currently no small plaice are observed in the Wadden Sea. Scientists added for consideration that the absence of young plaice during the monitoring surveys might be a result of mis-timed surveys. There is a tendency of earlier and faster development of young plaice, which results in a time compression of growth in the WS. The timing mismatch of the survey is known, but September was originally chosen for O-Group monitoring. From by-catch observations, it is documented that week 25-30 (end of June – August) show the peaks; therefore Sept surveys miss the peak for “stamp plaices” entering the WS.

While seasonal closing to save plaice resources was suggested as a management measure, fishermen stated that this is performed by them anyway, for up to six weeks once the small plaice occur. This was welcomed and further initiatives towards better handling of plaice in by-catch were suggested as future projects. Generally, the need for improved cooperation between the sectors was identified, but also as challenges for the future. The workshop was recognized as a fine first step.

Sea bass were mentioned as a problematic species example. It is expected to be overexploited in the channel region, with high implications for their Wadden Sea occurrence. The species was rated with high priority for management measures.

Regarding habitat types, the importance of salt marshes, and generally of the brackish tidal zone, for (young) fish was highlighted. Research in Germany on the abundance of larval herring highlighted the importance of brackish water zones. Further discussion evolved on factors like temperature and oxygen or on the dumping and dredging influence fish populations. A recently discovered threat to young fish was the mass occurrence of alien species such as jelly fish from the genera *Mnemiopsis*, originally introduced from American coasts. These organisms might feed on fish larvae, but might compete for food with young fish as well. Detailed information will be required to assess these phenomena.

There are data available on the nursery function of the Wadden Sea, although certain **data gaps** were identified (see Matrix). Mentioned examples were on the role of pelagic fish species and the contribution of saltmarsh creeks to the nursery function.

To solve the timing issue, a better **cooperation** in terms of monitoring between science and fishermen, who pointed to their 40 weeks per year at sea, was suggested and welcomed by the participants.

5.4 Fish migration: trends in species distribution and pathways of migration

The trilateral fish targets that are the most relevant for the discussion in group 4 are:

- Maintaining and restoring the possibilities for the passage of migrating fish between the Wadden Sea and inland waters

Matrix

Chair: Folkert de Jong; Group representative: Herman Wannigen; Rapporteur: Zwanette Jager

Understanding of underlying process (candidates)	Data availability	Cooperation within scientific community and stakeholders
<p><i>Do we know the swim ways of relevant species?</i></p> <ul style="list-style-type: none"> • Partly we know, but what happens in the Wadden Sea is still a "black box". <p><i>Which species are we dealing with (priorities, flagship species!)? Criteria?</i></p> <ul style="list-style-type: none"> ➢ EU Directives ➢ endangered-protected species ➢ which species bind us? (flagship species) ➢ grouping species with similar habitat needs - migration behaviour • Do we include North Sea, upstream rivers and small rivers? Meta populations i.r.t. regional? • Optimising policies and management strategies in the Wadden Sea region. 	<p><i>Tagging studies?</i></p> <ul style="list-style-type: none"> • Some small scale genetic-telemetry studies have been conducted for seatrout, houting • There are inventories of fish migration bottlenecks (in Germany and the Netherlands) • Some tagging studies have been done, e.g. by IMARES (<i>river lamprey</i>). 	<ul style="list-style-type: none"> • Is there sufficient commitment for international cooperation? • FLAGSHIP SPECIES! • Which species bind us all and need the complete Wadden Sea to fulfil their lifecycle?
<p><i>Which pressures affect the swimways (specify)?</i></p>	{this was not discussed in the group}	
<p><i>Do we know the location of spawning grounds of migratory species?</i></p> <ul style="list-style-type: none"> • What is the life cycle of the migratory fish species and its importance in the Wadden Sea? • We know for some species where the spawning locations are, but it remains unknown what these species do when they are in the Wadden Sea. 	<p><i>Data for which spp available?</i></p> <ul style="list-style-type: none"> • Studies on twaite shad in the Elbe and Weser (BioConsult) is available • Study on the smelt in the Ems estuary is available (see HARBASINS) 	

Discussion

The group discussion started with the notion and general **understanding** that the estuary is the transition between the Wadden Sea and rivers, and that improvement of the passage to rivers is most important in WFD perspective. Small waters have been cut off from the Wadden Sea, which became a problem for diadromous fish. These waters are heavily modified, but even the good ecological *potential* is not achieved. In the water framework directive (WFD), the most relevant anthropogenic pressures have been identified: damming, channelization, dredging, increased turbidity levels, water oxygen concentrations, loss of connectivity and loss of spawning habitats.

Concerning the **availability of data**, there are existing inventories of bottle-necks on the migration of different diadromous species along the Dutch and Lower Saxony Wadden Sea coast. Some of the swim ways are known, but the processes inside the Wadden Sea are merely a black box. In order to fill these knowledge gaps, more tagging studies could be performed. The really

important bottle-necks, e.g. gaps of knowledge of the life cycle, should be identified for each (diadromous) species.

One option to head forward is a **concerted trilateral action** to generate more power concerning the management of the Wadden sea “swim ways”: combine the nationally discovered bottlenecks and reflect on river district management plans. One or more “flagship” species should be prioritised. The economic value of fish species could also be visualized, to enhance management and create support for measures to improve stocks. All information could be collated in the form of a “Masterplan Trilateral Wadden Sea fish” (compare with the Masterplans for the international river districts of the Rhine and Meuse).

The group welcomed this idea and discussed on the possible terms of reference of such a project on trilateral cooperation. It should be dealing with: management – restoration measures – ecology – communication. The exchange of information between the trilateral countries is essential for the successful implementation of the trilateral fish targets. The formation of a trilateral Fish Expert Network Group was recommended by the participants.

The main tasks of such a group could be to:

1. start with the targets, specify or make them more testable
2. form a core expert group, individual invitations depending on the topic

This group would collate the background knowledge necessary for the implementation of the fish targets as requested in the ministerial declaration. As a next step, the workshop group collected further arguments for a trilateral swim way vision, in which the importance of the Wadden Sea for the life-cycle of fish species would be analysed.

The main elements are:

- write a synthesis document, like the fish masterplans Rhine, Meuse, Scheldt
- cooperate within the framework of a long lasting network group
- select appealing flagship species
- formulate a vision and corresponding goals
- collect and share knowledge and identify knowledge gaps
- deliver Wadden Sea wide management advice
- look at measures in and around the Wadden Sea and learn from best practice examples
- international monitoring and evaluation
- international communication, promotion,
- stakeholder involvement

furthermore

- include all fish items (group 1-4), using the WSP fish targets as a starting point
- include all systems draining into the Wadden Sea, as well as the North Sea.
- include licensing/permit processes: which areas are sensitive and should be saved in construction projects etc.

The discussion continued on **gaps in data and understanding**. It seems that trends in fish species are visible, but the drivers remain unclear. Human activities have severe impact, e.g. fishery by-catch issue or cooling water extraction. Qualitative data are relatively easy to gain, but how about quantitative data sets? Differences between migratory or non-migratory species in relation to e.g. sand suppletion should be explored.

However, the task of such a group is to explore and assess, but not to make decisions on measures. First get an idea of the drivers (e.g. lecture of *Ingrid Tulp*). For migratory species, there are obvious causes, but on the scale of the Wadden Sea or North Sea, it is much more complex and the impact on population assessment is rather difficult. Participants agreed that there are big **knowledge gaps** on population sizes. Plaice is an example of a species which is well explored though. For twaite shad, there is an idea of the good status from historical landings data and it is feasible to define the target (in Germany). But what is the influence of pressures (dredging, power plants etc.) and what is the relative importance of those? Sediment management in the Elbe estuary is already taking into account the requirements for twaite shad spawning. It is a small step, but the authorities become more aware, also forced by WFD. For recommendations on restoration we need to know more, for many species we don't have a clue.



Chair of the day Anne Sell (Thünen Institute of Sea Fisheries)

6 Plenary discussion and wrap up of the fish workshop

At the end of the second day, the chair Anne Sell summarised the discussions and conclusions of the fish workshop.

Stocks:

- missing quantitative estimates of the role of the Wadden Sea in the life cycles of key species (even plaice)
- data gaps on the effects of fisheries by-catch
- data gaps on the impact of predation by marine mammals and sea birds

Habitats:

- necessity of habitat mapping in order to define where major changes occurred
- which were the major changes in habitat quality (e.g. eelgrass)?
- could oyster beds take over the role of mussel beds as substrate for fish?
- what is the optimum monitoring scale and resolution?

Nursery:

- plaice: how important is the Wadden Sea at the moment?
- there is lacking information on pelagic young fish; what is their role in the Wadden Sea: predators? food competition? food web dynamics (role of jellyfish?)?

Fish migration:

- further develop the initiative of a common program/masterplan: swimways (broader than migratory fish) including habitat quality and life cycle approach; explore issues species-specific.

The **“swim way project/initiative”** (catching name and appealing flagship species to promote the activities).

General perceptions:

- intensify collaboration between science, policy and fishermen (sampling at higher spatial and temporal resolution), e.g. by targeting the issue of by-catch of young fish
- noticeable interest to form a trilateral Fish Expert Network Group or exchange platform.
- further ideas or suggestions: forward those to CWSS

In a final round of statements, the Chair asked for additional ideas:

- fishermen involvement: different type of fishermen see different aspects and different habitats.
- fish migration: a lot of information, but also make this information available.
- utilize even old and grey literature.
- the report of the project "Living North Sea" will be distributed among the participants
- the first next step is to get "green light" to continue with the fish platform, then to start working on the topics. At a lower ambition level, the elaboration of the targets and the preparation of the next Quality Status Report is an obligation; a lower ambition level may be more realistic.

7 Main findings and recommendations

The basis for continued work in the context of the trilateral cooperation on Wadden Sea fish is found in the Wadden Sea Plan (2010) and the formulated fish targets, which should be implemented. The formulation of the fish targets seems at a high abstraction level, but careful reading of the QSR 2009 already gives some explanation on the interpretation of the target and recommendations on the way to move forward.

The workshop revealed great enthusiasm among the participants and the wish to learn from each other within a trilateral cooperation setting, which could result in the formation of a Trilateral Fish Expert Network Group. The participants identified the need to develop a trilateral Wadden Sea "swimway" vision, as a framework within which to address most of the issues discussed during the two-day fish workshop (see listing below).

Several issues deserve more attention, according to the participants:

- try to make the fish targets testable and formulate working hypotheses
- possible impact of increased predation by marine mammals and birds on fish stocks
- evaluation of gained knowledge on the by-catch in the Wadden Sea (shrimp)fishery
- separation between natural and anthropogenic influences
- bottlenecks (trilateral inventories) and measures (best practice examples) of fish migration between Wadden Sea and inland waters
- the need to know more on pelagic fish species' abundance
- the need to know more on the availability (quantity and quality, historic and present) of different habitats.
- knowledge gaps on the importance of different habitats in the life cycle of (non-commercial) fish and on how habitats are connected in the different life stages of fish species
- fish mortality by several sources, a.o. large-scale cooling water extraction
- continue the trend analyses, presented in QSR 2009, based on demersal fish surveys (DFS, DYFS), stow net surveys and WFD surveys in the estuaries
- integrate the outcomes of the issues, defined above, into the preparation of the QSR 2016

The need to further develop indicators for the status of Wadden Sea fish was an issue in the previous QSR, but this topic was not discussed during the Hamburg workshop.

The results of the Hamburg workshop, as far as relevant, will be transferred into the 2016 QSR.

The Hamburg workshop also called for a closer cooperation between researchers and fishermen. Intensifying this cooperation could result in better data on fish distribution (more detailed spatial and temporal resolution). Additional data from the fishery (self-sampling) may fill gaps that exist in the current monitoring (mainly based on the existing demersal fish surveys, with a frequency of once a year in September or October).

However, attention should be paid to the conditions of closer cooperation with fishermen:
1.) find common ground and 2.) create a safe space for cooperation.

The latter could be realised within the context of projects, but it is worthwhile to discuss if and how the Trilateral Wadden Sea Cooperation can in addition contribute to such a safe, trusted and continuing cooperation.

Annex 1. Programme of the workshop

PROGRAMMA **NAAR EEN
RIJKE WADDENZEE**



Conservation Management of Fish Populations in the Wadden Sea

8-9 January 2015 - TI Hamburg

- Programme -

8 th January 2015	
09:00 - 10:00	Registration & Reception with coffee and tea
10:00 - 10:30	Welcome addresses by the organisers
10:30 - 12:00	Presentations: 10:30 Paddy Walker (NL) - Aiming for the Fish Targets 10:50 Andreas Dänhardt (D) - The bigger picture: supplementing established monitoring surveys with habitat-specific occurrence of fish in the WS 11:10 Katja Philippart/Martin Baptist/Henk van der Veer (NL) - Fish, food webs and freely available data 11:30 Barbara Rodenburg (NL) - How to include fishermen's knowledge in management
12:00 - 13:00	Lunch
13:00 - 14:00	Presentations: 13:00 Torsten Schulze/Katharina Schulte (D) - Fishing effort in the Wadden Sea - Difficult estimates in dendritic landscapes 13:20 Ingrid Tulp (NL) - Trends in fish in Dutch waters 13:40 Holger Haslob (D) - Demersal young fish survey in German waters
14:00 - 14:30	Introduction to group work by the organisers
14:30 - 17:00	Group work - two parallel sessions (including coffee/tea break): 1. Stocks: status and trends; drivers 2. Habitat: diversity; relationship fish-habitat
17:00 - 18:00	Plenary presentation of group work
18:00 - 19:30	Poster session with 2-min poster pitches & reception

9 th January 2015	
09:00 - 10:00	Presentations: 09:00 Niels Jepsen (DK) - Salmon, Sea trout and Houting in the Danish Wadden Sea - Management and challenges 09:20 Axel Temming (D) - Fisheries, climate and marine mammals conspire to challenge the paradigm of non-management of brown shrimp 09:40 Herman Wanningen (NL) - Fish Migration River project Afsluitdijk & Swimway Concept Wadden Sea
10:00 - 12:30	Group work - two parallel sessions (including coffee/tea break): 3. Nursery areas: a question of availability or changes in fish behaviour? 4. Fish migration: Fish migration: trends in species distribution and pathways of migration
12:30 - 13:30	Lunch
13:30 - 15:00	Plenary presentation of group work & Analysis
15:00 - 15:30	Wrap-up & Closing



Annex 2. List of participants

Last name	First name	Organization
Abel	Christian	Nationalparkverwaltung Nieders. Wattenmeer
Asmus	Harald	AWI Sylt
Berkenhagen	Jörg	TI Seefischerei
Borchardt	Stephanie	IHF Universität Hamburg
Borcherding	Rainer	Schutzstation-Wattenmeer
Breckling	Peter	Deutscher Fischereiverband
Buitjes	Henk	Viskotter ZK37
Dänhardt	Andreas	IHF Universität Hamburg
Dau	Kirsten	NLWKN – Niedersachsen
de Jong	Folkert	CWSS
Fock	Heino	TI Seefischerei
Friese	Julia	IHF Universität Hamburg
Goth	Simone	CWSS
Gröger	Joachim	TI Seefischerei
Hammann	Sven	TI Seefischerei
Haslob	Holger	TI Seefischerei
Hufnagl	Marc	IHF Universität Hamburg
Huisman	Jeroen	VHL University of Applied Sciences
Jager	Zwanette	ZiltWater Advies
Jepsen	Niels	DTU Aqua
Klöpffer	Sascha	CWSS
Knefelkamp	Britta	MELUR - Schleswig-Holstein
Koßmagk-Stephan	Klaus	Nationalparkverwaltung S.-H. Wattenmeer
Kouwenhoven	Angelo	Ministerie van Economische Zaken
Kraus	Gerd	TI Seefischerei
Liebich	Viola	WWF
Machura	Susanne	
Meyer	Julia	Senckenberg am Meer
Neudecker	Thomas	TI Seefischerei
Oberdörfer	Philipp	Erzeugergemeinschaft Deutscher Krabbenfischer
Otto	Thurid	GEOMAR Kiel
Philippart	Katja	NIOZ
Probst	Nikolaus	TI Seefischerei
Pusch	Christian	BfN Vilm
Rispens	Johan	Viskotter ZK18
Rodenburg	Barbara	Goede Vissers
Rösner	Hans-Ulrich	WWF
Scheiffarth	Gregor	Nationalparkverwaltung Nieders. Wattenmeer
Schermer Voest	Wilbert	Ministerie van Economische Zaken
Scholle	Jörg	Bioconsult Bremen
Schückel	Sabine	Bioconsult Bremen
Schückel	Ulrike	Senckenberg am Meer
Schulte	Katharina	TI Seefischerei
Schultz	Sebastian	TI Seefischerei
Schulze	Torsten	TI Seefischerei
Sell	Anne	TI Seefischerei
Temming	Axel	IHF Universität Hamburg
Thiemann	Kirsten	Schutzstation-Wattenmeer
Tulp	Ingrid	IMARES
van der Heij	Wouter	Waddenvereniging
van der Veer	Henk	NIOZ
van Es	Kees	PRW
Verheij	Herman	Waddenvereniging
Vorberg	Ralf	Marine Science Service
Walker	Paddy	PRW
Wanningen	Herman	PRW
Wätjen	Kai	AWI Bremerhaven