# WORKING GROUP ON ECONOMICS (WGECON; outputs from 2023 meeting)

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# WORKING GROUP ON ECONOMICS (WGECON)

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# Contents

# i Executive summary

The Working Group on Economics (WGECON) was established to address the challenge of bringing fisheries economics into ICES science and advice, with the growing recognition that this can facilitate the understanding of marine ecosystem uses, their drivers and responses to changes, and assessment and communication of trade-offs that include economic, social, and ecological dimensions. The first cycle of the group highlighted the importance of integrating economics in ICES science and the importance of identifying and reviewing specific problems that can be addressed, as this leads to a more concrete discussion on the applied contributions of economic research. Building on this perspective, the group has progressed in two complementary directions: reviewing current research and future needs for economic science and advice in ICES, leading to the publication of a review article in the ICES journal of Marine Science in 2023; and developing demonstrators of how economic information and analyses can help inform trade-off analysis. The latter included the integration of economic and social information in Ecosystem Overviews, a review of the approaches, data, methods and tools used to assess the economic and social dimensions of interactions between offshore wind development and fisheries, the identification of information and evaluation tools useful to address the economic consequences of rights-based management, and the development of a set of guidelines regarding the conduct of trade-off analyses.

In order to increase the capacity for economic analysis in ICES work WGECON has actively sought to develop links with other ICES working groups and initiatives, and to reach out broadly to the economic community through international conferences and meetings.

Future WGECON work will continue to elevate economic issues as an integral part of marine science and scientific advice regarding the use and conservation of marine resources, in order to meet the growing demand for such analyses. WGECON will thus continue to build additional capacity for economic science in ICES; identify and report on economic data-related needs and priorities for data collection, access and analysis and where possible propose systems to collect missing data; demonstrate processes needed to provide analysis of trade-offs relating to science-based fisheries management advice; assess and report on economic aspects of selected fisheries systems and their management; and coordinate economic analysis for integrated social-ecological evaluations in support of ecosystem-based fisheries management.

# ii Expert group information

| | |
|---|---|
| **Expert group name** | Working Group on Economics (WGECON) |
| **Expert group cycle** | Multiannual fixed term |
| **Year cycle started** | 2021 |
| **Reporting year in cycle** | 3/3 |
| **Chair(s)** | Arina Motova, UK |
| | J. Rasmus Nielsen, Denmark |
| | Olivier Thébaud, France |
| **Meeting venue(s) and dates** | 14-18 June 2021, online meeting, (31 participants) |
| | 9-10 May, online meeting, (28 participants)<br>19-20 May, online meeting, (30 participants) |
| | 19-23 June 2023, Edinburgh, UK, (25 participants) |

# 1 Review of current research and key future developments

Managing fisheries means managing human activities as part of social and economic systems. In acknowledging this, the International Council for the Exploration of the Sea (ICES) has been actively seeking to expand the scope of its scientific expertise beyond the natural sciences. The ICES Working Group on Economics was established in 2018 to address the challenge of integrating fisheries economics in the science and advice regarding the sustainable use and conservation of marine living resources.

As one of its first tasks, our group set out to review the status and progress made in applying fisheries economics in ICES marine areas, to policy topics and research of relevance to fisheries managers. The results of this review are presented in a recently published article of the ICES journal of marine science (Thébaud *et al.*, 2023). We find that while early fisheries economics work was largely theoretical, research over the past three decades has seen the development of strong empirical research of direct relevance to ICES science and advice.

First, economic analyses help understand how interactions between policy options and stakeholders' incentives affect the likelihood of achieving management objectives. For example, early economic studies of fisheries management under an industry-wide total allowable catch (TAC) provide an understanding of harvesters' incentives to further engage in capital investment (so-called "capital stuffing"), with resulting race to fish and dissipation of economic returns. Many fisheries policy innovations were introduced in light of these economic insights, such as the various approaches for allocating harvest rights.

Second, we show how trade-off analysis is embedded in how economists quantify economic value. As a measure of value, economists typically use differences in net benefits from a policy intervention compared to no policy, or differences in net benefits with and without a shock to the system such as an ecological disturbance. In supporting fisheries management, trade-off analysis can inform decisions on how to best allocate limited resources such as time, capital, and fish stocks to attain the highest net benefits to society.

We identify commercial fisheries management topics on which ICES science and advice is well-established, and economic analyses could provide important contributions. These include the economic dimensions of setting allowable catch limits, advising mixed species fisheries management, area-based and spatial management, adjustment of fishing capacity to resource potential, and shared stocks management as well as dealing with data- limited situations. We also identify important topics in the fisheries economics literature not commonly included in the standard science supporting fisheries advice. These include informing the design and operation of fishing rights allocation regimes and the management of small-scale fisheries, as well as improving our understanding of the links between the harvesting sector and markets for fish, the diversification of commercial fishing, fisheries-aquaculture connections and the evaluation of ecosystem services.

Overall, we find that a strong body of applied fisheries economics research exists, covering a broad range of topics at the core of fisheries management. WGECON will continue its efforts towards integrating this knowledge in fisheries science and advice (section 2). For example, the group has initiated, jointly with Working Group on Social Indicators (WGSOCIAL), a review of approaches, methods and tools for the evaluation of interactions between offshore wind development and fisheries. We are also working on developing guidelines for the selection of methods for quantitative trade-off analysis, and for informing the implementation of rights-based

fisheries management systems. The group is also planning to contribute to ICES advisory products, such as contributions to Ecosystem and Fisheries Overviews, as well as developing bio-economic assessment models for informing Mixed Fisheries management.

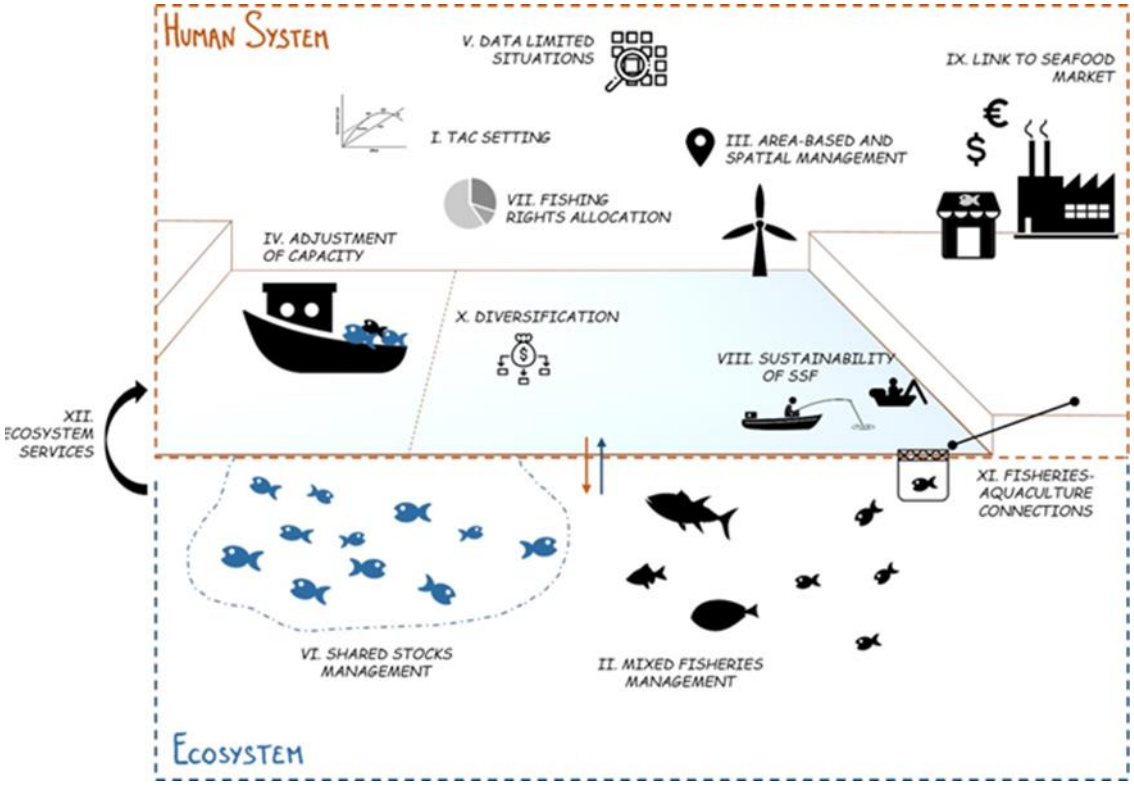


**Figure** 1.1 **Graphical representation of the topics for science and advice considered in the review (from Thébaud et al., 2023)**

# 2 Demonstrating integration of economic information and analyses

## 2.1 Ecosystem overviews

### 2.1.1 Contribution to the North Sea and Celtic Seas Ecosystem Overviews

The WGECON in collaboration with WGSOCIAL in 2021-23 continued working with ICES Integrated Ecosystem Assessments Steering Group chair Debbi Pedreschi, Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEAWESS), and Working Group on Integrated Assessments of the North Sea (WGINOSE). As a result of this collaboration, two Ecosystem Overviews (EO) were updated (For the Celtic Seas, see: https://iceslibrary.figshare.com/articles/report/Celtic_Seas_ecoregion_Ecosystem_Overview/21731615; For the North Sea, see: https://figshare.com/articles/report/Greater_North-_Sea_ecoregion_Ecosystem_Overview/21731912) incorporating socio-economic analysis of commercial fisheries that are mainly focused on:

- mapping ports of landings for commercial fleets (above 10m length vessels) operating within the ecosystem region;
- analysis of countries involved in utilizing fisheries resources and their main economic performance indicators, such as value of landings, gross value added and net profits generated as well as employment as full time equivalent (FTE) jobs;
- a short overview of recent external factors affecting the industry in the regions (such as Covid and Brexit).

### 2.1.2 Data sources and limitations

Two data sources were used to contribute to the EOs:

- ICES Regional DataBase (RDB);
- STECF Annual economic report (AER) dataset (Data available through Economic and Social Analyses - European Commission (europa.eu).

During the RDB data analysis phase, several limitations of the database were observed:

1. The RDB covers only EU countries and the UK data supplied to ICES. Information and data for other countries such as Norway and Faroes Islands that are also fishing in the Greater North Sea basin are not available in the database and those countries could not be included in the North Sea EO.
2. Some of the indicators are provided on a voluntary basis in the RDB and do not cover all countries or all years, e.g. within the Celtic Seas EO Ireland provided fishing days (soaking time) for 2017-19 (period analysed), but the UK provided sea days.
3. Some countries failed to provide data on small-scale fleets (<10m length vessels); therefore, maps were limited to >10m vessels.
4. Statistical rectangles are not provided by Ireland, therefore allocation of Irish data to the Celtic Seas ecosystem was based on broader ICES Area definitions, while for other countries statistical rectangles had been used.

5. A limited number of data quality checks were performed on the data extracts, mainly focusing on the coverage of countries, fleets and indicators used in both analyses.

STECF DCF AER data limitations:

- Only EU MSs supply economic data to the STECF economic data call. UK supplied data to the STECF AER database up to 2019. In future updates of the EOs, the UK economic data collected by Seafish and published through different platform (https://public.tableau.com/app/profile/seafish/viz/FleetEnquiryTool/1Overview) should be supplied, processed and used to extend the same dataset. As in the case of RDB, Norwegian economic data were also not available for the Greater North Sea EO analysis, and is therefore missing.
- STECF AER economic performance data are aggregated at the level of DCF fishing fleets (combination of fishing technique and vessel length category) and supra regions. Supra regions are defined at a very broad geographical level (North Atlantic Ocean for ICES relevant fleets), therefore assumptions and disaggregation techniques agreed to by STECF (EU STECF, 2021) are used to allocate costs and earnings by AER geographical regions.
- Due to the disaggregation technique outlined above there is uncertainty about the representativeness of costs for regional fishing activities.
- To analyse economic performance at the ICES ecoregion level, STECF AER regions were used as a proxy, however AER regions are not fully in line with ICES EO definitions, e.g. Northwestern Waters Management area that covers ICES areas 5, 6 and 7 was used in Celtic Seas EO.

### 2.1.3 Method used

RDBs data were processed using R software and visualized in maps published in both EOs using Tableau Desktop Software. The main issue visualizing the data were related to ports identification and coordinates. Existing public databases that contain port coordinates don't provide coordinates for all small ports and landing sites that are used to land seafood by catching sectors. Therefore manual work using internal UK, Irish, other North Seas Ecoregion countries and google maps information was conducted to fill in the gaps in ports coordinates coverage.

Other issues related to data submitted by MS were solved using statistical methods. One of the main issues of Celtic Seas EO related data as mentioned above was a mismatch between provided effort indicators by the main fishing nations – Ireland and UK. As Ireland provided days at sea and fishing time for historical time-series (2009-2012), the same ratio between fishing time and days at sea was used to estimate days at sea for Ireland when developing the effort map.

#### Future developments

With respect to the harbour of landing data, the procedure to access to the RDB has changed and is now more restrictive (ICES, 2023). The possibility to use the RDBES and changes in associated ICES Data Call should be investigated in the coming iteration.

Due to limitation in resource availability Regional analysis of the AER was used as a proxy of the EO regions. However regions defined for STECF AER are not fully in line with the definition of both EOs. Therefore more work could be done in future developing economic data disaggregation procedures that could better reflect definitions of the ICES EOs. The disaggregation of economic indicators could be done using the following main methods developed by previous projects and nationally:

1. Using the STECF AER methodology (EU STECF, 2021) that is based on effort and landings value allocation to specific fishing regions;
2. Using SECFISH project method developed in 2018-19 and published on CRAN as package and in Bitetto *et al*. (2022), CRAN - Package SECFISH (r-project.org);
3. National disaggregation techniques (further details of the methodology and information about other economic data disaggregation techniques used by different projects is also provided in the ICES WKTRADE4 report, 2024).

The national techniques could include a variety of options, e.g. in case countries are using more precise (compared to DCF supra region) regional definitions for their fleet segment stratification, those fleets could be grouped into relevant regional fleets prior to data submission. Countries also have better access to fishing activity information and are able to group vessels, or disaggregate their economic data based on this type of information, e.g. UK stratification is based on national fishing fleets definitions (Moran-Quintana *et al.*, 2020) and for Fisheries Management Plans (FMPs), assessment of natural capital value (by Office of National Statistics) and spatial assessments, some of the economic performance indicators are disaggregated at the vessel level in accordance with value of landing shares, then aggregated to the species or rectangle levels needed for specific analysis. Both the second and the third methods would require additional resources and application at a national country level, as well as a process to provide that information to WGECON or ICES through dedicated data calls or a pre-agreed workflow.

### 2.1.4 Availability of data (adding non EU countries to the analysis)

In depth description of EU DCF and data aggregation levels for European economic datasets was provided in section 4.1. of the previous ICES WGECON report (Thébaud *et al.*, 2021). In this section, we provide brief overview of the availability of selected non EU/UK economic and activity data.

#### Norway

Landing ticket data is made publicly available by the Norwegian Directorate of Fisheries and is updated on a yearly basis. Among others, these data include information on vessel gear, capacity, fishing and landing location, catch composition, volume and value. In addition, all vessels over 15m in length use the Electronic Reporting System (ERS), where they log information about their fishing activities such as the position when starting or stopping a haul or catch by species for each haul. The ERS data are also made publicly available by the Norwegian Directorate of Fisheries. The vessel registry includes registration, quota and licence information for each vessel. Various summary statistics are published annually by the Directorate of Fisheries, while the underlying individual vessel economic data such as cost of fuel, crew/labour costs are available by application only.

Groundfish species comprise the most valuable fisheries in Norway, with cod, haddock, and saithe being the most important ones by volume and total revenue. In Norway, all ex-vessel sales are conducted by fisher-owned sales associations, six in total, that set the rules for transactions, collect payments on behalf of the fishers, and guarantee a minimum price to the fishers. Norwegian fisheries are mostly managed with IFQs.

Unfortunately, the data on landing location does not include the information required to be mapped with the rest of the countries, (coordinates of landing locations, or names searchable in our current harbour database or on google maps).

### USA

Although not technically an ICES ecoregion, the Northwest Atlantic is a focus of a number of ICES expert groups, including the Working Group on the Northwest Atlantic Regional Sea (WGNARS) which develops capacity for Integrated Ecosystem Assessments in Canada and the United States. WGNARS sits under the IEASG, but does not produce ecosystem overviews unlike other regional sea working groups due to the fact that similar reports are produced nationally in both Canada and the U.S.

In US waters of the Northwest Atlantic, aggregate commercial fishing economic data are made available for public dissemination, including economic and social performance measures for federally managed species, a broader suite of community vulnerability indices, fixed cost data derived from periodic mail surveys, and trip cost data recorded on the subset of trips carrying human observers (Werner et al. 2020). With some exception (e.g. vessels holding only a lobster or highly migratory species licence), the majority of trips taken by federally permitted vessels report not only the landings, catch, and revenue generated from a trip at the species level, but also gear employed (including mesh size, number, etc.), crew, latitude and longitude where majority of fishing effort occurred, sail and landing date and time, and ports sailed from and landed in. These data can be joined to information on vessel tonnage, length, horsepower, and age, from the permit database.

For federally permitted recreational charter/head boat vessels, excluding highly migratory species, data includes landings and catch at the species level, number of anglers, latitude and longitude where majority of fishing effort occurred, sail and landing date and time, and ports sailed from and landed in. These data can also be joined to information on vessel tonnage, length, horsepower, and age from the permit database. In addition to additional charter/head boat information, both shore based and private vessel recreational data are derived from mail surveys, with species-level landings and catch data annual summaries available to download publicly. Geographically, data are only available by state of embarkment and broad fishing area (e.g. state vs. federal waters). Recreational expenditure data are also collected intermittently through a survey add-on.

## 2.2 Methods and tools for trade-off analysis

Term of reference c) of cycle 2 of WGECON aimed to "Demonstrate the approaches, methods, tools and information flow needed to provide analysis of trade-offs relating to ecosystem-based management of fishing (EBFM)." In cycle 1, the group had provided a description of the standard economic approach to trade-off analysis (ICES, 2021), highlighting that since economics deals with the efficient allocation of scarce resources, the idea of trade-off is embedded in the very concept of economic value. The two types of economic analyses often encountered in evaluating policy alternatives, welfare analysis and impact analysis, were described in the report, using a toy example relating to the issue of managing fishery production while also limiting the bycatch of a protected marine species.

Building on this background, and on work previously carried out by members of WGECON, the group set out to further develop a set of guidelines as to the selection of appropriate methods and techniques for carrying out quantitative analysis of trade-offs, depending on the context and issue at hand. This work was initiated by a subgroup of WGECON members, in collaboration with a subgroup of members of WGSOCIAL, as the latter group was also considering the question of trade-off analysis as part of its terms of reference. The rationale for this work is summarized in the figure below.

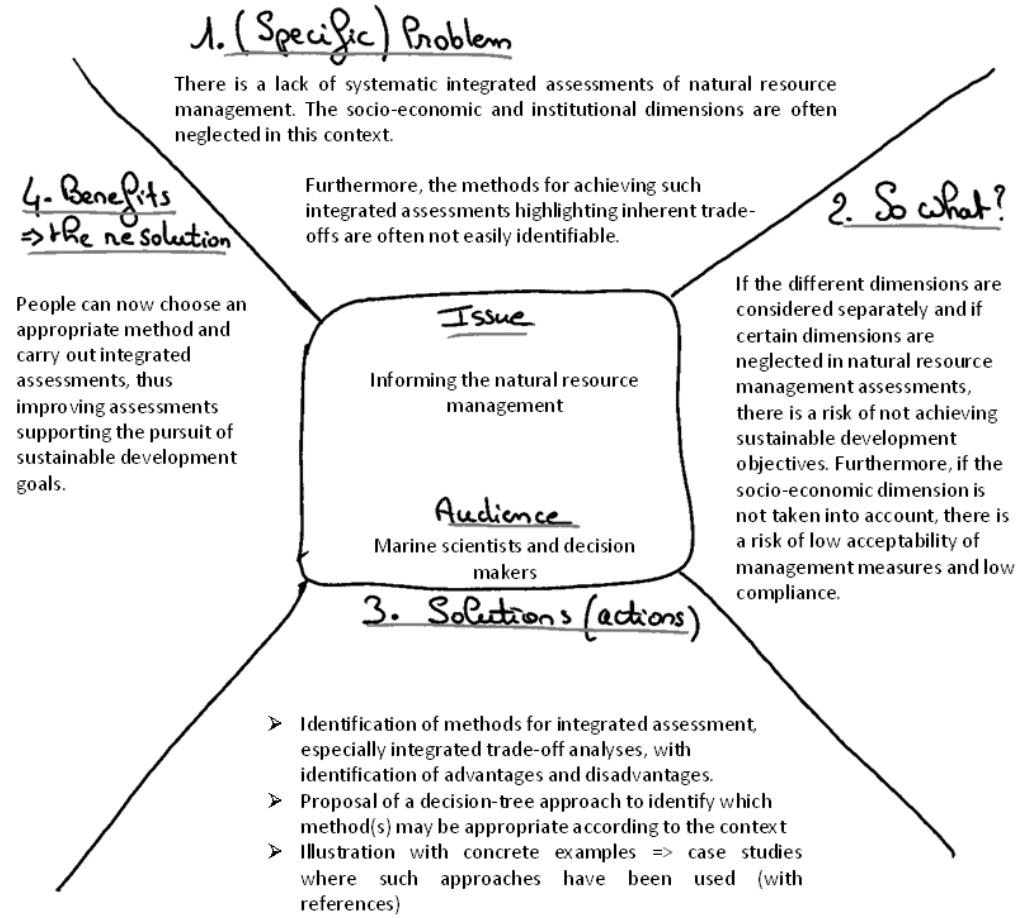


**Figure 2**.1 **Rationale of the work undertaken on methods and techniques for trade-off analysis.**

Trade-offs are fundamental in natural resource management. For instance, alternative management strategies often result in different combinations of outcomes for ecological, economic, social and institutional dimensions, and hence are likely to involve trade-offs which must be evaluated to determine the most appropriate overall strategy from the broader societal perspective.

However, these different components of trade-off analysis have traditionally been assessed in isolation. For example, environmental impact assessment has a long-standing tradition in assessing development proposals, under the assumption that economic outcomes are the concern of the developer rather than the decision maker. More recently, social impact assessment has been included to assess impacts of different alternatives of natural resource management. Economic analyses have also been commonly undertaken, in some cases including environmental costs but often ignoring social issues such as distributional outcomes of alternative proposals.

If the different dimensions are considered separately and if certain dimensions are neglected in assessments, there is a risk that at least some of the sustainable development objectives may not

be achieved. Furthermore, overlooking important social, economic or institutional dimensions may lead to low acceptability of management measures and low compliance.

There is thus a need for approaches to look at trade-offs in an integrated manner; i.e. that covers the full values of ecological, economic, social/cultural and institutional aspects. In this work, we aim to review the different methods available to carry out such analyses, across a range of disciplinary fields. Depending on the context, the data available and the objectives, differing methods will be appropriate. We aim to develop a systematic review of the different methods that can be used, to highlight their advantages and disadvantages and to propose a decision tree approach to help researchers and decision-makers choose appropriate methods according to the context of their assessments. The key questions we identify in carrying out a trade-off analysis include the following:

1. Is a formal evaluation of trade-offs required?
2. Does it involve unacceptable compromises?
3. Are monetary values acceptable as measures of outcomes?
4. Are monetary values acceptable for all components or for costs only?
5. Is it possible/feasible to value all important components?
6. Is it possible/feasible to value costs?
7. Do stakeholders want an interactive process?
8. Are there relatively few/many stakeholder groups?

### 2.2.1 Future work

We will develop a stylized example to illustrate how different methods and techniques can be used depending on the answers to these questions, and use selected demonstrators to document the practical implementation of the techniques in specific contexts, relying on published studies. WGECON will collaborate with WGSOCIAL in its third cycle to carry out this review, with the aim to produce a synthesis article by the end of this cycle.

## 2.3 Evaluating Rights-Based Management (RBM) systems

Rights based fisheries management has been rigorously studied in the economics literature highlighting effects on economic performance and capacity adjustments in fishing fleets. However, the shift from conventional fisheries management approaches to rights-based systems frequently produces impacts that extend well beyond the vessels encompassed within the program. These impacts include social effects on fishing communities, ecological impacts, and consequences throughout market channels from processing and distribution networks to final consumers. Consequently, managing authorities must not only take into account the fishing fleet but also consider additional social and ecological objectives that are impacted by the management systems.

### 2.3.1 Objective

The objective with the work on rights based management is to identify questions that arise in the implementation of rights based programs, and how these affect the types of economic data, methods and tools required to answer these questions. The scientific approach to meet this objective is through cases studies of rights based programs that were implemented in ICES countries with a focus on the data, methods and tools that were used at the beginning of the program, how these changed in the course of implementation and lessons learned with respect to the ways

in which economic analyses inform rights-based fisheries management (RBFM) program performance. Focus in the review is on mixed groundfish fisheries but allows for other types of mixed or single species fisheries.

The aim of the analysis is not to document the economic, social, or ecological performance of RBFM programs. Rather, the focus lies on examining the utilization of economic analyses prior to implementation and assessing whether the introduction of such programs has spurred the development of novel economic approaches or the collection of new data for program evaluation purposes. This new data could encompass indicators varying from social to ecological impacts, including economic factors such as quota prices.

### 2.3.2 Case study structure

In order for all case studies to provide comparable information, each study has adopted the following structure:

- Program objectives and development
    - What was the biological and economic status of the fishery in the years prior to the RBFM program?
    - What were the RBFM program objectives?
    - What were the key provisions of the program (e.g. eligibility, qualification for allocation, transferability)?
- Economic analysis for implementation
    - What, if any, economic analysis or economic models were used at the time of first implementation?
    - What economic data were available at the time of first implementation and how were the data used?
- New data and economic models post-implementation
    - Were any new economic data collected after the RBFM program was implemented? If so, what data were collected?
    - Were any new economic models developed post-implementation?
- Program changes since implementation
    - If any, what were the key changes in the RBFM program post-implementation?
- Lessons learned
    - What are the key lessons learned?

### 2.3.3 Included case studies

The analysis currently contains nine case studies. Seven case studies cover mixed demersal fisheries and two cover pelagic fisheries. Two of the studies are from the US and seven are from Europe (including both EU and non-EU countries as well as both northern and southern parts of Europe). The case studies are:

1. Mixed demersal fisheries in Spain
2. Anchovy coastal fisheries Xla region
3. Pelagic fisheries in Denmark
4. Mixed demersal fisheries in Denmark
5. Demersal fisheries in Sweden

6. French quota management cooperative system (mixed demersal)
7. Demersal fisheries in Iceland
8. Northeast Multispecies sector allocation
9. Pacific Coast Groundfish Trawl Catch Share Program

### 2.3.4 Work in progress

As of June, 2023 written versions of seven of the nine case studies had been completed and eight of nine case study synthesis evaluation templates had been completed. The remaining case study is under development. Additionally a second call for case studies has been issued to solicit case studies from any members that may have joined WGECON since the initial request for case studies in 2021. This has resulted in two additional Australian case studies that are now under development.

A comparative analysis of the quality of access rights across case studies has been presented at the conference on "Advantages and disadvantages of strong user rights in fisheries" held from October 16-18 in Copenhagen. A draft manuscript synthesising the case study findings and lessons learned will be prepared and submitted to a peer reviewed journal.

## 2.4 Generic approach for a review and characteristics evaluation performance matrix and survey on fisheries-windfarm interactions

With the stark increase of wind farms in ICES regions, the need for a better understanding of social and economic impacts of these developments for other users (most notably fisheries) and society at large, grows. WGSOCIAL and WGECON developed an evaluation performance matrix of fisheries-windfarm interactions to assess what social and economic information currently exists in all these different developments. This covers all types of products, e.g. development projects, publications, impact assessments, legislations, compensations schemes, etc., taking into account previous reviews. The matrix was sent to WGECON and WGSOCIAL membership as well as to ICES wind farm working groups to be filled in. The request focused on completed and ongoing case studies of wind farm projects directly addressing economic and social aspects of interactions between fisheries and wind farms covering the fishing sector, renewable energy sector, catch sector with fleets/fisheries/catches, harbours, fishing and renewable energy local communities, regions, nations, and international initiatives and stakeholders. First, the generic and standardized approach and evaluation matrix is presented together with explanatory notes for the rows in this matrix. After this, the individual case studies and approaches are presented with collected information and results. The survey categorizes different types of examples of what has been done, what is existing, as well as future initiatives and plans, and shows how and which criteria have been prioritized. The evaluation and discussion of the survey results identify key components for developing economic and social evaluations and providing advice on fisheries-windfarm interactions. As such, the survey can directly provide guidelines and advice on future needs and the necessary indicators, scales, methods, participation, etc. to be used for evaluation.

### 2.4.1 Objective and approach

We aim to gain a better understanding of social and economic impacts of wind farm developments for other users - most notably fisheries.

To achieve this, WGSOCIAL and WGECON developed an international survey and evaluation performance matrix of fisheries-windfarm interactions to assess, categorize, and identify gaps in the current social and economic information, as well as identification of criteria prioritized, based on historical and ongoing case studies, existing approaches, projects, publications, impact assessments, legislations, compensations schemes, etc. across ICES countries and regions. The focus is to assess the type of work, specifically in relation to socio-economic considerations based on review of existing approaches as demonstrators of data, tools, and evaluations. This covers simulation of impact scenarios, trade-off-analysis, compensation schemes, database establishment, analysis tools development, indicator identification, previous relevant reviews, etc.

Our target audience for this review is diverse, and includes the Fishing Sector (fleets, fisheries, processing), Renewable Energy Sector, Harbours, Stakeholders, Scientific Communities, Local communities / Regions / Nations / International Institutions, etc. to provide guidelines, science and advice on future needs including the necessary indicators, scales, methods, and participation.

### 2.4.2 Material and methods

The joint work on the socio-economic impacts of the interactions between offshore wind farms and fisheries has resulted in the definition, development and production of an evaluation framework in the form of a Survey, Review and Evaluation Matrix. The main topics covered in the survey are listed below, and the full survey and detailed explanations to this can be found in Annex 3.

#### Main topics of the survey and approach

**Approach Type, Aims, Governance and Coverage:**

- What type of approach (e.g. Impact Assessment / Legislation / Compensations scheme, etc.);
- Main aims of the approach (e.g. Spatial Management Plans, Management Advice, Science, Indicators, Databases, Simulation of Impact Scenarios, Compensation Schemes, etc.);
- Governance and Institutional Set-Up (Advisory, Management, Legislation, Policy, Government, Scientific Community, Policy, Stakeholders, Private Companies and Contractors, etc.);
- Who (Providers / Requesters);
- Where and When (Geographical and Time-scale).

**Approach Methodologies, Disciplines and Dimensions:**

- Type of Evaluations (e.g. Model Simulation of Impact Scenarios, E mpirical Value Estimation, Tool Development, Indicator Identification, Database Establishment, etc.);
- Methods (e.g. Evaluation Framework, Simulation Model, Qualitative Descriptive Tool, Qualitative Indicator Based, Spatial Explicit Databases, etc.)
    - Qualitative Indicator Based (Interview, Traffic Light, etc).
    - Quantitative Indicator Based (Observation, Estimation, etc.);
    - Simple Value Estimation – Static snapshot of possible losses (Deterministic or Statistical Methods, etc.);
    - Trade-Offs-Scenario Impact Analysis (Dynamic Simulation with Full-Feedback and Projections);

- Optimization of Objective Function or Iterations or MCMS;
- Equilibrium, Empirically Based Control-Impact/BACI/BAG, etc. Can a Value Chain be Followed and How Far?

- Sectors, Disciplines and Dimensions (Sectors Covered – e.g. Fishery and Energy, Economic / Socio-economic / Bioeconomic / Ecosystem Goods and Services, Spatial Explicit, Global/Regional/Local, Time Resolution, etc.);
  - Level of Linking Biological and Economic and Socio-economic Operating Parts in the Approach;
  - Type of Data and Parameters Involved.

**Type of Approach Outcomes:**

- Use and Status for Application and Implementation
  - Type of results coming from the use and implementation of the approach (Impact Assessments – single stringed or cumulative, Developed Evaluation Tools and Models, Indicators – qualitative or quantitative, Databases, Advice, Legislation, Management Measures/Regulations, General Policy Development, Public Science, Compensation Schemes, etc.);
  - Implementation Level / Time Horizon (Planned, In Progress, Applied/Implemented, etc.);
  - User Friendliness and Applicability and Acceptance to Policy-makers, Stakeholders, Scientific Community (Informative, User-Friendly, Complexity, Flexibility, Broad Applicability, etc.);
  - Dissemination and Documentation Level;
  - Gap Analysis and Future Needs, Investigations and Studies (e.g. Direct and indirect and cumulative spatial aspects of economic and social impacts and closures, legal obligations, requirements for management and legislation and policy development – and how this is delivered, development of compensation schemes – and negotiation / bargaining process, guidelines on SIAs, life cycles of wind farms, types of fisheries, etc.).

### 2.4.3 Results

**Progress of work and Preliminary Results based on Initial Analyses**

- The survey has been distributed within ICES WGECON and WGSOCIAL and also to other relevant ICES working groups including Working Group on Offshore Wind Development and Fisheries (WGOWDF) and Workshop on a Research Roadmap for Offshore and Marine Renewable Energy (WKOMRE). Currently, the survey is in case specific applications. So far, **12** applications have been completed and more are in the process of being completed. This will allow another round of application based on the initial experiences and coverage in responses. The first set of case studies collected was reviewed during the working group meeting week in June 2023, and the group agreed to pursue the survey effort while also continuing to evaluate preliminary results for a preparation of a presentation of the aim, approach, survey and its preliminary results at the 2023 ICES ASC in Bilbao in September 2023 in Session A which is dedicated to this topic (Nielsen *et al.*, 2023). The work will continue in the coming year under ICES WGECON and WGSOCIAL on requesting application and return of further surveys and conducting continued analyses and reporting of the results.

**Number of Surveys according to Coverage of Major Aims, Type of Surveys and Methods Used**

- Empirical data analysis of fishery data in OWF areas (estimation of catch, effort, revenue, profit, etc.)- among other valuation in relation to potential compensation schemes: **2**
- Agent based and dynamic spatial model simulation and projection of bio-economic consequences and indicators for fisheries and stocks of effort displacement by spatial OWF restriction scenarios (simulation framework): **3**
- Qualitative interview / indicator based evaluation framework and socio-economic impact assessment tool: **4**
- Ecosystem and ecosystem goods and services holistic modelling, simulation and projection: **1**
- Establishment of databases and quantitative mapping tools of fisheries / OWFs (effort, revenue, etc.): **2**
- **Region:**
  Europe (DK, F, NL): **8** North America (USA): **4**
- **Geographical Scale:**
  National (regional) waters: 5 National local waters: 4
  International (shared) regional waters: 3
- **Fishery / Fleet Scale:**
  National regional fisheries: 5 National local fisheries: 4
  International regional fisheries: 3 All fisheries in general: 0
- **Time Scale (horizon):**
  Short term: 2 Medium term: 9 Long term: 1
- **Requester/Recipient:**
  National Government: 5 Public Scientific Community: 3
  Private-Public Joint Venture Consortium: 2 Private Contractor: 2
- **Provider / Producer:**
  Nat. Research Institute: 11 Scientific Consultants: 1
  Private Contractor: 0
- **Governance:**
  National Scientific Advice: 5
  International Scientific Community: 3
  Private-Public joint venture scient. Development and stakeholder involvement: 4
- **Dissemination:**
  Scientific Advice Report: 2
  Project Report (internal or public): 3
  Scientific Peer Reviewed Paper: 5
  Database, Standardized Data and Tool: 2
- **Level of Implementation:**
  Planning phase: 0 In Progress: 8 Implemented:4

### 2.4.4 Future Perspectives

Future work will consider the following points, among others:

- Establish guidelines on what should be included into evaluations and management advice in relation to socio-economic interactions between fisheries and wind farms (incl. displacement) – in relation to scale, evaluation methods and indicators;
- One of the lines of thought is that we expect most work to be nationally oriented and therefore it may be useful to sketch what challenges there may be for ICES to work on this topic from an international perspective and on both sides of the Atlantic;

- Another is that wind energy work might be a nice case in hand for demonstrating advice on socio-economic impacts for fisheries – we can build on the fishing community and indicator development work we already do in our groups;
- We will also consider compensation schemes and demonstrators / guidelines for compensation schemes;
- We also plan to 'try out' evaluations using simulation tools for trade-offs and scenario analyses – which we also develop in our groups.

# 3 Collaborations and outreach

## 3.1 Interactions with scientific networks and scientific advisory bodies

WGECON membership has been well represented throughout a host of scientific networks and advisory bodies 2021 – 2023. Olivier Thébaud presented WGECON's review article (Thébaud *et al.*, 2023) during the 2023 North American Association of Fisheries Economists meeting in Woods Hole 23 – 26 May and the 2023 ICES ASC 11-14 September. WGECON members chaired sessions focusing on economic research relevant to ICES work, at the 2021 ICES ASC (online) and at the 2022 IIFET conference (Vigo), and a session on trade-off analysis at the 2023 ICES ASC (Bilbao), in collaboration with SIHD and Working Group on Balancing Economic, Social and Ecological Objectives (WGBESEO). The wind-farm-fisheries interactions survey was also presented at the 2023 ICES ASC (Bilbao) as a collaboration between ICES WGECON and WGSOCIAL. In addition, WGECON members participated in the 2023 EAFE conference (Athens). The seven complete case studies from WGECON's review of Rights Based Management systems were presented at a special session of the conference on Rights-Based Management organized in Copenhagen in October 2023. Several members of WGECON are actively engaged in the Scientific Committee of the 2024 ICES-PICES Marine Socio-Ecological Systems (MSEAS) Symposium, originally planned for May 2020 but rescheduled for June 2024 due to the COVID-19 pandemic, as well as in presenting and session chairing. A new session focusing on incorporating human dimensions to improve fishing opportunities advice has been accepted for the 2024 ASC conference, with a WGECON member as co-chair. In addition, with the help of Olivier Thébaud, current President-Elect of IIFET, discussions have been initiated by members of WGECON and WGSOCIAL with IIFET conference 2024 organizers, regarding holding a policy workshop during the conference.

Geret DePiper participated in the Marine Ecosystem-based Management Progress Evaluation Group (MEBM-PEG) 11 - 14 October, 2022 to assess the status of management implementation and future direction of Ecosystem-based Management globally, is a member of NOAA's Integrated Ecosystem Assessment Steering Committee, co-Chair of NOAA's Integrated Ecosystem Assessment Human Dimensions Working Group, and member of the US Mid-Atlantic Fishery Management Council's Scientific and Statistical Committee where he Chairs the Economic Work Group. Arina Motova, Francois Bastardie, Katel Hamon, Leyre Goti, Ralf Döring, Rasmus Nielsen, and Raúl Prellezo are members of The European Commission's Scientific, Technical and Economic Committee for Fisheries. Several WGECON members participate in national and ICES-wide initiatives related to the United Nations Decade of Ocean Science. Olivier Thébaud and François Bastardie also participated in an OECD workshop on the impacts of climate change on fisheries, held in Paris in November 2023.

## 3.2 Interaction and cooperation with other ICES expert groups and activities

An overall objective of ICES WGECON is to address the challenge of bringing fisheries economics into ICES science and advice. Over the first two cycles of WGECON, members have established collaborations with other ICES groups, workshops and other activities. In particular, since its inception, WGECON has collaborated extensively with WGSOCIAL to the extent that there are joint sessions during each WG's annual meeting to facilitate collaborative activities.

Table 3.1 presents selected collaborations between WGECON members and other ICES activities that have direct thematic connection to the ToRs of the group, over the second cycle of WGECON.

**Table 3.1. WGECON Member participation in other ICES activities (cycles 1 and 2).**

| WGECON Member | Participation in other ICES Working Groups |
|---|---|
| Alan Haynie | ICES Secretariat |
| Angela Muench | WGSEDA |
| Arantza Murillas | WGRMES |
| Arina Motova-Surmava | WGSOCIAL, WGEAWESS, WGINOSE, WKTRADE4 |
| Claire Macher | WGMIXFISH, WKSHOES |
| François Bastardie | WKTRADE2, WGFBIT, WKTRADE4 |
| Geret DePiper | WGNARS, training session "Economics of Ecosystem-based Management" for DG MARE on behalf of ICES (11/05/23), "Objective Setting within Integrated Ecosystem Assessments" presented during the ICES WGBESEO meeting (25/03/21), WKCCMM |
| J. Rasmus Nielsen | WGNSSK, SCICOM alternate for Denmark |
| Katell Hamon | Chair of SIHD (until sept 2023), active member of WGMARS, engaged with WGINOSE, WGBESEO, SCICOM alternate for the Netherlands |
| Olivier Thébaud | SCICOM alternate for France, WGMPAS, WKMIXFISH, WKCONSERVE, WKSHOES, IPOD |
| Sophie Gourguet | WGSOCIAL |
| Lisa Pfeiffer | WKOMRE, WGOWDF, WKTRADE4 |

Some of these collaborations have helped progress towards the integration of economic dimensions into ICES advice. In particular, section 2 of this report presents a description of the substantial collaborative work members of WGECON have undertaken on behalf of WGEAWESS and ongoing work on behalf of WGINOSE in developing economic analyses for inclusion in regional Ecosystem Overviews. This Ecosystem Overview work is being conducted jointly with WGSOCIAL. Another area of collaboration relates to the evaluation of trade-off scenarios between the impact on seabed habitats and provisions of catch-value (WKTRADE2, ICES, 2019), the report of which François Bastardie was a co-editor, as well as the 2023 WKTRADE4 (ICES, 2024) workshop chaired by WGECON chair Arina Motova-Surmava, in which several WGECON members also participated. The results of WKTRADE4 have been used in late 2023-early 2024 to update ICES Advice on trade-offs between fisheries impact on seabed habitats and economic performance. The final advice included definitions and analysis of Gross Value Added as an economic indicator to access trade-offs.

## 3.3 Fostering ECON and MIXFISH collaborations

Among identified key issues in this area reviewed in Thébaud *et al.* (2023), is the question of mixed fisheries management advice. This topic also relates to other topics like TAC setting, fishing rights allocation and adjustment of capacity or diversification strategies.

A number of integrated bio-economic models have been developed and applied (also in operational contexts as in STECF Impact Assessment processes) to explore the alternative management of mixed fisheries. A review of those models are proposed in Nielsen et al. (2018). Modelling interactions between fleets (or vessels) allocating their effort to different métier and stocks, they explore biological and socio-economic consequences of alternative scenarios. The distributional effects of scenarios among fleets are of particular interest. These types of integrated applications have however not been used in the ICES advice process to date.

At the ICES level, WGMIXFISH develops advice for mixed fisheries with the aim to identify so-called "choke effects". Based on FCube or FLBeia models, common predefined scenarios are run in the different mixed fisheries case studies and highlight the impacts on effort, landings and catches with regards to TAC constraints on the different stocks.

Other works connecting to ECON objectives have also been carried out, based on existing databases, to provide descriptions of the dynamics of fisheries from an economic point of view. These developments can provide inputs to Fisheries Overviews and Ecosystem Overviews. They could also provide useful information to identify fleet dependence to choke stocks in the Mixfish framework and help identify socio-economic consequences of choke effects for the different fleets. Advancing such economic considerations in MIXFISH advice would help address stakeholder demand, and result in more salience of the advice produced.

The use in ICES advice of such an integrated assessment approach, simultaneously considering biological and socio-economic dimensions associated with mixed fisheries management, could be further developed through common work between WGMIXFISH and WGECON. Practical steps towards this include favouring interactions between the two groups, to enhance mutual understanding. In particular, organising joint workshops, or joint annual group meetings on the methods development, could stimulate discussions and the sharing of perspectives on how to best progress integrated mixed fisheries management advice. This could also be further developed through the involvement of researchers from ECON in the MIXFISH advice group, with contributions to the development of applications in specific case studies. An application to the Bay of Biscay Case study of a bio-economic modelling framework based on previous work developed with IAM (see Macher *et al*., 2018; Briton *et al*., 2020; 2021) or FLBEIA could be developed to provide a demonstrator of possible bio-economic consequences and multi-criteria stakes of MIXFISH scenarios. This would illustrate the added value of such integrated advice on a particular Case study, as well as help advance methodological aspects, data requirements and potential outputs.

Among identified issues to advance integration of economic advice in MIXFISH is the need to include in the data call the DCF fleet level to be able to assess impacts at fleet level and facilitate connection between the Annual Economic Report and the fleets-métiers definitions in MIXFISH.

# 4 Future work

## 4.1 Future perspectives for economics in ICES science and advice

WGECON anticipates a growing integration of economics within ICES advice. Our review conveys that a large body of applied fisheries economics research has developed, especially over the past three decades, which provides information of direct relevance to various dimensions of fisheries management advice. Beyond this assessment of existing research in applied fisheries economics, the group also identified the potential for further developments of direct relevance to the science supporting management advice internationally. These are discussed in the article (Thébaud *et al.*, 2023), in relation to three key areas for future research, emphasizing their relevance to future developments of ICES work. These key areas are the provision of ecological-economic advice, assisting with the identification of fishing capacity targets and capacity adjustment strategies, and informing policy in relation to key interactions determining the responses of fisheries systems to management. For further details, the reader is referred to the published article, available online.

## 4.2 Potential future contributions to advice

WGECON expects to continue work developing advice through Ecosystem Overviews, in particular through integrating economic analyses in the North Sea through an ongoing collaboration with WGINOSE. Additional case studies will be developed with IEA WG as need arises and capacity allows, with the aim of developing an approach broadly applicable across ICES regions. WGECON will also look for opportunities to leverage the information developed in support of Ecosystem Overviews in additional management advice products.

Work will also continue developing an understanding of impacts from offshore wind development on fisheries, as described in Section 2 of this report. This work could include leveraging indicators developed in support of Ecosystem Overviews to assess incidents of impacts from offshore wind development across fleet segments and developing best practices in administering impact assessments within ICES. In addition, compensation is an issue of growing concern as the scale of development expands, and WGECON has interest in providing a comparative analysis of how compensation is addressed across ICES Member Countries.

Due to its importance across numerous ICES regions, WGECON will begin to assess available capacity for developing advice on recreational fisheries. This capacity assessment is likely to entail a review of current work within ICES regions that could be utilized in generating advice.

In collaboration with WGSOCIAL, a synthesis of methods and tools to carry out trade-off analyses has been initiated. The 2023 meeting developed a template which will be used in the next term of WGECON to produce this synthesis. In addition, WGECON anticipates continuing work on the review of Rights Based Management systems, with a synthesis envisioned for development in the first year of its next term.

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# Annex 2: Resolution

**2020/FT/HAPISG04** The **Working Group on Economics** (WGECON), chaired by Arina Motova, UK, J. Rasmus Nielsen, Denmark; and Olivier Thébaud, France, will work on ToRs and generate deliverables as listed in the Table below.

| | Meeting dates | Venue | Reporting details | Comments (change in Chair, etc.) |
|---|---|---|---|---|
| Year 2021 | 14–18 June | Online meeting | | |
| Year 2022 | 9–10 May<br>19–20 May | Online meeting | | |
| Year 2023 | 19–23 June | Edinburgh, UK | Final report by 15 August to SCICOM | Potentially introduce additional chair(s) to ensure transition towards future WGECON |

**ToR descriptors**

| ToR | Description | Background | Science Plan Codes | Duration | Expected Deliverables |
|---|---|---|---|---|---|
| a | Build additional capacity for economic science in ICES, giving consideration to research and institutional needs in all ICES Member Countries, as well as useful connections to international marine/ fisheries economics organizations such as IIFET, NAAFE and EAFE. | This builds on the initial scoping exercise within ICES carried out by WGECON, expands the capacity building efforts, and ensures coordination of activities with other international bodies and links to the wider scoping work in the Strategic Initiative for the Human Dimension (ICES SIHD). | 6.3; 6.4; 7.3 | Years 1,2 and 3 | Annual e-evaluation and final report sections on coordination activities |
| b | Identify and report on economic data-related needs and priorities for short and longer term economic data collection, access and analysis; and where possible propose systems to collect missing data. | To aid prioritization in data collection, management and analysis, to allow quantitative analyses and estimates of economic issues. The ToR links to ICES Data Centre and National and international economic data collection requirements (e.g. EUMAP). | 3.1; 3.2; 4.2 | Years 1,2 and 3 | Final report section on prioritization and continued scientific review paper |
| c | Demonstrate the approaches, methods, tools and information flow needed to provide | To develop toolboxes, expertise and processes to support potential future advice requests | 5.3; 6.1; 7.6 | Years 1,2 and 3 | Final report section on developments and potential |

| | | | | | |
|---|---|---|---|---|---|
| | analysis of trade-offs relating to ecosystem-based management of fishing (EBFM). | and development of ecosystem overviews and integrated ecosystem assessments. This includes collaborations with WGSOCIAL. | | | scientific manuscript |
| d | Assess and report on economic aspects of commercial fishing and its management for selected regions in the ICES area. | To support future potential advice requests and development of ecosystem overviews, using a case study approach. This requires identification of robust indicators to describe economic status and performance. | 6.6; 7.1; 7.2 | Years 1,2 | Final report section on case-study based identifications and assessments, and potential scientific manuscript |
| e | Coordinate the provision of economic indicators and analysis as part of integrated socio-ecological evaluations in support of EBFM. | Building on results from ToRs b), c) and d), to contibute to the development of a framework for integrated assessment of alternative scenarios for marine fisheries, as part of broader ecosystem-based management approaches, within ICES. | | Year 2, 3 | Final report section on economic contribution to integrated assessment framework (case-study based) |

**Summary of the Work Plan**

| | |
|---|---|
| Year 1 | Continue work started by WGECON in 2018-2020 on identifying needs for economic science in ICES, data gaps and opportunities to provide trade-off analysis, building the ICES capacity to integrate economic dimensions in fisheries management advice:<br>- Initiate the case study work identified in 2020, and request data from ICES Member States to address these where necessary;<br>- In collaboration with especially ICES WGSOCIAL, analyse possible ways to introduce human dimensions into Ecosystems Overviews (EOs) by e.g. mapping ports of fishing operation and bringing fisheries at sea to national territories dimentions to identify coastal / fisheries dependent communities;<br>- Continue sharing methodologies of economic data collection / analysis and modelling, and integrated assessment with other ICES working groups and ICES SCICOM and ACOM.<br>Produce e-evaluation report. |
| Year 2 | Progress case study work and inclusion of human dimensions in EOs and develop manuscript(s) presenting results. Continue sharing methodologies of economic data collection / analysis and modelling, and integrated assessment with other ICES working groups and ICES SCICOM and ACOM. Produce e-evaluation Report |
| Year 3 | Finalize case study work. Finalize manuscript(s). Discuss and plan strategies and concrete steps for<br>future work. Produce Final Report |

## Supporting information

| | |
|---|---|
| Priority | Nations are concerned about fish stocks and marine ecosystems not least of which because of their contribution to human wellbeing and economic welfare. The economic dimension should be an integral part of marine science and scientific advice regarding the use and conservation of marine resources.<br><br>Demand for science and advice to address economic considerations is increasing, but ICES does not engage many economists or address economic issues in many Member Countries in its existing work. The efforts of the Strategic Initiative on the Human Dimension (SIHD) with ICES have served to raise the profile of economics and social aspects in relation to fisheries in the last few years, but, with a few exceptions, SIHD efforts are not comprehensively supported and informed by the work of the ICES EG. Further, among the ICES groups addressing economic issues, only WGECON focuses on the development of fisheries economic metrics and core fishery economic analyses that are demanded in parts of the ICES network (e.g. further development of ecosystem overviews) and, in some cases, by clients for ICES management advice.<br><br>The need to expand the engagement of ICES in economics was also reflected in the outcomes of many recent meetings, especially the "Understanding marine socio-ecological systems" (MSEAS) Conference which ICES co-sponsored in Brest in 2016, as well as the results from the ICES Working Group on Integrating. Ecological and Economic Models (WGIMM). Other drivers include high level aspirations for Blue Growth in European countries and globally, the interest in accounting for economic objectives such as Maximum Economic Yield as well as for the United Nations sustainable development goals in management advice, and a desire to understand economic consequences of human-induced changes in the sea (WGHIST). There is also recognition in ICES, and from our clients, that it would be desirable to add economic metrics to ICES ecosystem overviews and better recognize people and their livelihoods as part of the ecosystem. |
| Resource requirements | The group will rely on ongoing international and national research projects with active involvement of WGECON members. The additional resources required to undertake additional activities in the framework of this group is negligible. |
| Participants | The Group is normally attended by some 20–30 members and guests. |
| Secretariat facilities | Standard support to EG. |
| Financial | No financial implications. |
| Linkages to ACOM and groups under ACOM | There are currently no linkages with ACOM, but the EG is working on providing standards for economic advice, on top of the biological advice, which should be relevant to ACOM. The EG will be ready to address advisory requests if these are forthcoming and possible to achieve with available efforts. |
| Linkages to other committees or groups | The subject area of this EG has close linkage with at least the following ICES groups: WGSOCIAL, WGMIXFISH, WGSEDA,WGIMM, WGSPA, WGSEDA, WGRMES, WGNARS, WGHIST, WGBESEO and the Strategic Initiative SIHD, as well as the ICES IEA groups. The working group has initiated strong cooperation and relationship with WGSOCIAL. |
| Linkages to other organizations | International Institute of Fisheries Economics and Trade (IIFET), North American Association, of Fisheries Economists (NAAFE), European Association of Fisheries Economists (EAFE), EU Scientific, Technical and Economic Committee for Fisheries (STECF), Food and Agriculture Organisation of the United Nations (FAO), Organisation for Economic Cooperation and Development (OECD). |

# Annex 3: RBM completed case studies

## A3.1 Danish demersal fishery (Rasmus Nielsen)

### Program objectives and development

**What was the biological and economic status of the fishery in the years prior to the RBFM program?**

The Danish demersal fishery targets a wide range of species for human consumption; the most important being Atlantic cod (Gadus morhua), Norway lobster (Nephorps norvegieus), European plaice (*Pleuronectes platessa*), and saithe (*Pollachius virens*). The demersal species are primarily caught in waters close to Denmark, i.e. the Baltic Sea (ICES area 3BCD), the North Sea (ICES area 4ABC), Skagerrak (ICES area 3AN) and Kattegat (ICES area 3AS). A majority of the Danish fleet lands demersal species. The economic importance of these catches are most essential to vessels below 24 meters. The vessels catching demersal species use several gear types including gillnets, Danish seines and various types of trawl.

The Common Fisheries Policy (CFP) defines the overall framework for management of Danish fisheries, being an EU Member state. One of the main regulatory elements of the CFP is the establishment of total allowable catches (TAC), which allocate a portion of a specific species catch by area to Member States based on the principle of relative stability originating from historical catch levels. The biological assessment of the stocks of demersal species is undertaken by the International Council for the Exploration of the Sea (ICES). Based on this, the EU Commission and the EU Council of Ministers in conjunction with other countries determines the final TAC for a species in a particular area. Another prominent element of the CFP is an overall capacity ceiling for the national fleets in order to prevent their overexpansion. Strict entry restrictions have been imposed to ensure Member States comply with these limits. A system of effort controls based on days at sea was introduced in 2003 with recovery plans for depleted stocks. The effort controls have since been changed to a scheme of transferable kilowatt days. Finally, a range of input controls, such as mesh sizes and minimum landings sizes, regulate the behavior of the European fleets.

Prior to 2007, national regulation of the vessels included in the Vessel Quota Share (VQS) system was based primarily on two directives: 1) the Regulation Directive (Directive no. 1028 of 11 December 2003) determining quota limitations etc., and 2) the Capacity Directive (Directive no. 124 of 27 February 2004) determining the rules for fishing vessels. The code of practice was based on a number of EU directives on regulation of the fisheries, including the regulations on resource management (Regulation no. 2371/02 of 20 December 2002, EØF-Tidende no. L. 358 of 31/12/2002), on fleet management (Regulation no. 1434/03 of 12. August 2003, EØF-Tidende no. L. 203 of 12/08/2003) and on technical regulations (Regulation no. 850/98 of 30. March 1998, EØF-Tidende no. L. 125 of 27/4/1998. See report 176 "Forvaltning af det danske konsumfiskeri (In Danish)" (2005) and report 193 "Report on the Faroese Fisheries Regulation – The Faroe Model" (2007) published by the Institute of Food and Resource Economics).

Fishing was governed by a series of regulatory measures, which could be divided into four main groups: (1) Quota restrictions, (2) Effort restrictions, (3) Technical measures, and (4) Capacity restrictions. Below, the quota and effort restrictions are described in more detail, the former representing the eventual backbone of the current RBM system.

The quota regulations in the Regulation Directive were changed from year to year according to the annual EU quota assessment. In addition, the detailed stipulation of catch possibilities was changed during the year through the so-called 'annex 6 information' determining cessation of fishing, as well as changes in the allocation of catch amounts dependent on how the fishery developed throughout the year. Among other things, changes could be made concerning the following:

1. Available catch amounts for certain periods,
2. Rations or number of days-at-sea, etc. in certain specified fisheries,
3. Transition to demand of permission in certain fisheries,
4. Requirement that fisheries be limited to further specified types or groups of vessels,
5. Requirement that landings take place under certain conditions, including specific geographic areas,
6. Use of catch,
7. Suspension of certain specific fisheries,
8. Demand that landings in a period are limited as part of a fishing plan which should balance landed amounts to the current market demand, and
9. Changed terms for permits already issued.

Hence, the basis for regulation of the fisheries was very comprehensive. There were provisions that applied to all nine areas, but the provisions regarding the available catch (item 1 above) and rations of days-at-sea (item 2 above) most directly controlled fishery compliance with the quotas determined at the EU level.

The right to target the most 'exploited' species required a license for that specific fishery, as was the case for most target species; while catching those species, which were of less economic importance and primarily caught as bycatch, often did not require a license. Quota restrictions were divided into three levels: (1) Species, (2) Areas, and (3) Vessels.

Effort restrictions in the form of days-at-sea were adopted as part of the restoration measures for cod in 2003. The regulation applied to vessels of 10 m and above fishing in the North Sea, Skagerrak, Kattegat, the waters west of Scotland, the eastern part of the English Channel, and the Irish Sea. Days-at-sea were allocated to each vessel depending on the type of fishing gear used. The system has since been adjusted several times and is currently based on a scheme of transferable kilowatt days, but the vessels fishing for demersal species have been subject to effort limitations before and after implementation of the VQS system.

Generally, the effort limitations have only been limiting in a few instances, primarily in Kattegat. Changes in fishing behaviour, the possibility to transfer days-at-sea between vessels and an overall total number of days sufficient to catch the EU quota are considered to have been the reason for this.

**What were the RBFM program objectives?**

In the end of the 1990's and beginning of 2000's the Danish fishing fleet was generating poor or even negative economic profits (Danish account statistics for fishery) being too many fishers fishing on decreasing stocks. This resulted in bankruptcies in the sector. To adjust the fleet, buyback programs and decommissioning schemes were established in order to help the fishers and reduce overcapacity.

The transition in Denmark towards using Individual Transferable Quotas (ITQs) began with a parliament decision (V117) on the 16th May 2001. Starting with the pelagic fleet fishing herring, mackerel and fish for reduction in 2003 and 2004. The aim was to establish a management system that provided for the possibility of longer term economic stability in the fishery and to structurally reduce fleet capacity.

The objectives of the VQS system set out in the political agreement of 3rd November 2005 were to:

- Facilitate that the individual fisher has opportunity to conduct a fishery suitable to his vessel and fishing methods (i.e. to enable business related decisions, such as acquiring a suitable quota portfolio that best matches their fishing strategy);
- Secure the total level of earnings from the fishery; and
- Develop and implement a management system, which results in a more sustainable utilization of the fish stocks, primarily by reducing discarding of fish.

The corollary of this statement is that these objectives were not being met at the time.

**What were the key provisions of the program (e.g. eligibility, qualification for allocation, transferability)?**

On the 1st January 2007, RBM was implemented in the demersal fishery in form of individual Vessel Quota Shares (VQS) covering the 28 most important quotas. The VQS were given to the fishers free of charge (i.e. the grandfathering method), and each vessel was allocated a share based on their landings in the reference period 2003-2005, providing they had a level of activity generating more than 230,000 DKK in landings value each year in that period.

The VQS distributes the Danish national catch limits for the species included in the system (e.g. demersal species) among the vessels holding a share of the catch for those species. The catch share (a fixed percentage) persists from year to year, but the annual quota allocation defines the absolute weight each vessel is allowed to land during a given year. Permanent (sale) of temporary (annual lease) transfers can be made between vessels holding a share. Individual vessel quota shares are not reduced over time unless traded, but the overall Danish catch quotas (TACs) of which the shares are part can of course change annually, which creates some insecurity.

The ITQ system can be terminated with a running eight-year notice based on a parliamentary decision. This eight-year notice is generally perceived as being a long enough time horizon for fishers to plan their business. After a later revision (2016 December), the ITQ system is now running with a sixteen-year notice based on a parliamentary decision.

The VQS system is in principle an ITQ system. The individual rights are tradable and can be sold, leased or rented out for shorter or longer periods of time. Each owner may only possess a certain amount of different quotas to avoid concentration on a few vessels/owners. However, there is no limitation regarding to whom you may sell the quota to (size of vessel or gear type etc.) as long as they are registered as a professional Danish fisher.

There are three basic requirements for being registered as a professional fisher in Denmark; these include:

1. Danish citizenship or residency in Denmark for at least two years before being registered;
2. Employment on a Danish fishing vessel for at least 12 months before being registered; and
3. At least 60 % of the gross income in the previous 12 months must originate from fishing.

## Economic analysis for implementation

**What, if any economic analysis or economic models were used at the time of first implementation?**

Prior to the implementation of the VQS, the consequences of implementing such a system in the Danish fisheries was discussed and analysed by the Institute of food and resource economics

(Løkkegaard *et al*., 2001 (in Danish). The report was drawing on experiences from other countries introducing ITQ systems as a fisheries regulation tool in Europe Island, Holland, Norway, United Kingdom and other international fisheries in Australia, Canada, New Zealand and USA.

**What economic data were available at the time of first implementation and how was the data used?**

The Danish account statistics for Fishery was established in 1995. This statistic provides a detailed economic picture of the fishing sector in Denmark. The statistics could be divided on areas, fishing gear, size of vessels, catches etc. This statistic was the foundation for several economic studies of the sector, before the introduction of ITQ.

Data available to further support economic analysis was two databases: 1) The Danish vessel register containing all Danish fishing vessels and trip reports including crew size, gear, engine power, area fished, homeport, and other vessel characteristics. 2) The landing and sales register where all landing and first sales volume and value are registered. It is mandatory to deliver this information to the authority.

## New data and economic models post-implementation

**Were any new economic data collected after the RBFM program was implemented? If so, what data were collected?**

There have been no new data collection after the implementation, however, the effect of the introduction have been analysed both prior and post the implementation in papers (Andersen and Bogetoft, 2007; Merayo *et al*., 2018).

Table A.2.1 shows the commercial vessels (a commercial vessel is defined as a vessel with a yearly minimum total landing value above a certain threshold provided by Statistics Denmark) in Denmark, which catches more than 95% of the value of the VQS for demersal species. For this subset of vessels, the reduction is happening very fast from 959 vessels 1st January 2007 to 575 vessels by the 31st December 2011 (a reduction of 40%).

**Table A3.1 Commercial vessels with VQS of demersal species 2007-2011 (Source: The Danish AgriFish Agency).**

| Vessel Category | 1/1-2007 | 31/12-2007 | 31/12-2008 | 31/12-2009 | 31/12-2010 | 31/12-2011 |
|---|---|---|---|---|---|---|
| <12m | 335 | 257 | 205 | 170 | 164 | 172 |
| 12-15m | 225 | 168 | 162 | 151 | 150 | 124 |
| 15-18m | 132 | 94 | 93 | 97 | 97 | 95 |
| 18-24m | 115 | 89 | 83 | 79 | 76 | 73 |
| 24-40m | 91 | 63 | 55 | 46 | 45 | 47 |
| >40m | 31 | 31 | 24 | 26 | 25 | 24 |
| Specialised fisheries | 30 | 33 | 45 | 38 | 44 | 40 |
| Total | 959 | 735 | 667 | 607 | 601 | 575 |

**Were any new economic models developed post-implementation?**

There have not been any new models developed for analysing the effects of the introduction of the VQS post implementation. However, there have been several statistical evaluations/analysis made for the ministry of fishery, providing a statistical overview of the development regarding vessels, employment, catches including economic key figures: Costs, income, GVA, net profit and tangible and intangible goods etc.

## Program changes since implementation

**If any, what were the key changes in the RBFM program post-implementation?**

The development of a coastal fisheries scheme was included in the VQS system to protect the small-scale fishery, which supports activity in small harbours and local communities. In order to make the scheme attractive, vessels were given extra allocation of cod and sole. Only vessels below 17 m with at least 80% of their trips being under 3 days were eligible to enter the coastal fisheries scheme.

This arrangement have been changes several times since the introduction. One reason for this was that the scheme was limited to a 3-year period after which the fishers could step out and sell the quota like any other fisher in Denmark. In the latest version of the scheme, coastal fishers cannot leave the scheme and sell their quota to vessels outside the coastal scheme. This means that the quota stays within the small-scale segment and therefore secures that small-scale fishing can survive (Nielsen *et al.*, 2021; Hoff *et al.*, 2021; Nielsen *et al.*, 2018).

## Lesson learned

From an overall perspective, the Danish implementation of the VQS for demersal species is regarded as a success. The demersal fishery and thus the VQS system cover a range of different vessels sizes and gear types. The VQS system has given rise to adjustments in the fleet structure and the available data indicate that the economic performance has improved compared to previous years.

- The system has managed to adjust capacity
- The adjustment of capacity happened fast and the adjustment continues
- Economic result has improved overall, especially for larger vessels
- Economic improvements for small vessels are less evident
- The value seems to be accumulated in the quota shares and not necessarily in increasing profit.
- Investment in new vessels follows after some time
- There has been a concentration of quotas
- Entrance to the fishery is harder due to large cost of quota shares
- Grandfathering gives fishers that are in the fishery at the time when quotas are allocated an advantage compared to “new” fishers coming in that need to invest in quota shares
- Employment has decreased, but crew sizes have increased
- Safety on board has been improved

**What are the key lessons learned?**

The objectives of the VQS system introduced in January 2007 were to secure the economic income from the fishery by facilitating structural adjustments and thereby making fishing an economically viable activity. Based on the data provided on performance indicators, individual vessel

revenue has increased, fleet diversity has been maintained, and, although overall employment has fallen, average crew wages seem to have risen.

Before 2007, the management system in the demersal fishery was primarily based on time-limited rations and capacity restrictions. The demersal fleet had gradually been reduced before the VQS system, but further adjustments occurred following the introduction of the new system. This led to an increase in the average vessel size and average revenue per vessel. The economic performance and crew payments per vessel seem to have increased to a higher level. However, given the variation in vessel sizes, there may be some different perceptions of this general conclusion at the individual level.

In order to give the demersal fishers flexibility in their decision-making, the VQS system includes the possibility for vessels to form a pool. Within the pool system, fishers can exchange quota amounts without restrictions and can more easily adjust their holdings to match their requirements and/or their catch performance.

The development of a coastal fisheries scheme was included in the VQS system to protect the small-scale fishery, which supports activity in small harbours and local communities. In order to make the scheme attractive, vessels were given extra allocation of cod and sole. Only vessels below 17 m with at least 80% of their trips being under 3 days were eligible to enter the coastal fisheries scheme. Based on the development in the number of commercial small-scale vessels in the coastal fisheries scheme and their holdings of vessel quota shares, the scheme seems to some extend have secured this component of the fishery. However, the flexibility of stepping out after 3 three years has contributed to decreasing quota shares in the segment. The newest coastal fisheries schemes, therefore, does not allows fishers to step out, which should secure that quotas are kept within the small-scale fisheries vessels.

An unintended positive effect of the VQS has been that the removal of the overcapacity also have reduced the fuel use and thereby the carbon footprint from fisheries (Merayo et al., 2018). Furthermore, fewer vessels also reduces effects of bottom trawling on the seabed (Merayo et al., 2018). Finally, safety on board seems to have improved, according to data on the number of incidents. The number of at-sea accidents was already falling prior to the introduction of the VQS, but the freedom to conduct fishery activities when conditions are most suitable (e.g. in relation to weather) under the VSQ is considered to be one of the drivers behind a continued decline since 2007.

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# A3.2 Danish pelagic fishery (Vivianne Mazzocco, Rasmus Nielsen)

## Program objectives and development

**What was the biological and economic status of the fishery in the years prior to the RBFM program?**

The Danish pelagic fishery targets mackerel and herring for human consumption and various other species for the production of fishmeal and fishoil (e.g. sandeel, sprat, Norway pout, horse mackerel, blue whiting and capelin). This latter "reduction" fishery is conducted mainly by vessels from Denmark, but mackerel and herring are targeted also by vessels from other EU member states around the Baltic Sea and North Sea, as well as vessels from outside the EU, including those from Norway, the Faroe Islands, and Iceland. The North Sea, in particular, has been an important area for herring catches as well as for reduction species.

Vessels that were mainly fishing for herring and mackerel (purse-seiners) were already doing well economically before ITQs were introduced in 2003. However, more general overcapacity and stock depletion, along with poor economic performance in other fisheries, were considered to be so problematic that managers determined that a fundamental change in the management system was necessary. In 2001, the government made a decision to establish an ITQ-based management system, despite strong opposition from Danish fishers.

Prior to the implementation of ITQs, the Danish pelagic fishery observed the same framework of overall TAC, capacity restrictions, and technical measures set at the EU-level. The fishery was generally managed through individual catch rations allocated to fishers to be taken within a fixed period. All vessels could apply for a ration for any fishery within which they wanted to participate. However, the total number of vessels in the pelagic fleet was already falling before introducing the ITQ system.

**What were the RBFM program objectives?**

The transition in Denmark towards using Transferable Fishing Concessions (TFC) in the form of Individual Transferable Quotas (ITQs) began with a parliament decision (V117) on the 16th May 2001. The aim was to establish a management system that provided for the possibility of longer term economic stability in the fishery and for a structural development to reduce fleet capacity and give the possibility for renewal. One of the primary reasons for implementing the ITQ system was the need to focus on the economic performance and thus economic viability of the pelagic fleet.

The ITQ system can be terminated with a running eight-year notice based on a parliamentary decision. This eight-year notice is generally perceived as being a long enough time horizon for fishers to plan their business. After a later revision (2016 December), the ITQ system is now running with a sixteen-year notice based on a parliamentary decision.

**What were the key provisions of the program (e.g. eligibility, qualification for allocation, transferability)?**

On January 1, 2003, the Danish government introduced an ITQ Program for the Danish herring fishery. In 2004, a voluntary program covering mackerel and some species for reduction was introduced. Finally, in 2007, the system was fully extended to cover all pelagic species including mackerel, horse mackerel, sprat, Norway pout, sandeel, and blue whiting. Rather than auctioned or sold, the rights were given to fishers, allocated through a grandfathering method based on historical participation between 2000 and 2002. The pelagic vessels targeting herring and other species are not regulated with any effort restrictions in form of days at sea.

The ITQ system distributes the Danish national catch limits for the species included in the system (e.g. herring, mackerel) among the vessels holding a share of the catch for those species. The catch share (a fixed percentage) persists from year to year, but the annual quota allocation defines the absolute weight each vessel is allowed to land during a given year. Permanent (sale) of temporary (annual lease) transfers can be made between vessels holding a share. Individual vessel quota shares are not reduced over time unless traded, but the overall Danish catch quotas (TACs) of which the shares are part can of course change annually, which creates some insecurity.

Permanent (sale) of temporary (annual lease) transfers can be made between vessels holding a share. During a year, a vessel can change the amount it is allowed to land by trading with other vessels owning the respective quotas; transferability is possible at two levels: 1) as a permanent transfer of quota shares between vessels, or 2) as an year transfer (lease) of vessel quotas between vessels. It is possible for a vessel to assign (lease) up to 20% of its annual allocation to be caught by other vessels in a given year.

Anyone that fulfils the general requirement for being a fisher and owns a vessel is eligible to buy quota shares from other fishers and apply them to his vessel in order to enter any fishery. Through a Fish Fund, one can also apply for additional allocations for a limited period. Although it is possible to receive an allocation from the Fund, these are limited and entry into the fishery still requires a large investment from the entrant. There are three basic requirements for being registered as a professional fisher in Denmark; these include:

1. Danish citizenship or residency in Denmark for at least two years before being registered;
2. Employment on a Danish fishing vessel for at least 12 months before being registered; and
3. At least 60 % of the gross income in the previous 12 months must originate from fishing.

At the start of each year, Denmark is allocated a quota for each pelagic species and management areas based on the agreed TACs at the EU level. Minor amounts of these quotas are set aside to support the development in the fishery in form of a Fish Fund, where for instance young fishers can apply for extra allocations. The remaining quota is distributed to the vessels that have the right to a percentage share of the individual quotas; this absolute weight of quota determines the initial level each vessel can land during a year. If vessels exceed their allocations, they have an opportunity within a limited period to purchase extra quota from other vessels.

The ITQs are subject to taxation as depreciation of the quotas at a maximum rate at 1/7 of the initial value per year, with exception for the initial grandfathered allocations. When the quotas are sold, the difference between the sales value and the depreciated value in the account is subject to taxation.

Other terms were put forth at the outset of the program. For example, a vessels' allocations of herring and mackerel were also affected by participation in other fisheries. Any vessel that participated in (1) the herring fishery for human consumption in the Baltic Sea, (2) the sprat fishery in the North Sea, or (3) the sandeel fishery in Norwegian zone had to "sign off" from the herring and mackerel fishery in the North Sea, Skagerrak and Kattegat. Larger vessels, which had the option of operating in these fisheries, were encouraged to remain in the herring and mackerel fishery, because "signing-off" would affect their future allocations. More specifically, the vessel's

individual quota for herring/mackerel would be reduced by 1/24 for every 15 days it participated in one of the three fisheries listed above.

For large vessels, the system could be considered to be a form of ITQ with limited security because they operated in pools (of up to seven vessels), within which transfers were allowed but the allocations were renewed each year. Vessel owners were able to apply for a change in allocation within a certain time limit if their participation in the fishery during the base years (considered for allocation rights) had taken place as a shared (pool) fishery. However, if one vessel within a pool fishery participated in the three aforementioned fisheries, all vessels within the pool were required to deposit their permits for the same period, implying that their quotas would also be reduced. This system was introduced to prevent fraud.

Further, a vessel was allowed to withdraw from a pool taking with it a quota allocation equal to a portion of the remaining quota in the pool based on the share (from the total pool quota) that the vessel had landed before it left. A redistribution of the withdrawing vessel's share to the remaining vessels in the pool was possible after application if all participating pool vessels accept.

Within the herring and mackerel fisheries specifically, eighty-five percent of the total herring and mackerel quotas were allocated for the year; the remaining 15% were set aside for monthly rations. The size of the annual allocation of herring and mackerel quota provided to a vessel was based on a combination of that vessel's landings history over the previous three years and the vessel's length (which could change over time). Vessels were required to obtain a permit to fish for herring in the Kattegat and/or the Baltic Sea. When fishing for herring, fishing for other species was prohibited.

## Economic analysis for implementation

**What, if any economic analysis or economic models were used at the time of first implementation?**

Prior to the implementation of the VQS, the consequences of implementing such a system in the Danish fisheries was discussed and analysed by the Institute of Food and Resource Economics (Løkkegaard *et al.*, 2001; in Danish). The report was drawing on experiences from other countries introducing ITQ systems as a fisheries regulation tool in Europe Island, Holland, Norway, United Kingdom and other international fisheries in Australia, Canada, New Zealand and USA.

**What economic data were available at the time of first implementation and how was the data used?**

The Danish account statistics for Fishery was established in 1995. This statistic provides a detailed economic picture of the fishing sector in Denmark. The statistics could be divided on areas, fishing gear, size of vessels, catches etc. This statistic was the foundation for several economic studies of the sector, before the introduction of ITQ. However, the statistics do not allow for separation of herring, mackerel, and reduction species fleets prior to 2001.

More generally, large pelagic vessels are obligated to use electronic logbooks, which combined with sales slips provide detailed information about their activity. The Danish AgriFish Agency publishes how much each pelagic vessel owns of different quotas on their website.

At the time of ITQ introduction into Danish pelagic fisheries, no explicit economic goals were defined, for instance, as quantitative targets for increase in profits or reduction in capacity.

## New data and economic models post-implementation

**Were any new economic data collected after the RBFM program was implemented? If so, what data were collected?**

There is not any observed market and price formation for the ITQs in the pelagic fishery so it is not possible to assess in detail how the market value has changed over time. The market is less transparent because fishing rights often are transferred as packages consisting of various rights in combination with the tonnage and engine capacity. All transfers of quotas in quantity are registered on a publicly accessible website hosted by The Danish AgriFish Agency. However, an indication of prices of fishing rights in the herring and mackerel fisheries is calculated to be around € 1.5 per kilo of herring and around € 10 per kilo of mackerel (Ministry of Food, Agriculture and Fisheries. 2006). These prices are calculated by a "shadow price calculation", which indicates the present value of profit of an increased catch in the current year and each subsequent year with an investment horizon of 10 years. The estimate of the value of the right is obtained by multiplying these prices by the quotas.

There is also lack of detailed employment-related data in the pelagic fishery. For example, no official records exist to document whether the ITQ system has changed the employment structure towards more full-time jobs instead of part-time jobs. Furthermore, there has been no information about changes in salary structures.

**Were any new economic models developed post-implementation?**

There have not been any new models developed for analysing the effects of the introduction of the VQS post implementation. However, there have been several statistical evaluations/analysis made for the ministry of fishery, providing a statistical overview of the development of vessels, employment, catches including economic key figures: Costs, income, GVA, net profit and tangible and intangible goods etc.

## Program changes since implementation

**If any, what were the key changes in the RBFM program post-implementation?**

At the start of the ITQ program, there were some restrictions related to the transferability of shares and quotas depending on the amounts that were to be traded. More restrictions were later put in place for vessels allocated more than 100 tons of herring to prevent these vessels from expanding their fishing activity to target a number of other species. Vessels with quota greater than 200 tons were subject to the same restriction, but also could only participate in fisheries in which they had participated in 2001 and 2002. In addition, if a vessel transferred 500 tons or more of its quota, or at least 50% of its total quota shares if it had been allocated 1,000 tons or more, that vessel should, be withdrawn from the Danish fishing fleet. The limitations of the transfer thus became progressively more stringent relative to the allocated amount. However, many of these restrictions have since been removed, because after some years they were considered to just incur cost to the fishers without providing any benefits.

Prior to 2007, if a vessel had transferred its allocated quota shares and retired from the fishing fleet, its capacity (kW and GT) could be reused by the fisher (that received the share) or provided to another fisher under the general rules of the legal notice for vessels used for commercial fishing (Capacity Order). These limitations were strict with respect to how the excess capacity from the ITQ fisheries could be used but were removed in 2007 with the extension of ITQs to include the remaining of the pelagic species. Currently the only concentration limitations are applied together with the overall capacity restrictions. These rules specify that a vessel can be enlarged

or have a larger engine only if correspondent GT and kW is purchased from vessels that are removed from the fleet (i.e. deleted from the Vessel Register maintained by the authorities). A revision of ITQ system in 2007, which covered all quotas for herring, mackerel and the reduction species, allowed fishers with economic problems to sell their shares and leave the fishery without a huge debt.

In April 2012, new regulations addressing the concentration of ITQs at the vessel- and owner-level were implemented, because the ministry, as well as the fishing organizations, considered the unwanted concentration of quotas at the individual vessel and owner level to be limiting the transfer of quotas between vessels reduced the effective functioning of the ITQ system. The proposed limits now vary with quotas types. For instance with sandeel quotas in the North Sea, an owner or vessel can accumulate a maximum share of 10%; for sprat in the Baltic Sea, ownership is a maximum of 15%

The biomass of mackerel and herring has generally fluctuated substantially between years; leading to changes in overall TACs agreed by the Council and hence available national quotas. These fluctuations are influenced by a range of factors including food availability, poor recruitment, and overfishing in some cases. Because reduction species are short-lived compared to most other commercial fish species, this has led to abrupt changes in TAC levels in order to keep the stocks within safe biological limits.

## Lessons learned

**What are the key lessons learned?**

From an overall perspective, the Danish implementation of the ITQ system for mackerel, herring and reduction species has been considered as a success. Since 2003, available quota has been spread across fewer vessels, resulting in an increase in average revenue per vessel. However, not all change has had positive effect. Adjustments have resulted in a capacity reduction driven by the ITQ program in conjunction with reduced catch opportunities for the reduction fishery, particularly for sandeel. The economic performance for vessels dependent on reduction species (e.g. herring and mackerel) therefore have worsened since the introduction of ITQs, probably due to the decline in the fishery for reduction purposes.

Besides more general patterns of improved economic performance, crew payments to the fishers remaining in the fishery have increased, and safety on board seems to have improved, according to data on the number of incidents. The number of at-sea accidents was already falling prior to the introduction of the ITQ system, but the freedom to conduct fishery activities when conditions are most suitable (e.g. in relation to weather) under the ITQ system is considered to be one of the drivers behind a continued decline since 2003.

At the time of the implementation of ITQs in the herring fishery, on the 1st January 2003, there were 3,825 fishing vessels registered in Denmark, of which 1,325 were considered to be commercial, having an annual catch value in 2002 above DKK 219,202 (approx. € 30,000). 95 of the total registered vessels (approximately 2.5%) initially qualified for the ITQ system, and nearly half of these were greater than 24 m in length. The larger vessels (> 24 m) held the majority of the quota shares of herring when ITQs were implemented; and the numbers of vessels holding shares reduced in subsequent years. There have been major changes in quota ownership for vessels over 24 meters. Specifically in vessels between 24 and 40 meters, nearly all vessels have left the herring fishery, with only 5 (in 2006) of the original 35 (2003) still in the fleet. Similarly, in the 18 to 24 meters category there was a reduction from 9 to 2 vessels that still had quota shares of herring

over the same period. As of 1st January 2012, the fleet consisted of 34 vessels with ITQs for herring, suggesting a significant slowdown in capacity reduction compared to the first three years.

The reduction in fleet numbers has also resulted in a reduction in the total tonnage and engine power of the pelagic fleet. However, the average size of the remaining vessels has increased. The ITQ system has given fishers new incentives to optimize the utilization of their vessel. This has also led to specialisation. The concentration on fewer, larger and more effective vessels means that fewer people can be employed without also reducing the landing.

The species targeted for reduction purposes are often short-lived and characterized by significant fluctuations in recruitment, and hence quotas. The decline in these quotas since 2003 have affected the ITQ fleet negatively and incited fishers to withdraw. Variations in the status of different fish stocks targeted by the pelagic fleet make it very difficult to reach any firm conclusions about the ecological performance of the fishery arising from the implementation of ITQs. However, in general, both the mackerel and herring quotas are almost entirely utilized and this does not seem to have changed significantly following the introduction of the ITQ system.

The price for the various species used to produce fishmeal and fishoil generally fluctuate together, while mackerel and herring prices change without any relation to each other. Therefore, it is not straightforward to see an effect from introducing the ITQ system on market supply and the average price of these species. Nevertheless, there has been a substantial increase in the price of fish landed by the pelagic fleet since the introduction of ITQs for herring, particularly in the last few years, but this is not necessarily been driven by the system.

Various fishery-independent externalities (e.g. the fuel price) may to some (unknown) extent have influenced the development of the pelagic fleet, however the implementation of a management system based on ITQs has generally been considered to be the major driver in the structural development of the fishery over the last ten years.

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## A3.3 Quota Management Program of anchovy fishery in ICES IXa South (Juan José García-del-Hoyo, David Castilla-Espino)

There are two anchovy stocks in IXa ICES region: Western and Southern stocks. The former involves ICES IXa North (Galicia), IXa Central-North (Portugal) and IXa Central-South (Portugal); while the latter involves ICES IXa South including Algarve (South of Portugal) and The Gulf of Cádiz (Southwest of Spain). Most of anchovy stock in IXa South is concentrated in the Gulf of Cádiz. The anchovy (*Engraulis encrasicolus*) fishery of the ICES IXa South region that is currently exploited by purse-seiner based in the Gulf of Cádiz (Southwest of Spain) is the one analysed here. The shape of IXa ICES region is shown in Figure A3.1.

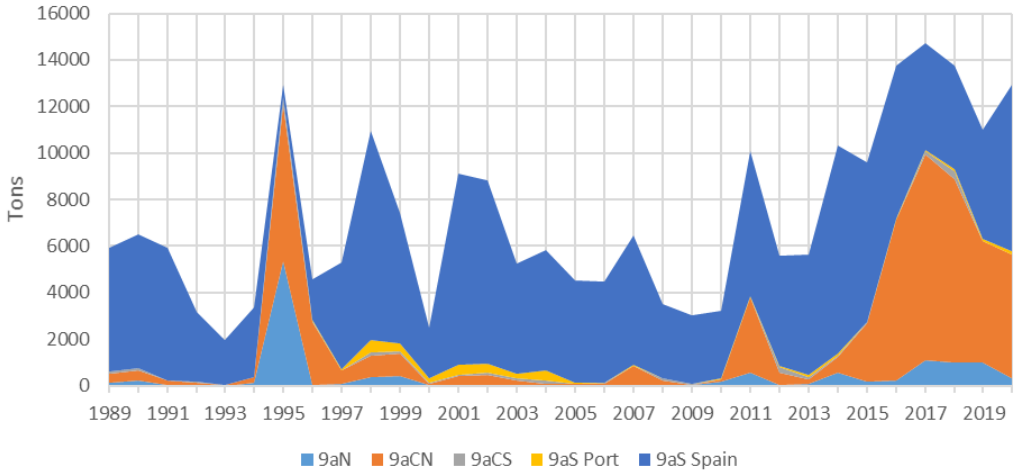


**Figure. A3.1. Evolution of anchovy catches in ICES Division 9a by subdivision (1989-2020). (Includes dis-cards).**

The management of this fishery has been developed in different stages since its origins in 1888:

- Input controls (1888-1985).

Purse-seiner based in the Gulf of Cadiz mainly target sardine for canning industry until de 60's when anchovy demand increased turning progressively the target to be the latter fish species due to price increase until it was 4 times sardine price in 1985. There wasn't a specific regulation for the fishery, and the management mainly consisted of technical measures that set the mesh size, minimum anchovy size; and minimum distance between operating vessels until 1984 when also included the characteristic of the fishing gear, a 48 hour closure per-week, and the minimum tonnage of vessels. Additionally, there was a general rule that limited fishing effort of all Spanish fisheries that were under the Maximum Sustainable Yield (MSY) capture level and the first census of the fleet was published in the framework of limited license program in 1985. However, this limited license program didn't involve vessels smaller than 20 GRT and included vessels that also fished in Morocco waters in certain periods of the season, making very difficult distinguishing IXa South landings from those from other regions. These difficulties have persisted until 2000.

- Input and output control (1986-2003).

The integration of Spain in the EU introduced significant changes in the regulation that combined fishing effort controls in the framework of a limited license program and output controls aimed at blocking fishers' incentives through Total Allowable Catch (TAC) set by the EU based upon ICES advice. TACs set for IXa South during first two seasons were not based upon ICES scientific advice that didn't evaluate this fish stock until 1993, however they defined the share of the stock for Spain (47.83%) and Portugal (52.17%) that continue nowadays according to the principle of relative stability despite the evidence that Spanish share should be significantly higher (Anchovy capture of the purse-seine fleet based in the ports of Huelva and Sanlúcar de Barrameda (Gulf of Cádiz, Spain) was of 7,241 T, while whole Portugal fleet landed 3,146 T in period 1982-1986).. This caused that most of the IXa South TAC of Portugal is sold to Spain.

- Fishery management plans (2004-2014).

Anchovy fishery of the IXa South region was first subject to specific regulation in 2004 when first fishery management plan for the fishery exploited by vessel based in the ports of the Gulf of Cádiz begun to be implemented. Seven successive plans that lasted between 1 and 2 years were implemented in this period that finalized with a management plan in 2013 that also allocated quotas of the TAC per port. These plans were aimed at biological sustainability including a whole set of technical measures, input controls and the implementation of the TACs set by the EU. Additionally, the plan implemented from 2007 also included Pigouvian incentives to exit the fishery aimed at adjusting the fishing capacity of the purse-seine fleet of the Gulf of Cádiz funded by EU structural funds.

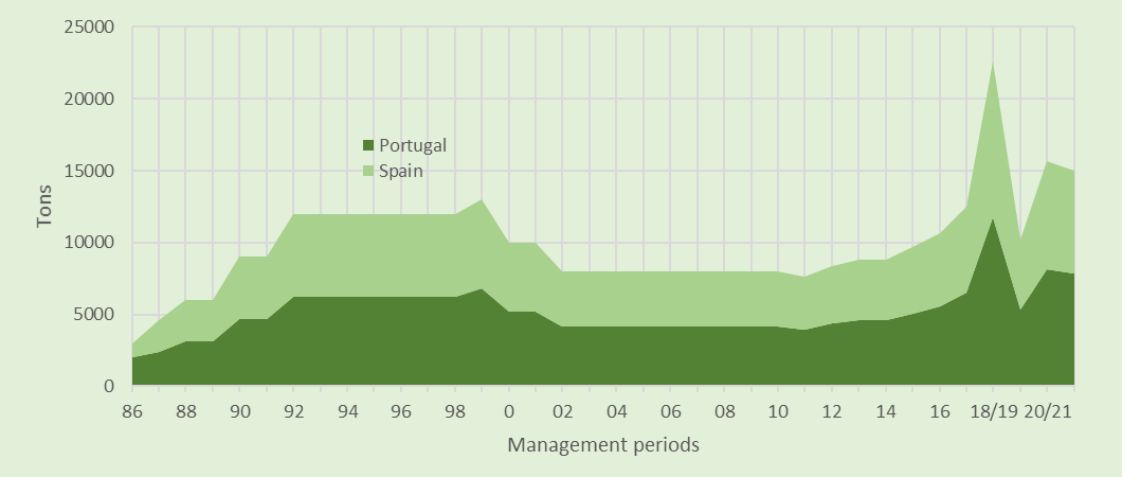


**Figure A3.2. Evolution of the TAC for anchovies in ICES subdivisión IXa South and initial country quo-tas (1986-2022). (TAC of period 2018/2019 includes 18 months).**

The anchovy fishery of IXa South exploited by the purse-seine fleet of the Gulf of Cádiz ended of period 1888-2013 at levels of exploitation that are considered sustainable according ICES assessment (ICES, 2020). At this point, an individual quota management system has been implemented in the fishery in the framework of two fishery management plans that main characteristic are explained in the following bullets:

- Individual Quota (IQ) Management System (2015-2017).

The management of the fishery during this period includes main technical and input controls posed in place previously for the fishery but output controls to adjust fishers' incentives to catch through Individual fishing quotas. This management plan is aimed at socio-economic sustainability according Spanish and EU rules; however, the sustainability of the TAC is based on biological reference points in the framework of ICES advice.

Quota share is allocated to vessels that are in limited license program at the date of the implementation and allocate partly lineally (30%) and partly according to historical landings in period 2005-2013 (70%).

The quota can be managed individually or by fishers associations, so at first implementation of the program 5 associations and 20 vessels in 2015.

Quota wasn't transferable neither temporally nor definitive, unless a vessel renew or exit the fishery. In the case that the vessel exits the fishery the quota share is allocated to the whole fleet

according to previous allocation of quota. 10% excess or defect of quota use is transferred to the next period according to the principle of flexibility.

- Individual Transferable Quota (ITQ) Management system (2018-).

A new management framework for the anchovy fishery of the ICES IXa South exploited by the purse-seine fleet located in the Gulf of Cádiz is set since 2018. This new framework responds to the necessity of define individual quotas of sardine (*Sardina pilchardus*).to avoid early closure of the fishery.

Main changes consist of setting a quota share of sardine that is allocated to vessels that are in limited license program at the date of the implementation and allocate partly inversely proportional to anchovy quota share (20%), partly depending on the employment certified by the fish owner (10%), and partly according to historical landings in period 2005-2013 (70%). Sardine and anchovy quota is tradable according to this program.

There have not been specific economic models for the implementation and post-implementation of the individual quota management program that mainly set the allocation of quotas according to historical landings. Additionally, there isn't evidence that the rest of management measure post in place respond to criteria different from biological. However, main technical and socio-economic variables together with Location and Track System for Andalusian Fishing Vessels (SLSEPA) were available at the implementation of individual fishing program.

Nonetheless, there has been published a little number of technical and scientific studies with economic background pre- and post-implementation of the quota program related to this fishery that have not been used, unless directly, as basis to define the details. Among them, it can be highlighted satellite and economic accounts of the fishing sector published by Andalusia (South of Spain) regional government (www.juntadeandalucia.es), García-del-Hoyo (1997) that use dynamic optimization methods to reference points for the management of the fishery accounting for socio-economic information, García-del-Hoyo *et al.* (2004) that insight in technical efficiency of this fishery using parametric techniques, , Cordón Lagares *et al.* (2016) that insight in the determinants that affect the exit decisions of vessels in the Spanish small-scale purse-seine fishery, Rincón *et al.* (2016) that insight on the use of insurance to cope with risk associated to fishing activity, or Ruiz *et al.* (2017) which o assess the biological and economic consequences of an individual quota management framework enveloped by a fixed Total Allowable Catch (TAC).

It is worth nothing, regarding the information available of the fishery during the ITQ program, that there is only information systematically gathered of quota transfer for control purposes, but no related to price what could allow to implement a whole set of economic models based upon financial economics.

## Lessons learned

There is a need for the exploitation of socio-economic information of the fleet to improve the management of the fishery.

The integration of spatial information for the management of the fishery aimed at the implementation of an ecosystem approach to fisheries management.

It is necessary to consider the mixed nature of the fishery so that sardine must also be under quota program to avoid early closure of the fishery.

It is necessary to gather systematically price and sale conditions of quota transfer to provide further analysis of the implementation of the quota management program.

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# A3.4 Northeast US Multispecies Sector Allocation (Eric Thunberg)

## Program development and objectives

The groundfish fishery in the Northeast US is managed by the New England Fishery Management Council (NEFMC) under the Northeast Multispecies Fishery Management Plan, hereafter referred to as the Groundfish plan. The primary managed species under the Groundfish plan include cod, haddock, pollock, white hake, Acadian redfish, winter flounder, witch flounder, American plaice, yellowtail flounder, and windowpane flounder (Managed species also includes the so-called "small mesh" species silver hake, offshore hake and red hake as well as Atlantic halibut, wolfish, and ocean pout. These species are not included in the sector allocation program and are not further discussed). From 1994 to 2010 the Northeast groundfish fishery was managed using a combination of direct and indirect effort controls including limits on days-at-sea (DAS), area closures, trip limits, and gear restrictions with a target TAC (TTAC). The TTAC for each species was set based on stock assessments and estimated catch from the previous fishing year but was not used to end fishing in-season if a target (TTAC) for any species was exceeded. Rather, adjustments were made to the suite of effort controls to reduce effort for the following fishing year. This system was unable to make sufficient adjustments to effort controls to meet conservation requirements leading to TTAC overages for Gulf of Maine and Georges Bank cod that were 2-3 times higher than their TTAC over the 5-year period from 1997 to 2001. The magnitude of these overages led to litigation against the National Marine Fisheries Service (NMFS), which ultimately resulted in implementation of Amendment 13 to the Groundfish Plan in 2004 (see Thunberg and Lee, 2014, for a more detailed evaluation of the groundfish effort control program). (Although the NMFS is responsible for approving and implementation of management measures recommended by the Councils, NMFS is in the Department of Commerce so it is the Secretary of Commerce that is the named defendant in any fisheries-related litigation under US law).

Amendment 13 was notable because it made fundamental changes to DAS allocations, introduced leasing of DAS, and most importantly, for this case study, implemented the option for voluntary groups of fishers to request a sector allocation. Under Amendment 13 a sector would be able to request exemptions from regulations in return for accepting a hard TAC that was based on the combined shares of sector members. As long as the sector's TAC was not exceeded the sector's quota would not be reduced in the following year in the event that the fishery-wide TTAC was exceeded. Furthermore, a sector could request an allocation for only one stock or for multiple stocks. This meant that sectors still had to abide by DAS and other effort control regulations when fishing for species that they were not allocated. Ultimately only two sectors (Georges Bank Cod Hook Sector and Georges Bank Cod Gillnet Sector) operated between 2004 and 2010.

While the Amendment 13 modifications to DAS allocations and other indirect effort controls were better aligned with annual TTACs overfishing was continuing to occur, which led the NEFMC to initiate development of an amendment to the Groundfish Plan during 2006. Concurrent to the NEFMC's scoping process the reauthorized MSA contained two key provisions that influenced the Council's decision to adopt Sector Allocation as its preferred alternative. First, an annual catch limit (ACL) and accountability measure (AM) had to be specified for all federally managed stocks, which had to be specified by 2010 for any stocks in a rebuilding plan, which was the case for most stocks in the Groundfish Plan. Second, the Limited Access Privilege Program (LAPP) provisions of the Act (the MSA defines any program that allocates a quantity of fish based on a percentage of catch to an individual as an LAPP, which means that the program is required to establish excessive share, cost recovery, and program review within five years post-implementation) required a referendum with a 2/3 majority vote for any individual quota program considered by the NEFMC where voting eligibility included holders of groundfish permits and any crew that earned a substantial part of their income from groundfish. (The referendum requirement applied only to individual quota programs developed by either the Gulf of Mexico Fishery Management Council or the NEFMC. Extending voting eligibility to crew was only required of the NEFMC). The coupling of the ACL and AM requirement meant the NEFMC needed to shift from an input to an output based management program with in-season accountability while the referendum requirement removed any IQ program from any serious consideration. Sector Allocation had already been implemented in 2004 and was exempted from the referendum requirement so it was seen as the only viable alternative for what became Amendment 16 in 2010.

The stated objectives for the Sector Allocation program included rebuilding of groundfish stocks as well as the following

- To address bycatch issues
- Simplify management
- Give industry greater control over their own fate
- Provide a mechanizm for economics to shape the fleet rather than regulations (while working to achieve fishing and biomass targets)
- Prevent excessive consolidation that would eliminate the day boat fishery

**Sector Allocation Program Provisions**

Upon implementation the key elements of the Sector Allocation program included establishment and formation of each Sector, qualification for sector contribution share by stock for each permit, trading, and catch accounting. Since establishment and membership in a Sector is voluntary, individuals that do not enroll in a Sector may continue to fish in the so-called Common Pool under the effort control regulations but remain subject to an ACL with in-season adjustments or closures.

Sector Formation - Any group of limited access groundfish permit holders may propose a sector to be approved by the NEFMC. Sectors must be comprised of at least three unaffiliated members

but are otherwise unlimited in size. Sector members must sign a joint and severable contract, which holds Sector members accountable for actions taken by one member that adversely affects other members. This requirement also means that Sector members may select who may be allowed to join a particular Sector. In addition to these general membership provisions each Sector is required to submit an operating plan that includes general operating rules and:

i. rosters of all named members and all permitted vessels owned by each member
ii. plan for reporting sector landings to NMFS
iii. requests for any Sector-specific exemptions from regulations
iv. describe how Sector quota will be distributed among members
v. identify how Sector quota will be fished or whether the Sector will be lease-only
vi. plan for reporting inter-sector quota trades and
vii. Sector-specific rules or limitations for inter-sector trading

The duration of each Sector is for one year, which means that Sector membership and the Sector operating plan may change from one year to the next and must be approved by the NEFMC.

Allocation – For any given Sector the quota or what is referred to as the Sector's Annual Catch Entitlement (ACE) is determined by the sub-ACL to all Sectors combined and the cumulative Potential Sector Contribution (PSC) assigned to each permit enrolled in the Sector where PSC is the proportion of every stock based on 10-year catch history assigned to a limited access permit. Procedurally, the PSC for each permit is summed by stock to determine the individual Sector's share of each stock. Summing the individual Sector shares across all formed Sectors is the total Sector share that is then multiplied by the aggregate ACL to determine the Sector total sub-ACL, which is then distributed to each individual Sector according to the Sector's shares and down to members according to the Sector's operating plan. Notably, the PSC is not treated as an individual allocation since the allocation is to the Sector, not to individual Sector members. For this reason, Sectors are not legally considered an LAPP and were exempted from the excessive share, cost recovery, and 5-year program review requirements of the MSA.

Trading – While trading may take place both between Sectors and within Sectors only the inter-sector trades are required to be reported. These trades are of ACE for any given stock as a monetary transaction or a swap of pounds of one stock for pounds of another. As such, any inter-sector trades are effectively leases. The rules for leasing ACE are set according to operating plans. Some sectors require the right of first refusal to trades among a Sector's members before making ACE available to other Sectors. At the Sector level there is no trading of quota share because the shares by stock are embedded in the PSC assigned to each Sector member's permit and PSC for any given stock cannot be separated from the permit. While it is possible to acquire another permit holder's PSC this is a transaction between permit holders that takes place outside the sector allocation program.

Catch Accounting – With the need to stay within the specified ACLs monitoring of groundfish catch switched from an annual evaluation of landings and discards to near real-time catch accounting. The pre-existing program of on-board observers was augmented by an at-sea-monitoring (ASM) program set up to monitor discarding of only groundfish species on declared groundfish sector trips. On Sector trips that carried an on-board observer the actual observed quantity of discards was deducted from the Sector's ACE. For Sector trips that did not have an on-board observer, the discard rate on observed trips was used to apply to the landings on unobserved trips. Where the assumed discard rate was sector-specific to reflect differences in gear and fishing practices among Sectors.

In order to continue fishing within any stock area (Gulf of Maine, Georges Bank, and Southern New England/Mid-Atlantic) the Sector as a whole is required to hold ACE in every species in the stock area. If a Sector runs out of ACE no one in the Sector may fish until ACE for the limiting

species/stock can be obtained from another Sector. At the end of the year all Sector specific overages need to be covered through inter-Sector trading. In the event the overage persists the remaining overage is deducted from the ACE for the next year and the share of the overage follows each Sector member to prevent vessel owners from avoiding an overage by switching to a different sector.

## Economic analysis for implementation

The primary measures under consideration by the NEFMC that were analysed at the time the Sector Allocation program was implemented were alternatives to establish PSC, the value of ACE allocation to sectors, and establishment of the effort control measures under the scenario in which no Sectors were formed. This may be thought of as a No Action or counterfactual analysis to formation of sectors. Of these alternatives only the last was based on an economic model to predict response to regulatory change.

Potential Sector Contribution – Potential sector contribution is the primary basis for establishing what any given permit holder brings into a sector. The PSC alternatives included 5 and 10-year qualification periods, alternatives that included capacity weighted PSC (the capacity baseline was a formula (10L + HP)(DAS) where L is vessel length, HP is main engine horsepower and DAS was allocated fishing days where the capacity baseline was proposed to be 50% of the PSC and 50% landings history), and alternatives that would provide PSC to all stocks as compared to only stocks that were landed. Available data to support analysis of these alternatives included vessel trip reports (VTR) that are completed for every trip, vessel characteristics, and DAS allocations. These data were used to estimate the resulting PSC by permit for each alternative where all alternatives were compared against the preferred choice which was landings history over the 10-years from 1996 to 2006. The PSC alternatives by stock were also compared by vessel length categories, by home port state, fishing history in stock areas, and named Sectors.

Annual Catch Entitlement – As previously noted, ACE is the product of the cumulative PSC and the sub-ACL that is allocated to Sectors. Analysis of ACE augmented that of the PSC alternatives by applying preliminary sub-ACLs to cumulative PSC. The potential revenue was estimated by applying recent year's average ex-vessel price. Since all PSC alternatives were analysed by vessel, pounds of ACE and potential revenue were summarized by vessel length categories, by home port state, fishing history in stock areas, and named Sectors.

Economic Model of Effort Controls - Amendment 16 only authorized sectors to be formed and established a process for annual specifications of OFL, ABC, and ACL's with sub-ACLs. Neither the sector-ACLs nor final sector rosters were known at the time these alternatives were selected by the NEFMC and when the economic analysis was conducted. For this reason, the primary economic analysis was based on an analytical model developed to analyse the biological effectiveness of the effort control measures was used under the assumption that no sectors would be approved. This approach may be thought of as a counterfactual to implementing the Sector Allocation program. The analytical approach was based on an application of positive math programming referred to as the Closed Area Model (CAM) because its development was motivated by the NEFMC's practice to use time/area closures as a substitute for DAS reductions. The CAM optimizes net returns of the distribution of effort by every vessel where the model coefficients are calibrated to approximate the month and area fished conditional on the suite of DAS, trip limits and area closures that were in effect during a benchmark fishing year. The model is re-estimated with the new set of effort control measures for DAS, trip limits, and closed areas. The model output includes changes in net returns above operating costs by vessel, which allows for summarizing economic impacts by any characteristic that can be traceable to each vessel.

To capture the tendency for economic impacts to be unevenly distributed, fleet-wide impacts were summarized by quintiles and by vessel length class, primary gear, home port state, dependence on groundfish trips, and landings ports.

In addition to the CAM a break-even analysis was conducted based on the minimum number of fishing days needed to cover operating and annual fixed costs. Break-even was adjusted for gear and vessel length and for different levels of fixed costs.

**Available Data Used in Supporting Economic Analysis**

Prior to program implementation beyond routine fishery-dependent data collection, no additional data were collected that were intended to inform economic impacts or support economic models of the Sector Allocation program. This was despite a Groundfish Plan objective adopted in 2004 to "Develop biological, economic and social measures of success for the groundfish fishery and resources that ensure accountability in achieving fishery management objectives." No action was taken to implement this objective.

The data that were available to support economic analysis prior to program implementation included four databases that were a census of all groundfish vessels and their activity and two databases that were sample-based. The former included vessel trip reports, permit applications, dealer reports, and DAS data. The data collected through these programs are mandatory and allow construction of a record of every trip taken by every vessel including (by species) gear, area fished, landed port, pounds and value, as well as vessel characteristics and allocated DAS. The variables from these datasets and the analyses that used these data are summarized in Table A3.2.

**Table A3.2. Summary of available data sources, content, and what data were used by type of analysis**

| | | PSC Analysis | ACE Analysis | Effort Control Analysis | |
|---|---|---|---|---|---|
| Source | Variables | PSC | ACE | CAM | Break-Even |
| Vessel Trip Reports | Gear, area fished, landed pounds by species, landed port and state | X | X | X | |
| Permit Application | permit ID#, home port, length, horsepower | X | X | X | X |
| Dealer Reports | landings and value by species, port landed | | X | X | X |
| DAS | allocated DAS, used DAS | | | X | X |
| Observer | Trip costs: fuel, oil, ice, bait, food, water, supplies | | | X | X |
| Fixed Cost Survey | repair and maintenance, haul outs, permits, professional fees, office rental etc. | | | | X |

Cost data used in the CAM and Break-even analysis were collected through an on-board observer program and a survey of fixed costs that was administered to all permit holders including groundfish. On-board observers collect trip costs for all trips where an observer is deployed. This was approximately 5% of all trips taken. The fixed cost survey was administered to all permit holders with varying responses rates from 20% to 12%. The types of data collected through these sampling programs is summarized in Table A.2.2.

## New data and economic models post-implementation

New Data - The Sector Allocation program created a new requirement to report all inter-sector trading of ACE including pounds and value for each transaction. As reported in Holland et al. (2015) these inter-sector trades include a substantial number of barter arrangements for quota swaps and block trades, which complicate the use of these data in economic analysis. Reporting of trades between members of the same Sector was not required, however, beginning in 2012 sector managers began to voluntarily report these intra-sector trades as part of the required annual reporting of Sector performance compared to their submitted operating plan at the beginning of the fishing year.

Although the primary purpose of the increased level of on-board observers associated with the ASM requirement was to monitor groundfish discarding, collection of trip costs was maintained, which resulted in a substantial increase in the sample sizes available for use in estimation of trip cost models (Werner *et al.*, 2020).

New Economic Models – The Sector Allocation program changed the incentives from maximizing net profit constrained by allocated DAS to profit maximization constrained by sector sub-ACLs by stock. This change meant trips that made most efficient use of available ACE, particularly of the most constraining stocks, were more likely to occur. Furthermore, the ACE efficiency changes as the stock-level ACLs change. The economic model used to analyse the economic impacts of annual specification of sector Sub-ACLs estimates the ACE efficiency from a reference pool of recent groundfish trips where ACE efficiency is determined by the ratio of ACE used on the trip to net revenue on the trip where net revenue is gross revenue minus operating costs and the opportunity cost of quota. The so-called Quota Change Model (QCM) uses a Monte Carlo simulation that selects trips from the reference pool where the trips with higher ACE efficiency under the revised Sector sub-ACLs have a higher probability of being selected (NEFMC, 2019). Trips continue to be selected for each stock area until any one of the stock area sub-ACLs has been reached and no additional trips can be taken in the stock area. The simulation for a synthetic fishing year stops when either a sub-ACL for a unit stock or at least one sub-ACL in each of the three broad stock areas have been reached. The Monte Carlo selection process is iterated 500 times to generate median and confidence intervals.

The QCM incorporates the opportunity cost of quota by estimating a hedonic model using trading data from reported inter-sector leases (Murphy *et al.*, 2018). As previously noted, inter-sector trading includes a substantial number of non-pecuniary and block trades but also includes a large number of trades for which valid trading prices can be estimated.

## Program changes since implementation

The Sector Allocation program established an annual process for setting ACLs, making adjustments to rebuilding programs, or the effort controls for the Common Pool. Since 2010 there have been 15 of these types of routine adjustments and three non-routine Amendments to the Groundfish Plan. The latter are summarized below.

Permit Banks – At the start of the Sector Allocation program the NMFS provided $6 million to the states of Maine, New Hampshire, Massachusetts, and Rhode Island. The intent of the grant program was to mitigate potential adverse impacts on fishing communities and small-scale fishing businesses by funding the acquisition of groundfish permits and their associated PSC. Doing so would allow each State to receive an annual allocation of ACE that they could lease out to their respective residents at below market rates. However, there were a number of conflicts among State laws with some sector formation and reporting requirements that inhibited the

ability for States to use the grant funds for their intended purpose. For this reason, the Groundfish Plan was amended during 2011 to allow states that received a NMFS grant to transfer ACE without having to either form or join a Sector.

Excessive Shares – At the time the Sector Allocation was an option with implementation of Amendment 13 in 2004 there was a cap of no more than 20% of any stock that could be allocated to any Sector. Since ACE is allocated to each Sector and not to an individual, an excessive share threshold that applies to individual quota programs was not required and the 20% cap was removed with Amendment 16 to allow sectors to form without regulatory inhibition. Due to public comment on removal of the cap and concerns over consolidation and reduced fleet diversity the NEFMC initiated an excessive share amendment in 2015, which was implemented during 2017. The share cap implemented in 2017 applies to limits on the accumulated PSC associated with an entity (individual, permit bank, or Sector) and to a cap on the total number of permits that may be owned by an individual.

Catch Accounting – Prior to the Sector Allocation program landings were monitored through a combination of mandatory VTR and seafood dealer reporting while discards were estimated through an on-board observer program where coverage rates were based on a target CV of 30%. These procedures applied to all fisheries. The Sector Allocation program required monitoring of groundfish catch through an augmented At-Sea-Monitoring (ASM) program to monitor Sector-specific discard rates where the sampling rate was set to achieve the same precision of 30% of CV. Provided, fishing strategies are unaffected by the presence of an on-board observer the discard rates based on sampling protocols would be unbiased. However, upon review of performance metrics on observed and unobserved trips a significant observer effect was found for composition of catch and trip duration concluding that observed trips were not representative of unobserved leading to biased estimates of total catch, which has implications for catches used in groundfish stock assessment model used to set ACLs. In response to this information the NEFMC initiated an Amendment in 2017 to improve catch accounting. The NEFMC has selected preferred alternatives but these measures have not yet been implemented.

## Lessons Learned

- Process – Although Sector Allocation had been implemented in 2004, Macinko and Whitmore (2009) suggest that the broader application of Sectors to virtually the entire fishery was driven more by meeting a statutory deadline and closing off of other alternatives than it was a choice made through a deliberative process. The authors note that the Sector Allocation program was poorly understood by many rank-and-file fishers and that a more focused planning process was needed.
- Objectives – The stated objectives for the Sector Allocation program were vague and were not well connected to the alternatives to determine how each one meets the objectives. Of the stated objectives, preventing consolidation that would eliminate the day boat fleet was measurable but no measures were put in place that would address this objective until 2017; seven years after the Sector Allocation program was implemented in 2010.
- Economic Data – At the time the Sector Allocation program was implemented, data available to support economic analysis of the program was limited to data that was routinely collected. No new data or supplemental economic data were collected. Upon implementation new data collection was limited to inter-sector leasing quantities and remuneration for leased ACE.

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# A3.5 Swedish demersal fisheries (Staffan Waldo)

The RBFM system for Swedish demersal fisheries was introduced in 2017 and allows individual quotas to be leased within a year. Thus, is not allowed to buy and sell quotas as in a system with individual transferable quotas (ITQs). In 2020 the Swedish Marine and Water Management (SwAM), which is the authority managing quotas, proposed a system with fully tradable quotas (SwAM, 2020). However, tradability in not formally under the jurisdiction of the SwAM but needs to be approved by the Swedish Parliament. The current status (January 2023) is that the Swedish government has asked the SwAM to analyse the effects of a system with individual tradable quotas. The Swedish case study will contain information on the system with "quota leasing", but when the proposed system for tradable quotas are of specific interest for the analysis references will be made to the "proposed ITQ-system".

Notably, the system with quota leasing was introduced to all demersal fisheries (pelagic fisheries has been managed with ITQs since 2009; SFS, 2009) and not only a single fleet or sea basin. This means that both Baltic Sea and North Sea fisheries are included. The stock status and economic performance of the fleets taking part in these fisheries might differ substantially.

## Program objectives and development

**What was the biological and economic status of the fishery in the years prior to the RBFM program?**

The species for which the system with quota leasing has been introduced are (SwAM, 2016)

- North Sea: Cod (Gadus morhua), haddock (Melanogrammus aeglefinus), whiting (Merlangius merlangus), saith (Pollachius virens), northern prawn (Pandalus borealis), Norwegian lobster (Nephorps norvegieus), and plaice (Pleuronectes platessa).
- Baltic Sea: Cod and haddock

The biological status differs between the species. E.g. plaice, saith, and Norwegian lobster did by the time of implementing the RBFM system in general have stocks with full reproductive capacity and/or have a sustainable fishing pressure (Fmsy) according to ICES advice in 2016 (ICES, 2016a,b,c,d). Cod, shrimp, haddock, and whiting are all less sustainably fished with higher fishing pressure and lower stock levels (ICES, 2015; ICES 2016e, f; ICES 2017). Notably, the Baltic Sea cod stocks are not biologically sustainable and targeted fisheries have been banned within the EU's Common Fisheries Policy since 2019 (EU, 2019).

SwAM (2020) calculates economic indicators from 2008 to 2018 which covers the years before the introduction of quota leasing as well as the first two years with the system. They show gross profits to be positive for the vessels included in the quota leasing system for the entire period (i.e. also before the system). Thus, there was no economic crisis that preceded the program. Further, it cannot be shown that the gross profit has increased after the program was implemented. The analysis does, however, show that the profitability has been higher for vessels included in the program compared to vessels exempted (smaller coastal vessels, see below) for the entire period. The indicator "value added per full time equivalent employee" shows the same pattern.

**What were the RBFM program objectives?**

The objective of the system with quota leasing is very clear; to facilitate the introduction of the landing obligation introduced within the EU's Common Fisheries Policy (SwAM, 2016).

To understand this objective some background information on EU and Swedish fisheries management is necessary. An important feature in EU's Common Fisheries Policy for 2014-2021 (EU, 2013) was the introduction of a landing obligation. Before the introduction of the landing obligation fish above quota were discarded and thus not accounted for in the landing statistics. With the landing obligation all fish (with some exemptions) shall be landed and accounted for. The landing obligation was gradually introduced from 2015 and is in full effect since 2019 (SwAM, 2016).

Before the system with quota leasing, Swedish demersal fisheries in the North Sea were managed with weekly (or in some cases monthly) catch limits per vessel for the most commercially important species (Norwegian lobster, saithe, haddock, cod, plaice, and shrimp). Cod fisheries were further managed with effort regulations. In the Baltic Sea, cod fishery was managed with individual but non-tradable (and non-leasable) quotas. In addition to quotas and weekly catch limits Swedish fisheries are managed with licenses and special permits. The former is a license to be a commercial fisher, and the latter are permits for accessing specific fisheries (i.e. targeting a species with a specific gear). Permits were (and still are) required for cod fisheries, for shrimp fisheries, and for Norwegian lobster. For Norwegian lobster, management differs between trawling permits and permits for fishing with pots.

The system before leasable quotas were introduced was assessed by SwAM (2016) to be difficult to combine with the landing obligation. For example, in mixed fisheries the quota that is fully utilized first (e.g. for a bycatch species) will limit the entire fishing operation. With weekly catch limits is was identified that fisheries might need to stop frequently at the end of the week as catch limits cannot be transferred from one week to another. Thus, the system of yearly leasable quotas aims at (SwAM, 2016)

- Create a system that facilitates for individual fishers to comply with the landing obligation by adapting their fishing opportunities (leasing quotas)

- Ensure that entire fisheries do not have to stop due to shortages of common quotas. Instead, the responsibility for adequate quota holdings should be with the individual fisher.

The latter also implies that the use of selective fishing gear is encouraged since using this will require fishers to lease less quota for bycatch species.

An interesting aspect of the objectives is that the system with leasable quotas was not motivated by issues common for ITQ-system such as reducing capacity, increasing product quality, increase fleet profitability, etc. (Brinson and Thunberg, 2016). However, already at the introduction of the system with quota leasing, many stakeholders (including the fishing industry) suspected that this was a first step towards an ITQ system, and this was also proposed by the SwAM in 2020 as presented above.

**What were the key provisions of the program (e.g. eligibility, qualification for allocation, transferability)?**

The system with leasable quotas was introduced January 1 2017. Individual quotas were allocated to vessels based on landings during the reference period 2011-2014. The shrimp fishery was an exception where the quota was allocated in proportion to the allocation of monthly catch possibilities applied before 2017 (SwAM, 2020). All allocations were made free of charge (grandfathering). The allocated individual catch share is a fixed proportion of the Swedish share of the total allowable catch for the stock (where total allowable catch is decided within the EU). Shares can be leased on an annual basis but not permanently traded.

The system with leasable quotas is primarily designed for larger vessels using active gear (trawls) but also the small-scale fishery for Norwegian lobster using pots is included. However, large parts of the coastal fishery is outside the system. This includes vessels fishing for cod in the Baltic Sea using passive gears (gillnet and hook; Note that the program was in place before the ban on Baltic Sea cod fisheries)., and vessels fishing in Kattegat/Skagerrak with vessels below 10 meters or for some exemptions also larger vessels with passive gears. Vessels not included in the system will have access to common pool quotas. The coastal quotas are prioritized in the quota allocation and the aim is to set them large enough not to restrict landings for the coastal fleet (SwAM, 2020).

The system applies concentration limits for all species included. These are shown in table A3.3.

**Table A3.3. Concentration caps in the Swedish system with quota leasing. Source: Author's translation from SwAM, 2018, table 3.**

| Species | Quota area | Concentration cap (%) |
|---|---|---|
| Saith | North Sea/Skagerrak/Kattegatt | 9 % |
| Norwegian lobster | Skagerrak/Kattegatt | 5 % |
| Haddock | Skagerrak/Kattegatt | 15 % |
| Shrimp | Skagerrak/Kattegatt | Vessel class A-C: 4 %<br>Vessel class D-E: 8 % |
| Cod | Skagerrak | 8 % |
| Cod | Kattegatt | 13 % |
| Cod | Western Baltic Sea (ICES areas 22-24) | 11 % |

| | | |
|---|---|---|
| Cod | Eastern Baltic Sea (ICES areas 25-32) | 8 % |
| Whiting | Skagerrak/Kattegatt | 9 % |

## Economic analysis for implementation

**What, if any economic analysis or economic models were used at the time of first implementation?**

In the material sent to stakeholders for consultation (SwAM, 2016) there is no economic analysis. Focus is on the landing obligation, how to comply with the new legislation, and details of the proposed system such as permits, licenses, quota allocation mechanizms, quota caps, coastal quotas, etc. However, in the evaluation of the first year of the system, the SwAM (2018) refers to economic concepts and the economic literature in a discussion on economic incentives for highgrading and/or the use of selective gears when specific quotas (e.g. for bycatch) are scarce.

**What economic data were available at the time of first implementation and how was the data used**

Sweden is part of the EU and all economic data collection is performed through the DCF and EU MAP programs (EU, 2021). The data collection is standardized for the entire EU and thus not dependent on the management systems in the member states. Data contains information on revenues from fishing as well as different cost items such as interests, depreciation, fuel, labor costs, maintenance, etc. From this it is possible to calculate economic indicators such as profits and value added. All these datadata were available at first implementation.

## New data and economic models post-implementation

**Were any new economic data collected after the RBFM program was implemented? If so, what data were collected?**

No new collection of economic data takes place due to the program. However, the quota leasing is registered by the SwAM. The data contains leased quantities but not leasing prices.

**Were any new economic models developed post-implementation?**

There has been no new models developed for analysing the effect of the system with quota leasing.

## Program changes since implementation

**If any, what were the key changes in the RBFM program post-implementation?**

There have been no major changes in the system for quota leasing. However, the SwAM has proposed a full ITQ system (SwAM, 2020) which is not yet decided on. The motivation for the proposal is that "Correctly designed [.] a multiannual demersal system can contribute to a simpler and more transparent regulatory framework, increased opportunities to reach an economically viable fishery, and increased flexibility to adjust fishing opportunities to individual fishing patterns" (SwAM, 2020 page 90; author's translation). The proposal is based on information

from several sources: An evaluation of the existing ITQ system for Swedish pelagic fisheries, international experiences with ITQs, scientific literature (including economics), and a stakeholder consultation. The SwAM (2020) identifies a number of risks associated with ITQs which formed the basis for the Swedish Government to assign the SwAM to further evaluate these (Swedish Government, 2022). The evaluation topics concern

- Economic, ecological and social consequences of quota concentration
- Effects on local processing industries
- Considerations for local coastal fisheries
- The fisheries contribution to competitive food value chains
- Recruitment of young fishers
- Effects on infrastructure and landing possibilities in Sweden
- Effects on the objective of Good Environmental Standard (GES) in marine areas
- Effects on the stock status of fish and shellfish
- The need to support the use of selective gear
- Information requirements for ex post evaluations of the system

## Lesson learned

Returning to the system with quota leasing, the SwAM (2020) evaluates the effects of the system and makes several observations:

- The system has made individual fisher's fishing opportunities more flexible as indicated by a large amount of quota leasing in the first year (SwAM, 2018), but the evaluation cannot conclude to what extent quota leasing has been used by the fishing industry to cover bycatches. During the period with a quota leasing system, the stock status has declined compared to the reference years, which caused the national quotas to be underutilized. Thus, the evaluation concludes that quota coverage has not been as big of an issue as expected.
- There is no indication of an increased use of selective gears.
- There are indications of discards still taking place in Sweden, as is the case for other EU countries in the region (EFCA, 2019).
- The number of vessels and the total value of catches have increased during the system with quota leasing. The economic indicators such as value added and profits were more difficult to evaluate due to lags in some of the economic indicators. However, for the first years of the system there are no indications of a positive development. The SwAM puts forward that the indicators analysed could be caused by several factors outside the system such as the development of fish stocks and landing prices.

**What are the key lessons learned?**

In addition to the lessons learned from the evaluation of the system presented above, the introduction of leasable, but non-tradable, quotas have gained several insights of importance for rights based management.

- The introduction of as system with quota leasing triggered a discussion on whether the system should be developed into an ITQ system. The major Swedish producer organization (Swedish Fisheries Producer Organization, SFPO) already in 2017 advocated for the system to allow for permanent transfers (SFPO, 2017).
- The system with quota leasing generated so called "quota vessels". These are vessels bought not for active use but for the quotas attached to them. The owner of the vessel can lease the quota within the company (on an annual basis) and in this way in practice

transfer quotas between vessels. Quota vessels are only used in active fishing with the purpose of landing the minimum amount required for being eligible to their quota shares next year.

- Since the introduction of the system with quota leasing the Baltic Sea cod stock has declined substantially and since 2019 the cod fishery is closed (EU, 2019). Since there is currently no fishing for cod in the Baltic Sea, it is not yet decided if the Baltic cod should be included in an ITQ system. Poor economic performance during the preceding years has caused a substantial reduction in the cod fishing fleet and the year before the stop only a handful of vessels were active. Anecdotal evidence tells that many vessels have been sold to fishers outside the region, although not actively used. Currently it might difficult to find fishers to allocate quotas to in a way that is acceptable among stakeholders. However, the allocation will be problematic also in future – the reference years for fishing (2011-2014) might be very old by the time the Baltic cod fisheries opens, fishers that were active then will probably to a large extent have left the industry, and allocating quotas to vessel owners outside the region that have not themselves been active cod fishers might be socially problematic. Thus, alternative allocation systems to grandfathering might be considered (see e.g. Libecap, 2007).

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## A3.6 Bay of Biscay common sole (Solea Solea) fishery (Olivier Thébaud, Benjamin Dudouet, Sarah Landru, Claire Macher)

**Program Name: French 2006 order setting out provisions for the allocation and collective management of fishing opportunities** (https://www.legifrance.gouv.fr/jorf/jo/2006/12/29/0301; amended by the French decree No. 2014-1608 of 26 December 2014; https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000006071367/LEGISCTA000029978029/)

Common sole is a benthic fish that lives on soft substratum in coastal areas and up to a hundred meters in depth. Sole reproduces from 2-3 years of age, spawning taking place from January to March, between 30 and 100 meters in depth. Sole nurseries are located in estuaries and in the bays along the coast. Sole live close to the coast in spring and move further offshore during winter. The growth of the species has been decreasing over the last decades, probably due in part to environmental drivers affecting recruitment.

Common sole is one of the two top species in value landed by French fishing fleets, total landings for Metropolitan France reaching 3 556 tons in 2020, with high average sale prices leading to a gross turnover of 52M€ (10% of the total turnover of French fleets processed through auction markets). The Bay of Biscay sole fishery (ICES areas VIIIa,b) represents two thirds of these total landings, hence significant economic stakes for the fishing industry depending on this species.

The fishery provides an example of a mixed fishery where multiple fleets interact with the different species being caught. It is exploited mainly (94% of official landings (ICES, 2021)) by French vessels, including multiple gears, with the largest fraction caught by netters, with the rest of catches by trawlers. In 2020, the Bay of Biscay French sole fishery counted 821 vessels catching more than 1 kg of Bay of Biscay sole among which 329 vessels catching more than 1 ton. A small fraction of the catch is by vessels from other countries, mainly Belgium in recent years (see quota allocation system below). We use this example to illustrate the implications of the regulations

which established the quota allocation system currently in place in France, but most of the features described are valid for other species under quota in France.

## Program objectives and development

**What was the biological and economic status of the fishery in the years prior to the RBFM program?**

Trends in the status of the fishery over the last four decades are summarized in figure A3.3, extracted from the ICES advice sheet. After peaking in the mid 90ies, landings have steadily declined since, despite the implementation of several management plans. In particular, after a first recovery plan adopted in 2002, a management plan was established in February 2006 to rebuild Bay of Biscay sole spawning-stock biomass above the precautionary level of 13 000 tons by 2008, by progressively reducing the fishing mortality rate on the stock. Once this target was reached, the Council was to decide on a long-term target fishing mortality and a rate of reduction in the fishing mortality for application until the target has been reached. However, although the stock was estimated above the SSB target in 2008, lags in adopting the long-term target fishing mortality rate and the associated rate of reduction occurred, due to the inclusion of the Bay of Biscay sole in a mixed fishery management plan under development at European level under the designation of "Multi-Annual Management Plan" (MAP). The "Multiannual plan for fish stocks in the Western Waters and adjacent waters" was only implemented in 2019. This multi-specific management plan, the development of which was initiated in 2011 (Lagière *et al*., 2012), aimed at maintaining stocks of harvested species, including sole, within ranges of fishing mortality around the maximum sustainable yield and thus reconciling fishing possibilities, avoiding choke effects, unwanted catches and discards (https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:4396036).

Low recruitments observed over the last ten years and particularly over the past 2 years have conducted to decrease the stock spawning biomass below limits reference points (MSY Btrigger and Blim) while still being above the precautionary Bpa.

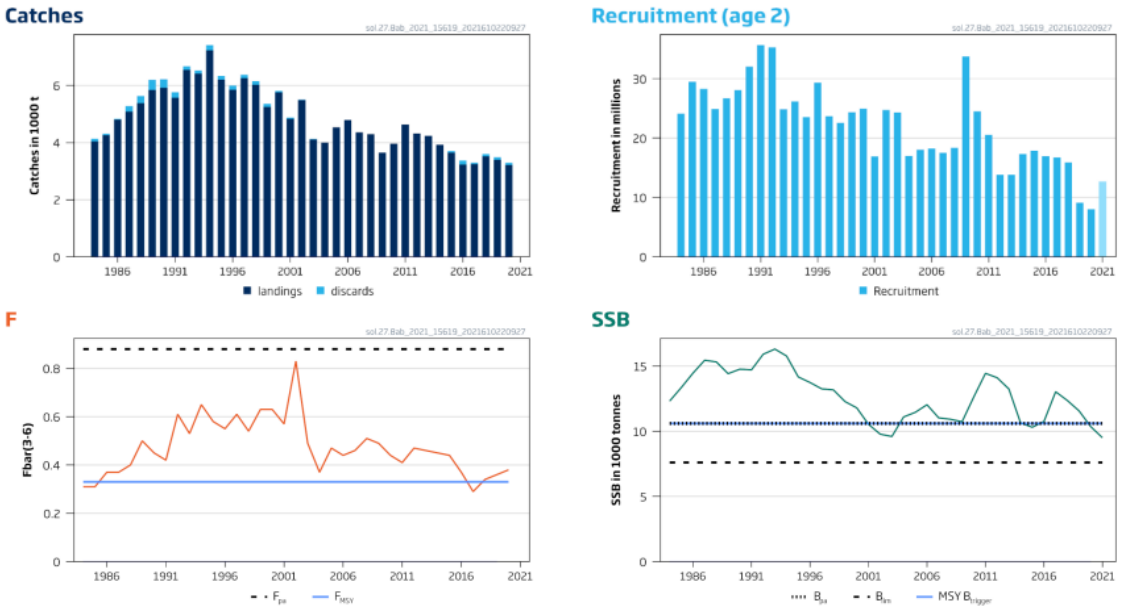


**Figure A3.3. ICES Sole VIIa,b advice sheet. Source: ICES. 2021. Sole (Solea solea) in divisions 8.a-b (northern and central Bay of Biscay). In Report of the ICES Advisory Committee, 2021. ICES Advice 2021, sol.27.8ab, https://doi.org/10.17895/ices.advice.9443**

**What were the RBFM program objectives?**

In France, management and monitoring of quotas was gradually delegated to Producers' Organizations - POs (acting as Fishery Cooperatives) over the past 15 years (Larabi *et al.*, 2013; Le Floch *et al.*, 2015). Quotas are thus managed by POs under a quota pooling system with reallocations to vessels or groups of vessels. Direct quota transfers between individual operators is not allowed in France. The regulation introduced in 2006 aimed at instituting a new regime for the allocation of national quota and effort units, for species / fisheries where these are capped. In particular, the regulation introduced a fixed allocation key based on 2001-2003 track records of landings for the national quota of species under European TAC management, with the aim to eliminate the race for fish which resulted from the use of sliding track records as a basis for allocation. This also aimed at providing more certainty on catch possibilities for fishers (Autorité de la Concurrence, 2015). The 2014 decree introduced additional mechanizms for short-term (infra-annual) quota reallocation between POS, aimed at improving the flexibility of quota allocation to changed circumstances in the fishery, as well as provisions for the creation of quota reserves by POs ( in cases where vessels are transferred or decommissioned), aimed at facilitating the allocation of fishing possibilities to new entrants in the fishery (see below; Larabi et al., 2013).

**What were the key provisions of the program (e.g. eligibility, qualification for allocation, transferability)?**

Under the Common Fisheries Policy (CFP), Total allowable catches (TACs) are set annually for many economically important commercial fish stocks, based on the scientific advice provided by ICES and STECF and on the objectives set in the CFP and further specified in multiannual management plans in some circumstances, such as has been the case for the Bay of Biscay sole. TACs are then shared as national quotas between EU countries according to a fixed allocation key (in % of the TAC), established at the inception of the TAC system (Marchal *et al.*, 2016). This so-

called "relative stability" principle was based on historic catches during a reference period from 1973 to 1978, with adjustments to account for preferential treatment of regions particularly dependent on fishing and jurisdictional losses following the implementation of the 200 nautical mile Exclusive Economic Zone (Hoefnagel *et al.*, 2015). Flexibility in the allocation of catch possibilities developed through two main mechanizms, which are in existence in the Bay of Biscay sole fishery (Figure A3.4). First, national quotas can be exchanged between countries (so-called "quota swaps"). In the sole fishery of the Bay of Biscay, a small fraction of the catch is by vessels from other countries, mainly Belgium in recent years. Since the mid-2000s, the Netherlands have been using their fishing rights in the Bay of Biscay for quota swaps with Belgium, exchanging the Dutch quota in the bay of Biscay for Belgian quota in the North Sea. Belgian vessels fish this quota in summersummer, mainly in Division VIII.b. Table A3.4 presents an illustration of this allocation process for common sole quota in the bay of Biscay for 2022.

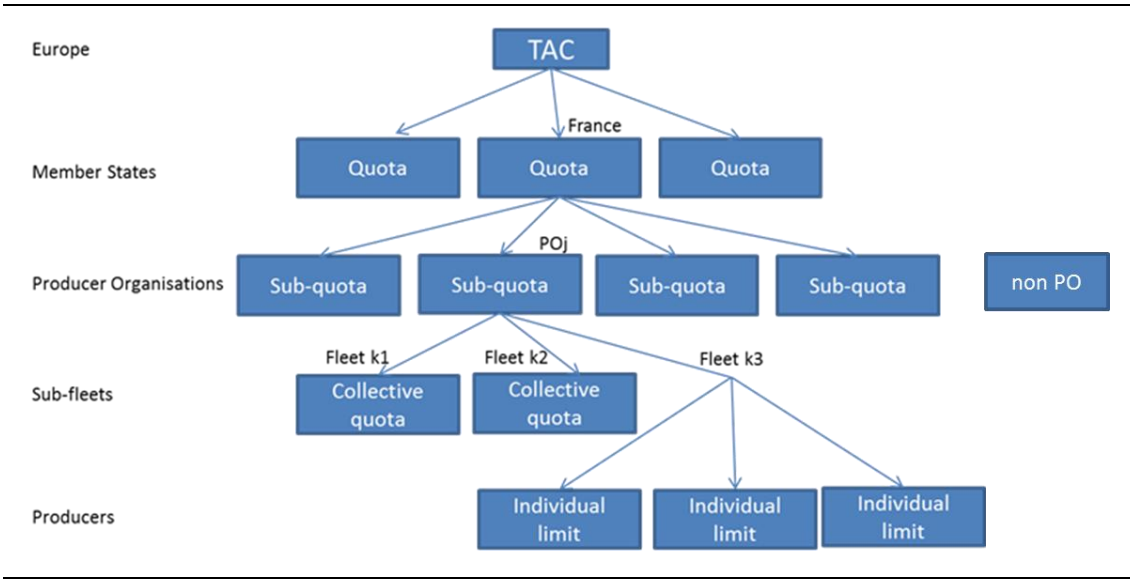


**Figure A3.4. The process of allocation of quota shares to individual producers in France**

Second, companies from a country can invest in fishing enterprises of another country, thereby gaining access to the quota allocation of these companies (so-called "quota hopping"). In the Bay of Biscay sole fishery, instances of this exist with Spanish investors operating vessels under joint French-Spanish companies (Lequesne, 2000; Kinds, 2021).

**Table A3.4 – Allocation of the 2022 EU TAC for common sole in the bay of Biscay**

**Source: COUNCIL REGULATION (EU) 2022/109of 27 January 2022 fixing for 2022 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in Union waters and for Union fishing vessels in certain non-Union waters (https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32022R0109&from=FR)**

| 2022 EU TAC for common sole in the bay of Biscay (Tonnes) | | | | |
|---|---|---|---|---|
| 2 179 T | | | | |
| Quotas by country (T/%) | | | | |
| Country | France | Belgium | Netherlands | Spain |

| | | | | |
|---|---|---|---|---|
| Before swap | 1997<br>*(91,6%)* | 27<br>*(1,2%)* | 150<br>*(6,9%)* | 5<br>*(0,2%)* |
| After swap | 1997<br>*(91,6%)* | 177<br>*(8,1%)* | 0<br>*(0%)* | 5<br>*(0,2%)* |

Countries are then responsible for ensuring that their national quotas are not exceeded, and are expected to close a fishery where the national quota for a species is exhausted. Countries are also expected to allocate these quotas among fishers using transparent and objective environmental, social and economic criteria (Article 17 of Regulation (EU) No 1380/2013). In France, no official methodology to share out the national quota was implemented until 1990, when the authorities decided to split the national quota for species that were being heavily fished, including common sole. Fishing authorizations were allocated between the different administrative regions, based on track records of the average landings of producers in each region over a sliding period of the previous three years. In this context, the limited role of POs and disagreements on the distribution methodology for sub-quotas created tensions interfering with the proper functioning of the system. In 1997, the Marine Fisheries Act reinforced the role of POs in the quota management system, while clearly rejecting the possibility for individual producers to directly swap or trade quota. Until 2005, the calculation of sub-quotas allocated to POS remained subject to "sliding" track record. The 2006 regulation froze the allocation key using years 2001 to-2003 as a reference, with some adjustments.

The regulation organized the allocation system in a hierarchical structure in which Producer Organizations (POs) play a key role (Larabi and al., 2013. The Department of marine Fisheries and Aquaculture (DPMA) is in charge with the allocation and control of national quotas, on behalf of the Ministry of Agriculture and Fisheries. The Member State may reserve a part of the quota at the beginning of the year, in particular to allow the quota swaps mentioned above, as well as to allow for a buffer for stocks under pressure. According to the 2006 regulation, for stocks for which the uptake of national fishing possibilities in the previous three years is above 70%, the remaining national quota is allocated between Producer Organizations and a group of producers that are not members of a PO, according to the track records of PO members and non-members. This allocation takes into account transfers between POs of track records of landings that may have occurred in relation with the movements of producers and / or of vessels between POs, as well as vessel decommissioning. Sub-quotas are attributed for a maximum of 12 months. Producers may choose not to belong to a PO, because they do not require the services provided by these, because they refuse the obligations linked to membership of a PO (payment of a subscription, monitoring …), or because they do not have sufficient catch history to be accepted by a PO (Autorité de la Concurrence, 2015). Their quota allocation is determined as a fraction of the non-PO sub-quota, based on their track records.

On the basis of the sub-quotas thus allocated, each producer organization must draw up a management plan which specifies the management measures adopted for its members for each quota species. Producer organizations may also operate sub-quota swaps with other French POs for similar or different species, duly informing the DPMA of these trades. To this end, as well as to allow flexibility in managing their allocations over the fishing season, POs can establish a sub-quota reserve. Individual producers (whether they are members of a PO or not) cannot trade sub-quota directly between each other. When the consumption of a sub-quota reaches 80% for the group of non-members of a PO, or 90% for a producer organization, the fishery for the corresponding species/stock is closed by the administration, for the members of that PO, and for the entire fishery if this quota uptake is observed at national level. Partial closures can be lifted after quota swaps at PO or Member State level that allow quota uptake to drop below 90%. The

Producer Organizations (POs) are entrusted with a mission of fisheries control: they must ensure that their members do not exceed the sub-quotas allocated to them, and have the possibility of sanctioning their members in case of non-compliance with the management rules they have established.

Six POs currently exist in the Bay of Biscay, the members of which take part in the sole fishery. These developed from a merging process which started 15 years ago (Lagière et al. 2012 ). Some of the POs are themselves grouped under two federations: the federation of artisanal fisheries producer organizations (FEDOPA) and the national association of producer organizations (ANOP). FEDOPA has 6 POs, which can be describe as "artisanal" and ANOP counts for four POs representing about 75% of the French fishery (Autorité de la concurrence, 2015).

At the beginning of the year, POs establish an annual management plan, which is validated by the administration (Article R. 621-60 of the Rural Code), in which they freely decide of the quota allocated to their members (as long as this allocation method is not discriminatory). All POs do not proceed in the same way to define these allocations. For species not under pressure, the POs often keep collective quotas and regularly monitor uptake by their members. Pressure on certain fish stocks has led the POs to introduce individual allocations, using a variety of methods including the use of track records of the vessels for the reference years, as well as fixed allocations as a function, for example, of vessel size and fleet/gear. Even where individual allocations are used, POs closely monitor quota uptake, and when this shows that fishing possibilities may remain unused in the course of a fishing season for some species, then they may allow fishing for that species as a collective quota pool, independently of initial allocations. In addition, where a PO manages to gain additional quota for a species, it may decide to allocating this across its members, on the basis of various criteria, including track records, but also the number of crew members on vessels (Source : survey of PO directors on the bay of Biscay coast, May 2022..

The 2006 regulation also made exchanges of sub-quotas between POs possible in order to increase flexibility in quota allocation. This regulation was strengthened in 2014, with the introduction of incentives for POs to voluntarily trade the sub-quotas they do not entirely consume (via forced reallocating all or part of the unused quota to POs who have used all their allocation and seek to increase this). By encouraging quota trades among POs, this measure aimed at ensuring an optimal utilization of the national quota, as well as preventing the anticipated closure of certain sub-quotas (Autorité de la Concurrence, 2015). The decree of 2014 also aimed at enabling producers to access quota while they did not have track record, because their vessel entered the fleet after 2003, or because they operated a change in their activity, or because of insufficient quota allocation. The decree specifies that in the event of the sale of a vessel:

- when a vessel ceases to operate and the producer's activity is terminated, 30% of its quota assets are allocated to the national reserve and 70% to the PO's reserve;
- when a vessel is sold to another producer, 20% of the vessel's track record are deducted. From these 20%, 30% are allocated to the national reserve and the remaining 70% to the PO reserve. The remaining 80% of quota assets remain attached to the vessel (i.e they are transferred to the new vessel owner).

Moreover, the regulation specifies two possible uses of the quota holdings from the national reserve:

- direct allocation to producers on the basis of environmental, social and economic criteria;
- allocation to POs in the event of a merger between POs (Autorité de la concurrence, 2015).

## Economic analysis for implementation

**What, if any economic analysis or economic models were used at the time of first implementation?**

The regulations considered here, which defined the quota allocation system currently in force in France, were steps in what has been a gradual evolution of allocation principles over the last 30 years. Their importance relates to the fact that they were correspond to the establishment of a fixed allocation key, along with principles for quota exchanges. Limited information exists on the nature of the data which was used at the time of designing and initially implementing this allocation system. However, it is likely that no publicly available economic analysis or economic models were used at the time to support the elaboration of the system.

**What economic data were available at the time of first implementation and how was the data used**

The systematic collection of economic data on fishing fleets in France was initiated in the early 2000s under the European Data Collection Regulation, and the very first results of these efforts were starting to become available at the time of the implementation of the regulations, through coordinated initiatives of European fisheries economists supported by funding (https://edepot.wur.nl/92357) which were later integrated under the work of the Scientific, Technical and Economic Committee for Fisheries (STECF; https://stecf.jrc.ec.europa.eu/reports/economic). We do not know whether any of this information was used by the regulator and/or stakeholders involved in developing the regulation.

## New data and economic models post-implementation

**Were any new economic data collected after the RBFM program was implemented? If so, what data were collected?**

A key information which has been collected at PO and national level relates to:

- the nominal allocations of fishing possibilities attached to individual vessels, and changes in these resulting the transfers of landing history associated with changes in vessel ownership or vessel decommissioning;
- the short-term transfers of quota allocations between POs, and in some cases, their allocation to individual members within POs, which may add or detract from nominal allocations to determine the effective quota allocations at vessel level ;
- the actual landings by each fishing vessel, and how these compare to effective allocations.

The information on nominal allocations of quotas to POs is published on an annual basis, and both permanent and short-term quota transfers are monitored by the national administration (however, this information is not publicly available).

POs use their empirical knowledge of the fishing activities of their members, to assess the potential implications for them of changed quota allocation. In some cases, they establish groups of vessels that they consider of similar characteristics, as a basis for distributing quota in fixed shares. Some POs also use criteria such as the size of crew to address the question of quota sharing, implying that this information is known to them.

In order to better understand the functioning and implications of the quota allocation system, two surveys of POs were carried out by Ifremer, in 2012 and 2022, which focused in particular on the rules adopted by each organization with respect to the allocation of their sub-quotas among their members and implications for overall quota distribution (see e.g. Bellanger *et al.*, 2016).

**Were any new economic models developed post-implementation?**

A key feature of the quota allocation system is that catch possibilities remained attached to the vessels, be they determined by the track records of that vessel, or by transfers following trade or decommissioning of the vessel. A direct consequence of this is that prices paid for second-hand vessels tend to reflect the value, not only of the vessel itself, but also of the catch possibilities that are attached to it. This led to the development of empirical research aimed at measuring the implicit price paid for access to these catch possibilities using data available on the market for second-hand fishing vessels (e.g. Guyader *et al.*, 2006).

## Program changes since implementation

Important flexibility provisions regarding quota exchanges between POs and quota reserves were introduced in the 2014 Decree (see above), with the aim to help ensure better quota uptake at the national level.

## Lesson learned

- On the co-management system and the role of POs: Although provisions have progressively been implemented over time to allow greater flexibility in the allocation of quota to individual operators, the French co-management system still largely relies on the central role of POs and the historical allocation key for its day-to-day operation. A recent survey of how POs operate to allocate quota among their members shows a diversity of strategies, some being directly tied to the track records set per vessel, and others relying on equitable allocations across vessels with similar characteristics. The allocation can also remain or revert to being managed as collective pools in certain circumstances (e.g. towards the end of the fishing season, when it appears that the POs allocation may not be entirely caught). The allocation system has been criticized for leading to barriers to the entry of new producers, and/or to the availability of catch possibilities for the most efficient operators, an issue which has been take up by the French competition authority (Autorité de la Concurrence, 2015). The authority recommended that the system evolve towards either the implementation of an ITQ system, or towards the strengthening of the collective management power of POs and the State, by favoring the merging of POs into larger organizations, and updating the quota allocation key and reallocation mechanizms between POs. This is likely to raise question related to the fact that the value of quota assets has implicitly been attached to the value of fishing vessels, which have been acquired over time by producers.
- On the use of economic information and models : only limited use of economic information and models has been made in developing and implementing the management system at PO level, and no publicly available economic evaluation exists at national level to support implementation of the 2014 decree. Evaluations of the impacts of the management system on the operation of the fishery have been carried out as part of research projects. However, there is interest by POs in : (i) better understanding the ways in which quota allocations (across the portfolios of species they manage the catch possibilities of) may affect the viability of their member's activities and how this could help base decisions relating to the collective management of quota allocation and reallocation among members with the aim to maintain economic activity across their membership; and (ii) how the impacts of quota availability across species on vessel viability could be better captured in the models used to support the evaluation of alternative TAC recommendations.

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# A3.7 Icelandic mixed demersal fisheries (Svein Agnarsson)

## Program objectives and development

**What was the biological and economic status of the fishery in the years prior to the RBFM program?**

The Icelandic mixed demersal fisheries take place within the Icelandic Waters ecoregions, which covers the shelf and surrounding waters inside the Icelandic Exclusive Economic Zones (EEZ), encompassing International Council for the Exploration of the Sea (ICES) regions 5.a.1, 5.a.2 and 12.a.4. Vessels operating in the area catch more than 40 stocks of fish and marine invertebrates, with cod (*Gadus morhua*) being by far the most valuable demersal species. Other important species include haddock (*Melanogrammus aeglefinus*), saithe (*Pollachius virens*), golden redfish (*Sebastes norvegicus*), demersal beaked redfish (*Sebastes mentella*), Greenland halibut (*Reinhardtius hippoglossoides*), Atlantic wolffish (*Anarhichas lupus*), plaice (*Pleuronectes platessa*), ling (*Molva molva*) and tusk (*Brosme brosme*).

In 1901, Denmark, to which Iceland belonged at the time, and England came to an agreement on a 3-mile fisheries zone around Iceland. This was in effect until after the Second World War, when Iceland, since 1944 an independent republic, began to extend her fishing zone, from 4 miles in 1952, to a 200 miles EEZ in 1975. By then, Iceland had gained complete control of her fishing grounds, but in that same year the Marine Research Institute (MRI) issued a "black report" which warned that the cod stock had been seriously depleted, and catches would have to be curtailed. Up until then, fishing had for all practical reasons been open, except for temporal and area closures and gear restrictions. This changed in 1977 when the government introduced effort limitations, which banned trawlers from fishing for cod for 42 days in that year. A similar 19-days ban applied to smaller vessels. In the ensuing years, the ban on cod fishing was extended further, culminating in 1981 in a ban of 150 days for trawlers and 40-62 days for smaller boats. Catches of cod were generally limited to 15-20% of total catches during the ban. In 1976, the laws of fishing within the Icelandic EEZ were amended to allow the authorities to limit total catches of stocks that were severely overfished. This provision was enacted for the first time in 1981, when a total allowable catch (TAC) was set for cod. Catches of other demersal species were, however, not limited by TACs.

By 1983 it was clear that the effort restrictions had been unable to halt the decline of the cod stock, with catches each year far exceeding recommendations. The day-restrictions had also increased pressure on other important demersal species, most notably redfish. Harvesting costs also rose as operators redoubled their efforts on days when cod-fishing was allowed. The poor economic performance in the early 1980s was further compounded by over-investments, high capital costs and depressed prices in export markets. Consequently, during 1980-1985 the fisheries were always in the red, with annual losses reaching 14.8% of revenue in 1982. The processing industry also experienced losses in 1982 and 1983. By the end of 1983, the idea of a quota system had gained considerable ground, both among fishers and vessel operators, not least because of the success of the vessel quota systems in the herring, capelin and inshore shrimp fisheries that had been put into place in the 1970s (Arnason, 1996).

The change from effort restrictions to a rights-based management system in the demersal fisheries did not take place overnight but was a process that spanned the years 1984-1991. The first step was taken in 1984 (Act no. 82/1983 and regulations no. 44/1984, 189/1984 and 356/1984), when a vessel quota system with TACs was introduced for cod, haddock, saithe, redfish, plaice, Greenland halibut and wolffish. The quota system was though viewed as a temporary arrangement and was only in place for one year. Quotas were allocated on the basis of fishing history in the period November 1st, 1980, to October 31st, 1983, but vessels with a short fishing history were allowed to opt for effort restrictions. As noted by Runolfsson and Arnason (2001), the results of the system were generally favourable, leading to the quota legislation being extended for the following year (Act no. 118/1984 and regulations no. 1/1985, 161/1985 and 167/1985), and subsequently also for the years 1986-1987 (Act no. 97/1985). However, to ensure enough political support for the system and appease those stakeholders that were sceptical about quota systems in general, vessels were also allowed an effort restriction option. The management regime in place in 1988-1990 was generally based on vessel quotas, with the effort restriction option a little bit

more restrictive than in the previous years (Act no. 3/1988). It was not, however, until 1991 that the authorities decided to abandon all effort restrictions and make ITQs the cornerstone of the Icelandic fisheries management system. In what follows we will therefore mainly focus the discussion on the regime that came about in 1991.

**What were the RBFM program objectives?**

Act nr 38/1990 on Management on fisheries that came into effect on January 1st, 1991, explicitly stated that all exploitable stocks in Icelandic Waters, including fish, crustaceans, shellfish, mammals, etc., were the common property of the Icelandic nation. The objectives of the law are stated in first paragraph, namely, to protect and utilize the stocks in an efficient manner, thereby ensuring secure employment and settlement in the country.

In practice the primary aim of Icelandic fisheries management has been to exploit the marine resources in a responsible and sustainable manner, which in the last decades has mostly amounted to following a policy of maximum sustainable yield. This biological objective has then allowed harvesting companies to take advantage of the possibilities an ITQ system opens for efficient and profitable operations, which in turn have made the sector able to offer employment opportunities and contribute to the well-being of the nation.

**What were the key provisions of the program (e.g. eligibility, qualifications for allocation, transferability)?**

The RBFM system that came into effect in 1991 made it mandatory for all professional operators to hold a general fishing license which was issued for one year at a time. In addition, harvesting of certain species, with certain gear or vessels, or in certain areas could also be subject to specific licences. Fishing for own consumption was allowed without a licence, but caches could then not be sold.

Licences could only be issued to vessels that were eligible according to laws nr 3/1988 and were granted licences in 1988 for the years 1988-1990 and had not since been decommissioned. Similar provisions had applied in the years 1984-1987. In essence therefore, licences were granted to vessels that had been eligible for licenses in 1984 and had not been decommissioned. In cases where vessels had been replaced, the quota could be transferred to the new vessels. This provision only applied to vessels that were all 10 GRT or larger. New licenses were therefore not issued unless a vessel similar in size was decommissioned.

Licences could also be issued to vessels 6-10 GRT in size which were registered by the Icelandic Maritime Administration or had been commissioned and were being built. Vessels smaller than 6 GRT in size could opt into the ITQ system but were otherwise subject to effort restrictions (days-at-sea). Almost all preferred the latter option. These boats were issued hook licenses, which drew their name from the fact that the boats were only allowed to employ handline or longline. The quota allocation to vessels smaller than 10 GRT was to be based on fishing history in the years 1987-1989, and the share of the small boat fleet in total catches in 1989.

The Act makes a clear distinction between TAC-shares and annual catch shares (ACEs) where the former indicates the percentage share of each vessel in the fishery, while the latter refers to the annual quota in kg allocated to each vessel. ACE may be defined as the product of TAC-shares and TAC.

In 1984, when a quota system was introduced into the demersal fisheries for the first time, vessel quotas were generally allocated based on fishing history in the period November 1st, 1980 – October 31st, 1983. Newly built vessels and vessels that had a shorter fishing history than 12 months during the reference period could though chose between receiving a vessel quota equal to the average in the fleet segment to which they belonged or operate subject to effort restrictions (number of days-at-sea). A special provision was also made for vessels that had changed ownership

or captains in 1983. This provision though only applied to few cases. When the quota system was extended for another year in 1985, the allocation was primarily based on the allocation in the previous year. Similar provisions were in place when the quota system was extended for another two years in 1986, and when the management system for the years 1988-1990 was agreed upon. Individual vessel quotas did though change during these years in line with changes in TAC and because of changes in quota holdings brought about when vessel owners opted for effort restrictions in 1985-1987, but during those years vessels that took up the effort option could increase their quota shares through increased catches. When a comprehensive ITQ management regime was introduced in 1991, the initial allocation of TAC-shares was based on allocated vessel quotas in 1990. Thus, fishing history in 1980-1983 determined to a large degree the vessel allocation in 1991, although provisions had been made both for new vessels that entered the fishing fleet, as well as ships that had limited fishing experience during the reference period, and changes due to the effort restriction option.

TACs were set for six demersal species and vessel allocated quotas in the above-described fashion. The Act stated that when a new fishery would be included in the management system and a TAC determined for that species, the allocation of individual vessel quotas should be based on fishing history in the previous three fishing seasons.

The TAC-shares were allocated on a permanent basis. The shares were perfectly divisible and could be transferred between vessels provided the vessel quota after the transfer did not exceed the fishing capability of the vessel receiving the quota. Quotas of decommissioned vessels could also be transferred to new vessels. However, when a vessel holding TAC-shares was to be transferred between different communities, the community from where the vessel was to be sold would have first refusal.

ACEs were perfectly divisible and could be transferred between vessels under the same ownership or between vessels operated out of the same home harbour. Other transfers were allowed subject to approval by the Ministry and after consultation by the community from where the quota was to be transferred and the local fishers's union. ACEs in different species but of the same value could though be exchanged between vessels. The Act contained a provision of minimum utilization of ACEs; TAC-shares would be revoked from vessels that utilized less than 25% of their ACEs for two years in succession.

The Act allowed for certain flexibility between species and seasons. Catches of all demersal species except cod could exceed ACEs by up to 5%, provided catches of other species were correspondingly smaller than the ACEs held for these species. Catches could also exceed ACEs by up to 5%, in which case they would be reduced by the same amount the following season. Up to 20% of ACEs could also be carried over to the next fishing season.

## Economic analysis for implementation

Formal models played a minor role in the paradigm shift when the Icelandic government abandoned an effort-control management system and moved instead towards a rights-based management regime. The poor biological state of key fish stocks, most notably cod, and depressed economic state of the fisheries sectors were the fundamental reasons behind this policy change. Opinion was right from the start divided on the decision to change to an ITQ system, and this debate and criticism has continued unabated since.

**What, if any economic analysis or economic models were used at the time of first implementation?**

The first models developed for Icelandic fisheries focused on pelagic species. In 1966, a Danish-Icelandic team constructed a simulation model for fishing and landings of herring while Ingjaldur Hannibalsson in his PhD thesis (1978) focused on the optimal allocation of boats to fishmeal factories in the capelin fishery. The latter model was never used in practice (Ólafsson et al., 1994).

The first models constructed for the demersal fisheries were highly aggregated linear programming optimization models for the demersal fisheries (Helgason, 1981). The main purpose of the models was to estimate the optimal size of the fishing fleet, but the models yielded "bang-bang" results and were never accepted as decision aids.

In 1979, the Ministry of Fisheries set up a working group with experts from the MRI, the Science Institute and the Faculty of Business Administration, University of Iceland, the National Economic Institute (NEI), and others, with the aim to develop a model of the demersal fisheries that could be used as a decision-support tool for the Ministry when formulating management policy in the short- and long-term. Using data stretching over a few decades, the experts at the University of Iceland compiled a detailed simulation model of the demersal fisheries that could be used to predict fish stocks, catches and economic performance, given certain assumptions regarding number of vessels, vessel type and size, gear use, management policy and conditions of fish stocks. The first version, which included only cod, was completed in 1983, as part of the work undertaken by a committee set up in May 1982 by the Minister of Fisheries with the task of revising the current laws on fishing within Iceland's EEZ. The committee delivered its proposals early in 1983, but a bill based on those findings was not put to parliament until in December 1983.

In his doctoral studies, Ragnar Arnason developed a model of the Icelandic demersal fishing industry, which included both a detailed description of the harvesting and processing sectors, and a less detailed analysis of the marketing side (Arnason, 1984, 1990). The model included cod, haddock, and saithe. A computer version of the model was written in Fortran and used to estimate the rent maximizing time-paths for size, composition and effort of the fishing fleet and calculate the maximum rents obtainable from the fisheries. Arnason also wrote two papers in Icelandic on fisheries management that introduced the ideas behind a quota system to policymakers and stakeholders (Arnason 1977, 1980).

In 1988, in accordance with Act no 3/1988, a new committee on fisheries was set up with representatives from political parties and stakeholders. The committee was charged with preparing recommendations for a new management system for the demersal fisheries once the current legislation had run its course in 1990. In particular, the committee was asked to examine the impact Act no 3/1988 had had on the economic performance and efficiency in the fisheries, and how fishing rights could be allocated, including means of not tying the allocation to individual vessels. The committee set up four working groups which were allocated specific tasks. The first one examined how total catches could be determined, fishing licences and fleet size, and undertook a comparison of quota systems and other ways of managing fisheries. The second group analysed how fishing rights could be allocated or sold. The third group focused on who could hold the fishing rights, the duration of the rights and what restrictions should be placed on the disposition of the allocated quotas. The fourth group analysed the fishing fleet and fleet segments, disposition of catches, flow of information, monitoring, control, and surveillance. The working groups delivered their results to the committee which in turn based its recommendations on the main findings.

**What economic data were available at the time of first implementation and how was the data used?**

NEI collected data from various firms and agencies and published regularly. In October 1983, for example, NEI published a volume on private enterprises, that included detailed profit and

loss statements and annual accounts for each industry, as well as information on the number of firms in each industry, their size distribution, the number of employees, and investments. The information was obtained through a survey conducted among a sample of firms in each industry. Most of the data were for the year 1979, but data on size distribution of firms and labour market was more recent. For the fisheries sectors, special operating accounts for the year 1979 were generated for two fleet segments; trawlers and other boats, as well as for the main processing industries; freezing, salting and fishmeal and –oil. The following year, a similar volume was compiled that covered the years 1980 and 1981.

Several reports and models were used in in conjunction with the revision of the management system that took place in 1987 (Ólafsson *et al*., 1994). A more general version of the model developed at the University of Iceland was completed in 1987. This model did not only include cod, but also the other main demersal species. The model revealed that the boat fleet was 20% more efficient in 1984-1986 than in the previous two years when the cod fishery was managed by effort controls. The trawler fleet was also more efficient, but the improvement was though substantially smaller. Variable fisheries costs had also decreased, both as measured by cost per unit catch or value. Days-at-sea were also fewer in the quota system than they had been under effort restrictions.

The analysis undertaken by NEI revealed that although catches per day-at-sea had increased in 1983-1985, and then decreased again in 1986, costs of fuel and gear had not increased correspondingly. Catches per day were higher than before, and the quality of the landed fish better. When the quota system was introduced in 1984 it was hoped that effort would be directed more towards underutilized species, like deep-water prawn. This appeared to have been borne out, leading to increases in the value of total seafood production and exports. NEI also compared the economic performance of trawlers in the quota system to trawlers that had opted for effort restrictions. Results showed that the quota trawlers had registered higher profits than the effort vessels both in 1984 and 1985. NEI also pointed out that transfers of quotas between vessels would improve efficiency in the fisheries even further, as quotas would end up in the hand of those that could make best use of them.

Ragnar Arnason, professor at the Faculty of Business Administration, developed a mathematical model that illustrated the relationship between the value of all quota holdings and total wealth creation in the quota system. Using data on quota transactions, Arnason concluded that the quota market was quite efficient, as transfers between vessels had amounted to 10% of total catches and 25% of all allocated quotas. Most of those transactions were between firms, and not between vessels under the same ownership. The efficiency of the market had been increasing, as indicated by the fact that the number of transactions per year had been rising. Earnings before interest and depreciation had also shown increases year-to-year.

In a separate analysis, Arnason examined changes in total fishing effort during 1978-1986. His study revealed a breakpoint in 1983, with total effort after that year much smaller than before.

## New data and economic models post-implementation

**Were any new economic data collected after the RBFM program was implemented? If so, what data were collected?**

The primary objective of NEI was to construct national accounts and produce analysis for trends and prospects of the Icelandic economy. Part of the work undertaken by NEI consisted of putting together detailed profit and loss statements for individual industries, including the fisheries sectors. The industry data were based on samples of firms in each branch of economic activity, but

this changed in 1997 when NEI began to use the tax records of individual firms to construct industry accounts. At first, the tax data covered 85-90% of all firms, but the coverage is now around 98%.

NEI was disbanded in 2002, with the Central Bank, Ministry of Finance, and Statistics Iceland (SI) taking over the work previously performed by NEI. The data collection from individual industries is now in the hands for SI which publishes the data on its website as well as in special reports. A publication on profitability in fishing and fish processing for the previous year is usually published in December.

The fisheries data are based on tax records for almost all firms in harvesting and processing, as well as on a sample of the largest firms in the fish industries. The large firms often operate many vessels and produce a range of outputs, and the data obtained through the survey can be used to disaggregate the cost data between vessel and gear categories, and production processes. The information now collected by Statistics Iceland on costs associated with harvesting and fish processing is more detailed than the data collected by NEI before 1997. Variable cost is more disaggregated, and there are more fleet segments and processing industries.

The data on the revenue side is also better than that used by NEI. The Directorate of Fisheries (DoF), which was established in 1992, collects information on the quantity and value of all landed catches in Iceland, as well as export value. SI has full access to these data and the information on revenue in the harvesting sector provided by the agency is therefore precise.

Among other duties, DoF handles the issuing of fishing licenses to vessels, allocation of catch rights, and transfers of both ACEs and TAC-shares. The DoF website provides access to all ACE transaction, with information available on the number of ACE transactions for a certain species over a specific period, as well as the total quantity involved, average price, minimum price, and maximum price. The data on TAC-share transactions is poorer, as data are only provided on the holdings of each vessel for each species at the beginning of the fishing year, the net quantity of all transfers during the season, and the holdings at the end of the same fishing year. The value of each transaction is not included so that the price of the TAC-shares cannot be calculated.

**Were any new economic models developed post-implementation**

Due to the huge national importance of the fisheries sectors in Iceland, economic policy has for much of the 20th century focused strongly on the harvesting and processing sectors. Changes in catches and prices in foreign markets, would vibrate through society and cause booms or contractions. The economic performance of the industry was therefore closely monitored, with the government prepared to step in with accommodating measures when seas became troubled.

The models developed by NEI and other experts in the 1980s were very much centred on predicting how catches and effort could develop, given information on stock size and fleet structure and management of the fisheries, and how the fortunes of the fisheries would affect other parts of the economy. The last of these simulation models was a cooperative effort between Icelandic and Norwegian scientists in the early 1990s, which resulted in a model called the Nordic Fisheries Management Model (Wallace and Ólafsson, 1994). The model is an extension of earlier Icelandic modelling efforts and a model developed in by experts in Bergen 1988-1990, and simulated the fishing stocks, fishing quota system and the decision making of individual companies. The model was, however, not used much in Iceland.

The need for these simulation models also became less pressing, both because of the waning national importance of the fisheries and because of the introduction of a the comprehensive ITQ management system in most Icelandic fisheries in 1991. Although fishing is still a significant industry, and earnings from exports of seafood still account for 40% of all exported goods, other branches of economic activity, like aluminium smelting, and tourism, have grown in importance and lessened the reliance on the fishing sectors. The new management system has eroded the

overcapacity that existed in both harvesting and processing, and vastly improved economic performance of the Icelandic fisheries sectors.

In Iceland, the primary emphasis has in the last decades been on improving stock assessment, fishery advice, and knowledge of the marine environment around Iceland. As discussed earlier, data gathering on the fisheries sector has also improved, with more and better data now available.

Less weight has been put on developing models of the Icelandic fisheries, and a comprehensive model like, for instance, Fishrent (Salz *et al.*, 2011) has not been explicitly used for official policy-making although it has been applied to Icelandic fisheries (Nielsen et al., 2018). Three other models may merit a special mention. The first is a non-linear aggregate model of the Danish, Icelandic and Norwegian cod fisheries that uses certain mathematical techniques to generate explicit feedback solutions (Arnason *et al.*, 2004). The second is an end-to-end model of the ecosystem of the Icelandic Waters which uses the Atlantic modelling framework (Sturludottir et al., 2018), while in the third study, multi-criteria analysis was used to assess the impacts of changes in management of the Icelandic cod (Elvarsson *et al.*, 2020).

## Program changes since implementation

**If any, what were the key changes in the RBFM program post-implementation?**

In the current management system, there are two distinct types of general fishing licences; a license with a catch quota, and a licence with a hook and line quota. Vessels cannot employ both kinds of fishing licenses in the same fishing-year. In addition, tourist operators can obtain special permits for boats used for sea-angling tourism. The restriction that licences could only be issued to previous licence-holders was abolished in 1998 when the Supreme Court of Iceland ruled that it was unconstitutional to restrict the right to fish to those holding a title to a vessel during a specific period. Instead, licences may now be issued to all seaworthy vessels that are registered with the Iceland Transport Authority.

All restrictions controlling total fleet capacity were lifted in 1999, and the desired renovations and newbuilding of vessels could therefore by carried out at will (Runolfsson and Arnason, 2001).

When the management came into operation in 1991, owners of most vessels smaller than 6 GRT decided to remain outside the quota system and operate instead under effort restrictions (Matthiasson and Agnarsson, 2010). As mentioned above, these hook-licence boats were only allowed to use handline or longline. During the next decade, fishing of this fleet segment was governed by an intricate web of various effort restrictions, but in 1999 the boat owners were given a choice between transferable fishing days and a quota system. The transition to a quota system started in all earnest in 2001, and in the following years the effort option was slowly phased out. The quota system set up for these boats at first only included vessels smaller than 6 GRT but the upper limit has since been raised to 30 GRT or 15 meters in length. A total quota in cod, haddock, saithe, and wolffish, determined as a certain percentage of the TAC, was set for all the hook-licence boats, with individual vessel allocations in 1999 mostly based on catch history in the fishing-years 19967/1997 and 1997/1998.

Similar provisions regarding TAC-shares and ACEs apply to vessels holding general licenses and hook-licenses but quotas may though not be transferred from boats holding hook-licences to vessels holding general licences. Quota transfers are, however, permitted from larger vessels to boats.

Caps have been introduced on the combined TAC-share holdings of vessels under the same ownership, both for vessels holding general licences and boats holding hook-licences. The cap is lowest for cod, 12% of the total quota allocated to vessels holding general licences, for vessels holding hook-licences the maximum is 4% of total quotas allocated to boats holding hook-licences. For haddock, saithe, and Greenland halibut and other demersal species of significant value, the cap is 20% for vessels holding general licences, but 35% for redfish. Owners of boats holding hook-licences may at most hold 5% of the total haddock quota allocated to all boats holding look-licences. The combined quotas of all vessels holding general licences and under the same ownership can though never exceed 12% of the total value of all species for which TACs have been set. For vessels holding hook-licences the corresponding cap is 5%.

The provisions regarding minimum utilization of the ACEs have also been made stricter. TAC-shares may now be revoked from vessels that utilize less than 50% of ACEs allocated in the current fishing-year.

Since 1991, various amendments have been made to the Fisheries Management Act that have primarily aimed at strengthening harvesting and processing in vulnerable coastal communities. Present legislation thus includes provisions on coastal fishing (Gunnlaugsson et al., 2021), special allocations by the Ministry of Food, Agriculture and Fisheries, and the Rural Institute, and a certain concession for operators of longliners who do not employ on-board baiting machines but have their lines baited on land. Together the quantity set aside for these measures corresponds to 5.3% of the TACs for cod and other important demersal species.

Certain restrictions have also been placed on the provisions regarding fishing more than ACEs. Thus, catches of all demersal species except cod can still exceed ACEs by up to 5%, provided catches of other species were correspondingly smaller than the ACEs held for these species, but the excess can though neither exceed 1.5% of the total ACE for the species in question nor 30% of the ACE for the relevant vessel. The quantity that can be carried over to the next fishing season has also been reduced from 20% to 15% of ACEs in each demersal species.

## Lesson learned

The Icelandic RBFM system has been successful but remains controversial. Efficiency in the Icelandic fisheries has improved, and the economic performance of harvesting and processing firms is vastly better than 30 years ago when the system was introduced, as witnessed by recent estimates of the resource rent generated by the fisheries (Gunnlaugsson & Agnarsson, 2019). The quota system provides good incentives for sustainable harvesting of fish and can be regarded as one of the cornerstones of Icelandic fisheries and important reason Icelandic firms are competitive in international markets.

However, there is also a deep dissatisfaction with the way the fisheries are managed. The closed-club nature of the management has caused resentment, with many unhappy that entry into the fisheries is closed to others than those who can invest in quota. The fact that some have made a financial fortune by selling off the quotas they were grandfathered has also been criticized. The consolidation that has occurred has led to some communities losing some of its quota holdings, and this is claimed by some to be the main reason some of these settlements have fallen on tough times. Many believe the fishing fees currently paid by harvesting firms are too low, and that the state should receive a higher share of the resource rent generated. The high profits generated in recent years by firms in the industry have exacerbated these demands. Some political parties strongly believe that the TAC-shares should not be allocated on a permanent basis but have a certain lifetime and be auctioned.

The quota system in Iceland was first introduced in the demersal fisheries to deal with acute problems at hand, declining stocks, and a loss-making industry. It was not regarded as a permanent solution to these difficulties, as witnessed by the fact that quotas were at first only allocated for a single year. However, as noted by the OECD, "[w]here governments need to ask quickly to avert a crisis," a balance needs to be struck to provide opportunities for stakeholder engagement, without unduly delaying the reform process" (OECED, 2017, p. 13). This stakeholder engagement may have lacked when a comprehensive ITQ system was put into place in 1991, and although overall economic gains may be positive the development since has caused divisions within society.

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# Annex 4: Survey Matrix: Fisheries-Windfarm Interactions and evaluations – approaches, projects, publications, Impact Assessments, Legislations, Compensation schemes, etc.

## Survey Abstract

This Approach Review and Characteristics and Performance Matrix followed by an Approach Summary (Abstract) is used in the international survey on existing approaches, projects, publications, impact assessments, legislations, compensations schemes, etc. (taking into account previous reviews) of fisheries-windfarm interactions in ICES countries and regions. This focus on historical and ongoing case studies and approaches directly addressing economic and social aspects of interactions between fisheries and windfarms (fishing sector, renewable energy sector, catch sector, fleets/fisheries/catches, harbours, communities, regions, nations, internationally, etc). It includes among other collecting information on existing cases of economic/social fisheries-wind-energy interactions and impact assessments that have been carried out in different countries and regions. First, the generic and standardized approach evaluation matrix is given together with explanatory notes for the rows in this matrix. After this the individual case studies and approaches are presented. The survey will give examples of what has been done and what is existing and show how and which criteria have been prioritized. As such it also directly point towards (in the discussion of the survey results) what is needed according to providing economic and social evaluations and providing advice on fisheries-windfarm interactions. As such the survey can directly provide guidelines on that (indicators, scales, methods, etc.).

**Table A4.1. Generic Approach Review and Characteristics and Evaluation Performance Matrix: This Fisheries-Windfarms interaction and evaluation review matrix and list on approaches, projects, publications, impact assessments, compensation schemes, legislation, etc. is used as a matrix template and survey for collecting information on individual approaches.**

| |
|---|
| **0-a) Case Study / Approach / Report / Paper / Impact Assessment / Legislation / Compensation scheme;** |
| **0-b) Contact:** Authors / Contact Persons* / Companies / Organizations; |
| **1) Aim:** Management or research objectives / questions addressed; |

**2) Governance:** Governance /

Manage-ment / Advice / Scientific Guidance provided or needed or addressed; Indicators / Reference levels;

**3) Institutional Set-up:** Bodies involved; Needed partners (Fishery, OWF, Science, Stakeholders, Governance, etc.)

**4a) Type of Evaluation and Approach:** Ecological,

Economic, Social, Mixed, Long-term, Short-term, Dynamic, Static, etc.;

Basic Evaluatoin Methods used (Analytical-Observation, Model, Simulation, Optimization, Stochastic, Iteration, Qualitative indicator, projection, Static, etc.);

Linking / Coupling / Integration;

**4b) Structure**, Scales and Dimensions of Evaluation;

**5) Focus and Trade-offs** and Controversies; Usefullness of the Approach (pros, cons, limitations, problems);

**6) Data / Information** in Case study / Approach:

- Needed

- Available

- Used

**7) Status for Application / Implementation:**

Approach output (Type / Format);

Effects: Economic / Ecological / Social / Governance / Linked

(Fishery~OWF);

**8) Dissemination:** Published / Approach Platform / Accessibility / Programming Language / Programs (freeware, commercial) / etc.

The Generic Approach Evaluation Matrix summarizes most importantly the below information which gives explanatory text to the rows in the survey table on the approaches with respect to the collective experience with and collective consensus on the approaches.

For each of the topics in the matrix the answers could be given according to a scaling of the degree / level (of the approaches), i.e. low, medium, high.

As such each bullet (row or column) could be used as an axis in a multidimensional diagram showing the coverage of all the approaches according to this scaling.

1. Aim: Management questions addressed and/or relevant research questions the approach address: Aim and management objectives and/or research objectives addressed such as biological or socio-economic objectives? Recipients: intended / realized in management and/or research? Type of regulatory framework used (key initial provisions, requirements, qualification criteria, actual measures)? Harvest rules addressed, e.g. can the model address impacts of closures (technical measures) in fishery in relation to wind farms? Do the approach focus on fisheries or wind farm impacts / consequences or both? Is the approach used for environmental impact assessment and/or economic and social impact analyses? Key controversies / conflicts? Potential compensation: Is the approach used to evaluate and estimate compensations or compensation schemes? Does the case study (approach) cover existence of compensatory schemes that e.g. have been presented as remedial measures to possible losses, if any, and if this compensation comes from public or from private funding? Does the case study address and does the approach describe actual legislation for compensations/mitigations in relation to fisheries-windfarm interactions

and impact assessments? What research topics does the approach cover? What is the intended use of the outcome of the research?

2. Governance: Corresponding advice (biological and economic and social) or governance or scientific guidance the approach provides: Whether and how the approach has been used in management, advice, practical evaluations, scientific guidelines and output, etc., according to policy (management directive, national legislation, etc.) or strategy or for specific evaluation call/announcement, i.e. has it been used in relation to advice and management and actual evaluation (e.g. scientific evaluation)? What type of management and/or scientific advice such as biological / economic / social advice or scientific guidance (according to objectives, indicators, reference points, etc.)? Which indicators are used and/or produced for advice and/or scientific guidance? Qualitative or quantitative indicator based output? Reference levels for indicators included? Time frame on short (1 year) to medium term (2-3 years) current advice and/or medium (2-3 years) to long-term (>3 years) strategic advice / evaluation / guidance? Type of results coming from the use and implementation of the approach (see also usefulness and implementation of the approach below)? Other approaches use of output from the approach?

3. Institutional set-up and platforms for the approach: This is split up in relation to management and advice and scientific purposes, but also in relation to who is involved and necessary to involve in developing, informing, implementing and conducting the approach and evaluation (see also needed partners below). In both cases it shall indicate where and in which context the approach was developed and/or used and/or where supposed to be used (should be used), i.e. split into intended / realized. Also, information on whether approach output has been validated or not is given here. Who have called for and launched and financed the approach, who are the recipients, and who are conducting the approach / evaluations: Intended / realized providers and recipients? Public evaluations, public institutions, private and consultancy companies, etc.? Fishery cooperative formation in relation to OWF for example?

Needed partners: Involved partners and/or needed partners for partly developing, informing, using, and implementing the approach? This involves contributions and information from stakeholders (e.g. industry (fisheries, wind sector), management, advice, science), needed partners, institutions, platforms, capacity building, etc. Also it includes information on whether the approach has been well scientifically documented or not?

4. Type of evaluation and approach: Ecological (biological), Economic, Social, Bio-Economic, Socio-Economic, i.e. type and characteristics with respect to which parts the approach contains such as biological, economic, social, fishery, windfarm, management, implementation, etc.? Which level or part of the system does the approach address: ecosystem (ecosystem / habitat / multispecies / single species / single-stock) and/or economic system (fishery system / fishery sector / fisheries catch sector / fleets / fisheries / individual vessels / wind energy system and sector / windfarms offshore sector OWF / windfarms inshore sector / other) and/or, sociological system (same categories as for economic system)? Maritime cross sector economics and social aspects (broader socio-economics)? What is the orientation of the approach with respect to management regimes, advice and advisory or scientific evaluation types it can address - can it only handle one orientation or several? Also, to address this, it is informed what level and complexity of the systems the approach address and was intended to address (complex or simple type approaches), time range in form of short to medium term projections and advice/management/evaluation or/and medium-long-term strategic projections and advice/management/evaluation with respect to type of approach?

Type of approach with respect to evaluation method: Analytical tool/observation approach, or simulation approach (what if? trade-offs scenario simulation), or optimization of objective function (what´s best?), or deterministic or stochastic approach, or Iteration (MCMC) approach, or qualitative indicator approach or other, or combinations of the above? Is the approach capable of performing a projection or evaluating static scenarios? Is the approach (e.g. the Impact Assessment) static (i.e. a snapshot of the possible losses), or dynamic (possibly long-term gain after recovery etc.), empirical or based on modelling? If empirically based, was it a Control-Impact, or BACI, or BAG etc.? If modelling-based was it your entries in your matrix etc.? Can the approach consider uncertainty (and in given case on which parameters)? Is parameter estimation stochastic or deterministic? Can sensitivity tests be performed with the approach (and in given case with which method and on which parameters)? Are there behavioral components included to model human behavior in the approach, i.e. is behavior explicit (behavior as high uncertainty factor)? Approach output indicators and approach performance criteria (and precision and robustness and risk assessment)?

Approach linking, coupling and level of integration: What level of integration of biology, economy, and sociology is there in the approach and what are the links between the components, e.g. how are the economic and biological and social components linked to provide management advice or scientific evaluation? Main components of the approach, e.g. separate components for the biological and economic and social procedures as well as sector specific procedures? Coupling of biological-economic-social operating approaches: dynamic / static / equilibrium e.g. static representation of the economy? How is fishery and windfarms linked? Is there dynamic full feedback and integration between different parts (modules), i.e. is it fully integrated and highly detailed or is it a less integrated, simple or static approach? Micro-scale or macroscale feedback? Feedback according to strategic or tactic goals of the approach? Uncertainty in feedback approaches in relation to medium term or long-term projections?

Approach dimensions and approach structure: Approach dimensions and scales (spatial explicit with flexible spatial dis-aggregation and/or area specific and/or regional and/or global? Seasonal explicit with months or seasons or yearly based or long-term based ? What spatial and temporal resolution and scale does the approach operate on? Local or national or regional? Does the approach cover the level of detail needed to capture realism sufficient for management, advice and scientific evaluation?

5. Focus and trade-offs and key controversies: What is (and can be) addressed in the approach and case studies and what cannot (in relation to the main aim of the approach and main questions to be answered and main scientific/advisory/management scenarios/options/problems to be addressed)? How is the approach used (generic or case specific; strategic or tactical; short to medium term or long term)? Is the approach balanced according to trade-offs between using fully integrated and highly detailed dynamic approaches or less integrated, simpler or static approaches? Is the approach used for environmental impact assessment and/or economic impact analyses, and/or to evaluate and estimate compensations or compensation schemes? Key controversies addressed or coming out of the approach?

Usefulness of the approach: In which context is it useful and where are there detected problems (pro, cons, limitations, problems) - this is mainly in respect of use and implementation but naturally also addresses the development of the approach?

6. Data or information requirements and implementation (data required / available / used): Approach input, data need, parameters, and functions (with respect to data need what resources and information is required such as high or low quantity of data need? Including specification

of approach variables and parameters – both endogenous and exogenous? Requirement of data from special databases and/or sampling systems? Available data (data collection frame-works)? Any estimations necessary or data processing needed before the approach can be applied? Handling data rich or data-limited systems; with respect to values such as market values or broader non-market values what does the approach use: market values, consumer utility functions, price elasticity, non-market values for certain parts, shadow values with the protection of certain parts, can the approach/method/model follow a value chain and how far, etc.? Fishery data (catch sector - logbook, sales slips, VMS/AIS/logger, catch, effort, prices, revenue, costs, GVA, types of gears/vessels/fisheries/fleets; land-based sector economics – processing industry and potentially follow business – revenue, prices, costs, GVA)? Wind farm data (sea based sector and land-based sector economics - energy production, prices, revenue, costs, GVA)? Social information, e.g. employment data?

7. Status for the development, application, implementation, output and use of the approach in case studies: Output and effects estimated from the approach (economic, social e.g. employment, fisheries catch and effort e.g. catch change or effort reallocation/reduction, OWF/windfarm placement/dimensions, effects on other sectors, ecological/fish stock effects and sustainability, etc.)? Governance: Regulations made according to fishery - wind farm interactions? Approach use in advice and/or management and/or scientific evaluation/guidance as well as decision tools obtained – and how or why / why not? Which sector most benefitted by the regulation? Fishery cooperation formation in relation to wind / OWF? Compensation schemes (economic / other) ? What makes the approach informative and useful to policy-makers and stakeholders (user-friendliness, flexibility, complexity)? What improves or impedes the approach acceptance and how can we best communicate the approach and its results and learn from it? The challenges and processes involved in the implementation? Important to obtain information from the approach developers on this as well as on the progress and problems in this, and why it is so? Is the approach well documented scientifically? Is the approach only developed and used for either or scientific purposes / advice purposes / evaluation purposes / management purposes? Progress of linking biological and economic and socio-economic operating parts in the approach?

8. Dissemination of the approach: Links and References for scientific literature and technical and advisory reports - including a reference list for each approach? Guidelines for use and websites?