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# 1.1 Fisheries enforcement with a stochastic response function

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Fishers' response to the enforcement of fisheries management rules is generally not known with certainty. There are many reasons for this. Different fishers have different risk attitudes and the composition of active fishers is usually not known beforehand. Fishers' profit functions are usually imperfectly known and parameters such as prices are variable over time and, to some extent at least, stochastic from the perspective of the fisheries manager.

It follows that the enforcement of fisheries rules is usefully perceived as a stochastic problem. This paper investigates some of the implications. Among other things, it attempts to derive and explain certain necessary modifications to rules of optimal enforcement. To illustrate these principles it produces numerical stochastic simulation results. Finally, the paper discusses the practical issue of incorporating this stochasticity in practical fisheries models.

## 1.2 Random Penalties within fisheries

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In fisheries compliance and enforcement problems arises. This makes individual catches unobservable and, consequently, moral hazard problems arise. In order to attempts to solve these problems we may draw on the non-point pollution literature and in this paper it is proposed to apply the random penalty mechanism by Xepapadeas (1991). Because individual catches is unobservable total catches, measured throughout stock size, is the penalty variable. If aggregated catches is below optimal catches each fisherman receives a subsidy, while two possibilities exist if catches is above optimal catches. First, the fisherman can get randomly selected and shall pay a fine. Second, the fisherman is not selected and receives a subsidy. By proper selection of the subsidies and fine is can be shown that expected optimal individual catches is reached. Thereby, the compliance and enforcement problem within fisheries is solved.

# 1.3 Non-Compliance in Fisheries: A Corporate Crime Perspective

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Non-compliance with fisheries regulations occurs in most commercial fisheries. In the traditional fisheries economics law enforcement literature, this is dealt with by treating the fishing firm as one cohesive unit or individual. The fishing firm is typically assumed to violate a regulation if the expected gains are larger than the expected fine/punishment associated with the violation. However, in many cases violations are not committed by an individual, but by a collective entity or by agents acting on behalf of a collective entity. This calls for analysing the principal-agent relationship of the fishing firm and integrating this into the economic model of crime. We analyse the case in which the employees (the crew) do not necessarily obtain any direct benefits from corporate crime. The owner of the fishing firm may, on the other hand, benefit from such activity. Hence, the structure of the compensation scheme facing the employees may be set up to induce them to commit offences. In this paper, we study these aspects of non-compliance in fisheries and implications for enforcement.

# 2.1 Towards Bio-Economic Stock Assessment through Open-Source Framework: a Case-Study of Baltic Salmon

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The paper puts forward a model currently used in the Baltic salmon stocks assessment. The model accounts for full life-history of 15 naturally reproducing and 4 hatchery-reared salmon stocks. Designed to give economically and biologically sound management recommendations, the model accounts four countries whose fleets target salmon with different types of gear in a different time of year. It is calibrated by using the latest stock assessment results and salmon price and fishing costs data from the four countries. The model is executed by using FLR framework (Fisheries Library for R) that is an open-source framework that promotes both the transparency of modelling and the co-operation of fisheries biologists and fisheries economists. The model is used to run different scenarios for catch and effort options and the model outcome results both the status of the stocks and the economic performance of the fishing fleet. Further, the analysis includes a game theoretical study of the allocation of total allowable catch (TAC) between the four countries. The model is easy to apply for every commercial fishery and therefore provides a general tool for bio-economic stock assessment.

## 2.2. A biological, economic and social impact assessment of the Long Term Management Plans for Sole and Plaice in the southern North Sea

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The main objective of this paper is to report on the first attempt to conduct a biological-economic-social impact assessment of a long term management plan within the EU.

A long term management proposal for plaice and sole in the North Sea was adopted by the European Commission in January 2006. The Commission drew up terms of reference for assessing social, economic and environmental impacts of the plan and an STECF working group of independent experts met for four days in September 2006 to develop impact assessments.

This paper reviews the processes and methods used in arranging and preparing the impact assessments, the outcomes of the working group and subsequent discussions by the STECF plenary committee. The strengths and weaknesses of the approach are evaluated in comparison to best practice for integrated impact assessments.

Several shortcomings the in process and methods were identified, including lack of preparation and follow up time, lack of integrated data sets and modelling tools for economic and biological modelling, and lack of appropriate data for social impact assessments. It was noted that ideally, an impact assessment should be conducted prior to selection of the proposed plan so that the outcomes can inform the choice of plan. The working group report was considered by the STECF plenary committee to contain some inconsistent or poorly explained findings. A follow-up working group was convened to address specific questions.

In conclusion, this process did not deliver a successful output but has shown the necessary processes, data, tools and inter-disciplinary liaisons required to achieve success.

## 2.3 Socioeconomic Considerations To Inform A Decision Whether Or Not To List Three Populations Of Atlantic Cod Under Canada's Species At Risk Act

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Historically, Atlantic cod was an extremely important component of the fishery in Canada's Atlantic Provinces and Québec. However, in the early 1990's it became clear that cod populations were in distress. Many stocks were closed to fishing in 1992/93. Cod management through the 1990's and into the early 2000's focused on the recovery of a collapsed fishery. Moratoria on directed fishing of many cod stocks prevail to this day, throughout much of Canada's Exclusive Economic Zone.

In 2005, three populations of Atlantic cod were recommended for listing under Canada's new *Species at Risk Act (SARA)*. This new Act required the Canadian Cabinet of Ministers to consider the potential socio-economic impacts of a potential listing under SARA before making a decision whether or not to add these populations to the list and thereby extend the protections of the Act to them.

In order to inform this decision, an analysis was conducted to attempt to estimate the potential socio-economic impacts of listing these populations, including examining the impact of adopting certain fisheries management scenarios that restricted or eliminated fishing mortality. This paper presents the results of the analysis. Both the immediate and long-term impacts were analysed. The immediate impacts included potential foregone revenue and jobs in both the harvesting and processing sectors, while the long term impacts included the potential future benefits from increased harvesting and processing revenues resulting from the potential increased productivity of a larger stock that had been protected from fishing due to the listing.

## 2.4. A modelling perspective on impact assessments

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Current EU legislation requires that every management plan proposed by the Commission is also evaluated from an economic perspective, before being implemented. The first plan considered by a STECF working group was the long term management proposal for plaice and sole in the North Sea (SGECA-SGRST-06-05).

The paper describes the model used to make impact assessments for different fleets. The approach was to combine long term biological stock assessment from ICES with an economic model. The model used was the EIAA-model (Economic Interpretation of ACFM Advice), modified to cope with long term assessment.

The objective of this paper, is to describe some of the most controversial modelling aspects encountered, when making the impact assessment of long term management plan for flat fish. Emphasis is placed on the production function and the assumptions that are related to this. The challenges making impacts assessments in mixed fisheries are furthermore discussed. The importance of making the “right” assumptions regarding production function and mixed fisheries is shown by some examples from the STECF flatfish meeting.

Topics which needs to be considered in future impact assessment studies is also addressed, and it is the hope that this paper will serve as inspiration for fisheries economists to go more into detail with some of the crucial and fundamental issues of impact assessments that needs to be considered in the future.

# 3.1 Inefficiencies of effort restrictions in fisheries management – An empirical study

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Icelanders gradually adopted an Individual Transferable Quota (ITQ) system in the Icelandic fisheries. This property rights based system yielded benefits to the economy but was not applied to all fishermen. Some fishermen remained outside of the ITQ system and were subject to other management measures. In this paper we investigate the effects of various effort restrictions on the behaviour of fishermen outside of the ITQ system. Empirical estimates from duration model analysis are presented which measure the effects of various management measures aimed at effecting the behaviour of those ‘outsiders’ as well as the indirect effect of the ITQ system on the behaviour of those who stayed outside of it. The conclusions show that outsiders had incentives to stay outside of the ITQ system and free-rided from the behaviour of the ITQ fleet. Management measures aimed at restricting their effort proved to be useless. The conclusions can be generalized to other situations where property rights based management systems are used and economic agents harvest a common resource pool.

## 3.2 Economic Data Collection of the Fishing Fleet: What are we aiming for?

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Although all European Member States provide data to the European Union on their national fishing fleet, it is still quite difficult to compare these figures. The reason behind this is that some member states are using thresholds based on the activity level of the fleet and some are not. From 2004 onwards, each EU member state is obliged to collect economic information on their fishing fleet, which is defined as all vessels registered in the EU fishing fleet register. This implies that Member States also have to submit data about a large number of commercially inactive vessels. This paper questions whether the goal of the DCR is served by including these commercially inactive vessels.

Including these vessels in the sample population has important impacts, both on the effort involved in composing the sample as on sampling results. This paper investigates the economic importance of the commercially inactive fishing fleet in The Netherlands and shows that for this large group of vessels (55% of the registered fleet) the economic importance is negligible. In addition to this investigation, this paper shows that it is relatively easy to estimate the main economic indicators from readily available data sources. This data should be enough to have a general idea on the economic potential of the non-commercial fishing fleet.

Based on these conclusions, it is proposed that a distinction be drawn between commercially active and inactive vessels based on a minimum income from fishing, as is already done in the agricultural data collection system. Collection of economic data by Member States should primarily focus on commercially active fleet segments; data about the commercially inactive fleet can be estimated. Thus it should be sufficient to send out an additional survey only once every few years to check whether the economic estimators are still correctly calculated.

## 3.3 Community Transferable Fishing Quota: The Best of Both worlds?

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The decline of fish stocks worldwide has often been attributed to problems inherent with resources that are treated as common property. The common practice around the North Sea is the allocation of fixed TAC shares to States which in turn utilise specific allocation systems that guarantee each fishing company a more or less fixed share of the national quota.

This individual quota management, and especially the system of ITQs, has been criticized for inducing behaviour that contradicts the goal of sustainability and secondly for disregarding societal factors. Especially in regions considered fisheries dependent, such as Finmark in Norway, Shetland in the UK and in Iceland, the debate centres on possibilities of introducing Community Fishing Rights or a system of community transferable quota in order to maintain local fisheries communities.

This paper discusses the back ground of the debate and seeks to assess whether the incentives to achieve a situation of optimal allocation of resources (labour, capital and fish stocks) can be cohesive with a strive to counter the trend of marginalisation of fisheries dependent regions.

## 3.4 Evaluation of the Capital Value, Investments and Capital Costs in the Fishery Sector: The Italian Case

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The main objectives of this study has been to find a proper method for the evaluation of the capital value and of capital costs in the fishery sector.

Taking into account that the Perpetual Inventory Method (PIM) has become the most important international standard for valuation of tangible capital goods, the study has focused on the application of the PIM to the Italian fishing fleet. PIM proposes to determine the aggregate value of the tangible capital goods used in the current year by aggregation of the value of all vintages (year classes). Such aggregation can be based either on historical, current or constant prices. Once the value of the capital goods in a given benchmark year has been determined, the capital value of each subsequent year is calculated by adding investments of that year (gross capital formation), revaluing the existing stock and subtracting value of capital goods taken out of operation. The capital costs (depreciation and interest) are then calculated, using agreed depreciation schedule and interest rate. Different schedules of depreciation can be applied in both approaches, although the linear depreciation seems most popular.

It is important to stress that there is no one unique single definition of capital value and capital costs. The definition to be used depends on the analytical purpose. Two fundamentally different types of analysis are distinguished: a) macro (economic) approach, which values capital at replacement (current) prices and accounts for opportunity costs and b) micro (fiscal) approach, which is close to fiscal accounting, values capital at historical prices and accounts only for interest costs paid.

## 3.5 Rights based management in the UK – The Shetland Experience

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Community quota (CQ) schemes have been introduced in some UK fishery-dependent areas in an attempt to address the detrimental effects of the current market based approach to quota management.

The most established and largest scheme operated in the Shetland Isles, where concerns grew that, as the trade in quota developed, local quota holdings would be traded out-with the community to the detriment of the island economy and its inhabitants.

The Shetland Fish Producers Organisation (SFPO) subsequently became the first UK Producer Organisation (PO) to purchase commercial fishing quota in its own right to ensure the Shetland whitefish fleet had the fishing opportunities necessary to safeguard employment for current and future generations of local fishermen.

After an investigation by the European Commission (EC), in 2003 the Shetland Community Quota (CQ) scheme was found to contravene European Union (EU) State Aid law and deemed incompatible with the rules of the common market.

This paper provides a qualitative assessment of the Shetland CQ scheme, both before and after the EU ruling. Significant changes were required to allow the scheme to continue, however these changes removed any real benefit afforded to Shetland fishermen.

The question that arises from the Shetland CQ experience is; can CQ schemes designed to benefit local communities be compatible with EU State Aid Law and the rules of the common market?

The Shetland experience suggests other regions thinking of setting up CQ schemes may find it hard to achieve their original objectives. The current approach to rights-based management (RBM) could therefore be improved to address both the social and economic objectives of the UK fishing fleet.

## 3.6 Right based and effort management tools and the role of the European Management Fund

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It is generally recognised that, because of the physical nature of the Mediterranean and of the artisanal multigear, multispecies features of its fisheries, effort based management is the best solution for achieving a sustainable exploitation of its living aquatic resources. EU and the CGPM have adopted this position since a long time, but I would suggest that, as far the Mediterranean is concerned, effort is only a part of the many measures needed to manage fish stocks.

While it is difficult to estimate the impact of each single measure with respect to the status of biological resources, it is nevertheless possible to draw some conclusion on the effectiveness of the effort reduction schemes. A preliminary conclusion is that an effort based management strategy is a necessary, but not sufficient, condition for successfully achieving a better state of stocks, either in case of small scale fisheries and in the case of larger fleet segments.

Better results can be expected in case effort is part of a local management plan, together with other measures specifically tailored for a given area, whose dimension could vary according to the specific fishery. The EFF provides for such a strategy and, for what small scale sector is concerned, management plans are consistent with the introduction of territorial use rights, following a co-management approach. Effort based management schemes, namely days at sea, also play an important role in case of larger fleet segments, mainly trawl fishery.

In these cases also, evidence shows that results are largely variable according to the specific area and fleet. As far as activity is not limited by any management scheme, reduction in capacity leads to an increase in activity in most cases, but it is true that a reduction in days at sea is often experienced. A firm conclusion cannot be achieved and fishermen behaviours clearly show that its importance and intensity can consistently vary.

## 3.7 Effects of foreshortening of transferred quota in an ITQ market

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This paper models and investigates the foreshortening of transferred quota which is applied in the Norwegian fisheries management. This reduction in the transferred quota amount by 20% is then redistributed amongst all vessels in the relevant vessel group. It is shown that fishing units are operated longer, and capital is renewed at a slower rate under foreshortening than if foreshortening is not used by the government. Under some conditions foreshortening is a disadvantage for old firms.

## 3.8 Socially Optimal Allocation of Fish Resources among Competing Uses: A Dynamic allocation model applied to Western Australia's Wet Line fishery

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Resource sharing is emerging as an important policy area in fisheries management in Australia and New Zealand. Various jurisdictions are considering formal allocation systems in which economic values play a role.

This paper presents a model of allocation that in principle allows allocation decisions to be made explicitly with a focus on maximizing the social value of the fishery and applies it to the wetline fishery in Western Australia. A starting allocation point is established based on equating the estimated marginal net benefits from recreational and commercial use. These estimates are derived from contingent valuation surveys of recreational fishers and production, revenue and cost surveys of commercial fishers. Optimal allocation over time is estimated based on an equilibrium model in which key drivers of changes in the respective marginal benefits over time, such as population, real incomes, the income elasticity of demand for recreational fishing and development of aquaculture supply, are explicitly incorporated into a model that then equates marginal net benefits over a five year period.

The results show the optimal compared to the actual allocation of the sustainable harvest currently, how adjusting intra-sectoral allocations could make improvements and how optimal inter-sectoral allocations will change over time. The results indicate that inter-sectoral allocation planning could potentially be made more strategic by applying a model which explicitly takes account of expected changes in marginal net benefits over time and allows a time path of allocation to be determined. The paper recognizes that research results like those presented are still a long way from being incorporated in any actual allocation regime and the paper considers the range of issues that would have to be addressed in designing an actual allocation framework that incorporates formal modeling and valuation as a part of the decision making process.

### 3.9. The “*fishing local systems*” as a competitive key factor for fisheries resources co-management: The case of Sardinia

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Agri-food production systems, as well as fisheries and aquaculture, work today in a new competitive arena where the *territory* plays a prominent role. Each territory is characterized for the presence of a close network of social, economic, historical and cultural relationship, all together defining a specific way to produce. So, it is important to analyse the extra economic linkages between the firms and the *territory* in which they work. More in detail, the analysis has to make reference to an organizational model similar to the *district* one, because fisheries and aquaculture production systems, as well as the other economic activities, must observe the requirements of this integrated conception of local development. The identification of the local systems of fisheries and aquaculture becomes, therefore, an essential strategic option in order to approach EU Fisheries and Cohesion Funds 2007/2013 and for an effective management of the fisheries resources. With reference to the last argument, special ‘fisheries districts’ can be considered the institutional basis of a successful cooperative management of local fisheries resources.

This paper proposes a methodology devoted to the identification and the characterization of fisheries local systems, which is preliminary to more deepened and accurate empirical studies. A factorial analysis has been applied to Sardinia Census dataset (Istat, 2001) in order to draw, on the basis of some socio-economic variables, a regional map of the different types of Labour Local Systems, preliminarily identified as specialized for fisheries and aquaculture. This analysis is a part of a wider research project aimed to design the Sardinian Plan of Fisheries and Aquaculture.

## 3.10 West of Scotland Nephrops Fishery – A review of the management objectives in the nephrops fishery

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The main objective of this research is to help inform efforts, by government and industry, to identify effective solutions to the issues adversely affecting the profitability of vessel businesses and the sustainability of nephrops stocks in the west of Scotland region. This research raises the question of whether current management rules, especially allocation of fishing rights, are designed to deliver the desired balance of profits and employment against higher total profit from the nephrops fishery. The appropriateness and effectiveness of management measures in the west of Scotland nephrops fishery are also examined.

During early 2006, the Seafish economics team conducted structured interviews with nephrops processors, vessel owners and skippers about the issues affecting the west of Scotland Nephrops fishery. Interview answers were analysed using quantitative and qualitative techniques. Responses received enabled us to characterise the issues facing the fishery along with fishermen's views of some potential solutions to issues.

Making sure that management measures deliver the required balance between profits and employment is complicated, however understanding stakeholder preferences is the first step in ensuring that management measures are likely to deliver what is wanted.

The survey findings could form the basis of discussion between industry groups and the fisheries administration seeking to make some improvements to management measures and practices. However, further research is required to answer the question of the balance between employment and profit in management objectives.

## 3.11 A quest to diversify the Belgian fleet: an economic evaluation.

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This paper evaluates the possibility of diversifying the overspecialized Belgian fishery fleet structure by vessel types. This diversification seems necessary because the fleet currently lacks economic stability (company profits are decreasing) due to decreasing production and increasing costs. The overspecialisation of the Belgian fleet is double, both towards target species (mainly sole and plaice) and towards the fishing method (over 85% of the fleet consists of beam trawlers) (Tessens and Velghe 2004, 2005). Only the last overspecialisation is taken into account in this paper.

This paper firstly statistically analyses the economic data of the Belgian beam trawling sub fleet. This statistical analysis sheds light on the economic differences between the different beam trawlers (eurocutter, large beam trawler and shrimp trawler). Secondly, the same analyses are performed on the few Belgian vessels using passive fishing methods (i.e. set netters). Thirdly, five multivariate statistical analyses between the vessel types are performed to research if diversification of the fleet is possible and necessary. We hypothesize that these multivariate analyses will be unveiling the differences in catch composition, fishing effort, fuel effectiveness and profitability between the different vessel types. This study contributes to the current strategic thought of converting and diversifying the Belgian fishery fleet which is vividly present in the heads of Belgian scientists.

## 3.12 Pulse fishery: A more environment friendly and economic alternative for beam trawl on flatfish?

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Whereas in the past technological development of fishing gear and fishing methods was aimed to increase production, the present situation is quite different now. Many stocks are over-fished and possibilities to expand fishery on underexploited resources are very limited. Beside that, concerns about the environmental impact of fisheries are growing more and more. Development of gear is now much more focussed on selectivity and reduction of impact on environment.

The traditional beam trawl is the most commonly used fishing gear in the Dutch North Sea fisheries, mainly to catch flatfish such as sole and plaice. Recently an experimental project on pulse fishery was started in the Netherlands. One Dutch beam trawler used pulse gear to catch flatfish and during the trips, research was done in the field of effects (saving) on benthos, discards and selectivity, fuel consumption and the quality of caught and landed fish. Fishing effort, catches, prices of fish, (extra) investments and costs and earnings were monitored during this period and outcomes were compared with those of reference vessels. During the experiment, fuel prices rose to a very high level.

In this paper, the pulse method is explained briefly and the first economic results and opportunities and threats for the Dutch fishery sector are presented. More studies on effects on ecology and economic performance of pulse fishery are still going on and the first results will be published soon.

# 3.13 Cooperative or non-cooperative fisheries management of straddling stocks in the Patagonian Large Marine Ecosystem: An economic perspective

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The Patagonian Large Marine Ecosystem (PLME) is one of the most productive ecosystems in the world, with important commercial straddling stocks such as the Argentine short-fin squid, the common squid, the Argentine hake, the southern blue whiting and the Patagonian toothfish.

The need to explore the importance of straddling resource management is supported by the fact that this is a critical issue in international fisheries management because of these resources are exploited by the distant-water fleets' activity in the adjacent zone of the Argentina Economic Exclusive Zone and Malvinas/Falkland Islands conservation zones. However, little research has been done on economic perspective of straddling stocks in the region. Therefore, after reviewing the UNCLOS and 1995 UN Fish Stocks Agreement provisions on straddling stocks, this paper presents the first comprehensive attempt to analyze and discuss elementary game theory concepts that could be applied to these stocks. Possible and future extensions of this work include (i) discussions on the application of the game theory to the analysis of strategic interactions between all players involved, and (ii) an empirical analysis of the exploitation of straddling stocks to investigate the economic benefits of cooperative and non-cooperative fisheries management.

# 4.1 When will trade restrictions affect producer behavior: Oligopsony power in international trade

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The exploitation of oligopsony power is an increasingly important topic for a number of reasons. There has also been a recent increase in trade measures against countries whose production practices are perceived as unacceptable or unfair. The trade measures have been undertaken due to environmental, social and anti-dumping concerns. The common feature of these measures is that their effect depends on the importer's market power. In this paper, we derive a residual supply schedule to investigate the degree of oligopsony power. An empirical application is provided for U.S. swordfish imports, and the results indicate that the U.S. has market power against four of the six countries investigated.

## 4.2 Risk perception and risk management in Norwegian aquaculture

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This exploratory study seeks to provide empirical knowledge about fish farmers' risk attitudes, risk sources, and risk management tools by presenting the results from a survey among Norwegian fish farming companies. The results show that fish farmers think of themselves as only moderately risk averse compared, for instance, to crop and livestock farmers. The most important sources of risk are considered to be future salmon prices, institutional risks, and fish diseases, while keeping costs low is the most important risk management tool.

## 4.3 Substitution between salmon and white fish species on the French market: An empirical evidence

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Substitution effects between farmed and wild caught species have become a traditional issue in seafood market analysis with the growing importance of aquaculture in the global supply of aquatic products. In the early nineties, salmon imports were suspected to be the cause of the fall in domestic white fish prices, especially on the French market. However, a few economic studies have generally failed to demonstrate the substitutability between salmon and a few white fish species, therefore concluding to the neutrality of farmed salmon imports, either on the French or European markets.

In the present study, an AIDS model is estimated in a VECM framework with monthly price and quantity data at the retail level of the French marketing chain for a set of fresh wild caught gadiform species (cod, hake, saithe and whiting) and fresh salmon. Four cointegration vectors are found for a five goods AIDS, which allow to identify exactly all equations in the model. The results lead to clear conclusions: over the period 1988-2005, salmon is proved to be a close substitute to cod in France. The results also suggest that this substitution effect is higher for the second half of the period as the market share of big retail stores is increasing. The main characteristics of fish farming production do fit with the organisational changes that have occurred in the supply chain. Methodological and policy implications of this new empirical result are discussed.

## 4.4 A demand analysis for farmed fish in Spain

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In this paper, we study a complete demand system for fish species of aquaculture origin in Spain, using a recently available data basis from January-2004 to December-2006. Several specifications of the linear almost ideal demand model are tested. Own price demand elasticities for seabream and trout are elastic. Trout, salmon and turbot are price inelastic. Fish expenditure elasticity for seabream is very low, and seabass is a luxury among fishes. There is a complex and interesting complementarity pattern.

## 4.5 Household demand for seafood and other animal products in Spain

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This paper continues the analysis by Millán and Aldaz (IIFET2006) in which only seafood demand is analysed. In this paper, censored demand systems of household seafood and other products of animal origin are estimated with a two step procedure, using cross-section data from Surveys of Consumption Expenditure in Spain for 1981, 1991 and 1998. Contrary to findings in the single demand analysis above, there is no evidence of increasing own price elasticities. On the other hand, very important changes in complementarity and substitution patterns are in line with our previous study. Very interestingly, there is evidence of increasing expenditure elasticity for seafood.

## 4.6. Is the French angler market integrated? A copula functions approach

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As in a number of other sectors, the opening of the seafood market to the world market should mean a liberalization of prices with a disappearance of exportation assistance, and even assistance for price support (such as withdrawal price levels for the fishing industry). In addition, certain species are already subject to large price variations and to an established seasonality. In this context, it appears essential to be prepared to manage price risk as soon as there are weak profit margins for the operators and/or high price volatility.

The use of financial derivatives helps achieve this objective as we can see already in the agricultural sector for certain crops. But before, we need to evaluate the possibility to launch a representative price index. Indeed, it is difficult to have a liquid derivatives market if the underlying spot market is not one. The fresh angler markets have two difficulties from this point of view. First the production of fish depends on the Size, the Presentation of the product, and the Quality (SPQ henceforth), as well as the concerned fishing port. Second, landed quantities are uncertain and variable. Hence we conduct a statistical analysis of the French spot market for angler to address the questions of correlation between the different spot prices and of liquidity, which are the first elements to consider before launching a derivatives market. This work is based on the daily data furnished by OFIMER during the period 1994/01 – 2006/12 relative to the SPQ criteria and auction markets. And we use the copula functions methodology to handle the co-movement between the different SPQ price series.

## 4.7 Willingness of Spanish Consumers to pay for eco-labelled fish products: An empirical Approach

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Ecolabelling is becoming increasingly relevant internationally as a means of promoting sustainable fishing. This was boosted by the creation of the Marine Stewardship Council (MSC) in 1996 at the request of the World Wildlife Fund and the multinational company Unilever, whose function it is to accredit world fisheries sustainably managed in accordance with the directives put forward in the FAO's Code of Conduct for Responsible Fishing.

Ecolabels are certificates given to fish products which have been obtained while generating the slightest possible impact on marine ecosystems. They guarantee buyers and consumers that a certain fish product comes from a fishery which conforms to regulations on sustainable fishing, allowing the consumer to exercise his/her environmental preferences when choosing a product. Therefore the fundamental factor which will determine the success or failure of ecolabelling is the acceptance of the products by the end consumer. If consumers do not choose the products, the ecolabelling programme will not achieve its final aims. It is fundamental, therefore, that we understand consumer preferences, specifically preferences for ecolabelled fish products versus non-labelled products.

In this study we aim to find out Spanish consumers' preferences for ecolabelled fish products and estimate their willingness to pay for them. In order to do so, we have selected the Spanish market's most highly-demanded fish products whose consumption has undergone a growth in trend in recent years. The results clearly show the preference of Spanish households for this type of product and their willingness to pay significantly more for them.

## 4.8 Analysis of the Price Transmission along the Spanish Market Chain for different Seafood Products

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Spain is one the main seafood markets in Europe and the world. Seafood consumption has traditionally been very important in Spain (in 2005 were consumed about 36.7 kg per capita) (MAPA, several years).

However, little attention has been paid to the market and how the different levels of the market chain interact. Hence this paper, using weekly data, analyses the Price Transmission Elasticity for eleven seafood products along the Spanish market chain (Ex-vessel, Wholesale and Retail levels).

Moreover, then it is investigated the Price transmission asymmetry along these market levels. The results obtained show important implications when examining demand analysis and margins along the seafood value chain. By ignoring them, estimations would be biased.

## 4.9 Bilateral trade agreements and preferences in international fish trade

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Over the last decade a large number of bilateral trade agreements have come into being with more than 180 now in force among WTO Members alone. Many of these have been negotiated in parallel with the Doha Development Agenda (DDA) negotiations, and the recent increase in bilateral trade agreements may in part be a reflection of the lack of progress in the DDA.

Bilateral trade agreements have also implications for trade in fish and fishery products, in particular for exports from developing countries to developed countries, but increasingly also for developed country exports and for trade among developing countries themselves, whether on a bilateral or regional basis.

Whereas data and studies exist on international fish trade in the aggregate, including the recent publication by FAO on tariffs and seafood trade (FAO Fisheries Circular No. 1016) only limited attention has been paid so far to the effect and impact on fish trade from bilateral trade agreements.

For this reason FAO has initiated a project in co-operation with the World Bank and IFPRI to arrive at a better understanding of the impact of bilateral trade agreements and preferences on international fish trade. The presenter will report on progress so far in the project and possible implications for positions held during current trade negotiations and the future implementation of new multilateral trade agreements.

## 4.10 Market interactions between tilapia and several whitefish in the US market

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This paper investigates the market integration between American produced catfish and tilapia imports in the US market as well as the market segmentation between tilapia products. The substitutability between catfish and tilapia is of interest as recent market reports have suggested the fast increase in tilapia imports during the years is a result of importers substituting catfish for tilapia following the first ban on Vietnamese catfish imports in November 2001. In this paper, the competition between fresh and frozen fillets of American catfish and tilapia imports in the same market are examined using market integration and demand analysis. The results indicate tilapia fresh and frozen fillets are within different market segments, while fresh and frozen fillets of American produced catfish compete in the same market. Furthermore, fresh and frozen fillets of US catfish and tilapia imports are in different markets.

## 4.11 Causality in demand: A co-integrated demand system for trout in Germany

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This paper focuses on causality in demand. A methodology where causality is imposed and tested within an empirical co-integrated demand model, not pre-specified, is suggested. The methodology allows different causality of different products within the same demand system. The methodology is applied to fish demand. On the German market for farmed trout and substitutes, it is found that supply sources, i.e. aquaculture and fishery, are not the only determinant of causality. Storing, tightness of management and aggregation level of integrated markets might also be important. The methodological implication is that more explicit focus on causality in demand analyses provides improved information. The results suggest that frozen trout forms part of a large European whitefish market, where prices of fresh trout are formed on a relatively separate market. Redfish is a substitute on both markets. The policy implication is that increased production of trout causes a downward pressure on fresh trout prices, but frozen trout prices remain relatively unaffected.

## 5.1 The costs of a persistent pollutant in an optimally regulated fishery

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Traditional simple bio-economic models deal with the biology, for example in the presence of a fish stock, and the economics of exploiting this stock. These simple type of models are beneficial in many aspects but are only considering exploitation of a single stock, not the interaction with the surrounding ecosystem. The aim of this paper is to keep the simplicity of the traditional bio-economic model but in addition also to capture more of the eco-system complexity. This is done by introducing pollution into the traditional Gordon Schaefer model.

The interdependence between pollution and fish resources is well known. Several studies deal with pollution and fish resources attempting to model and manage the flow of the pollutant and the harvest strategies. There is, however, a lack in studies dealing with the general problem with pollution, where the stock of the pollutant is the problem and not the flow. The importance of the pollution treated as a sink is relevant to study when the half-life period for the pollutant is sufficiently high; the pollutants are persistent. Examples of persistent pollutants are dioxin (PCDDs and PCDFs) and dioxin-like PCBs (biphenyls). If the sea in addition is a semi-closed area, as is the case with for example the Baltic Sea or the Black Sea, the problem becomes even more relevant. The focus in this paper is to identify the cost of an optimally regulated fishery if a persistent pollution is present. The paper sets up a theoretical model and the Baltic Sea salmon is applied as a case study.

## 5.2 An application of DEA Windows Analysis to the Production Efficiency of the Madeira fleet

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Data Envelopment Analysis is applied to the two main Madeira's fisheries (Portugal) to examine technical and scale efficiency. These two fisheries (Black Swordfish and Tunas) represent more than 70% of Madeira's landings in 2004. Tunas are harvested by the baitboat fleet composed of larger vessels while Black Swordfish is targeted by smaller vessels using longline.

Efficiency measured with DEA is generally based on cross-sectional data. This non-dynamic approach can be misleading since it may reveal seemingly excessive use of resources that are intended to produce better results in future periods. In order to take into account this time issue, this paper applies a DEA Windows Analysis by using panel data from a representative constant sample of fishing units. The results suggest that estimates of fishing vessels efficiency deeply fluctuate over time and discriminate the two fleets according to the characteristics of the vessels and the specific biological context of each fishery.

## 5.3 A bioeconomic model of non-renewable habitat-fisheries linkages

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A scientific knowledge gap exists of how benthic habitat is affected by certain fishing methods, such as trawling, and how this in turn impacts upon the productivity of commercial fish stocks. This paper addresses the uncertainty pertaining to habitat-fishery linkages between a non-renewable habitat and a renewable fishery by analysing bio-economic optimal steady states when the habitat is *preferred* and when it is *essential* to the species' survival. The former implies a lower level of habitat necessitates a higher level of optimal stock to compensate for an increase in harvest costs, while the latter can imply the opposite, i.e. a higher input of habitat raises the optimal stock level. The results are then evaluated in a bio-economic model of spatial protection with differentiated harvesting methods and accounting for spill over. Our findings highlight the need for scientific information about the ecological role of habitats and spill over mechanisms if stakeholder support for protection is to be gained.

## 5.4 Productivity in the Icelandic fisheries

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Productivity in the Icelandic fishing industries, especially the harvesting sector, has increased rapidly in the last 3 decades. The objective of this study is to analyse productivity in the years 1974-2004, which covers both the period before and after the introduction of the quota system in the demersal fisheries in 1984 and all fisheries in 1990. Two types of productivity measurements are calculated; single-factor productivity and multiple-factor productivity. The latter calculations are done both with and without taking into the effects of changes in stock size, but a serious dimension is left out if the stocks are not included. Results from this study are compared with similar studies in other European countries, and comparison is also made with productivity developments in other Icelandic industry branches.

## 5.5 Global fisheries rents loss: New results

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Most fisheries around the world are severely lacking in private property rights in the underlying natural resources or their close complements (e.g. harvesting volume). Therefore, according to standard property rights theory, these fisheries should be highly wasteful of potential economic rents from these resources. The available global data, as compiled and interpreted by the FAO, confirm this prediction. More detailed evidence from individual fisheries, both the typical common property ones and those that have become subject to reasonably effective private property rights such as ITQs, recounts the same story.

This raises the question of the global economic waste or, more politely put, global rent loss, due to this inappropriate institutional framework of most fisheries world-wide. This question is particularly poignant due to the fact that a large portion of the global fishery is conducted by dirt poor people in the developing world who would really benefit from added income.

This paper builds on the theory of fisheries rents and global fisheries data primarily collected by the FAO to obtain an estimate the global fisheries rent loss and to assess reasonable lower and upper confidence bounds for this loss. It is found that this eminently avoidable rent loss probably constitutes a large fraction of the global development aid every year.

## 5.6 Basque inshore vessel's exit behaviour: A logit approach

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Fishing firms face up to different short term and long term dilemmas. In the short term, given the surrounding circumstances of the fisheries (the state of the sea, economic aspects related to output and input prices, etc.) they firstly decide whether they go fishing or not, and also several relevant issues such as the objective species, fishing gear and area, and last but not least, the fishing effort to be exercised. Frequently, the set including all the short time feasible alternatives are restricted by a wide variety of regulation measures, such as minimum legal mesh sizes, maximum catch or effort quotas, limited spawning areas, licences, etc. The most relevant basic long-term firm's decision is binary, that is, exit from the fishing activity itself in front of carrying on. Additionally, those skippers who decide to continue face a series of nested decisions related to alternative investment choices, that may vary from the minimum maintenance inversion cost needed to keep on the security on board until the building of a new vessel.

Based on the discrete optimal choice theory and RUM framework, this paper focus on firm's long- term decisions. We estimate a logistic regression by maximum likelihood estimation method from a set of socio-economical panel data for the years 2003-04 from a sample of 74 inshore vessels belonging to the inshore fleet of the Basque Country. Specifically, we aim to determine the set of covariables and factors that may influence on the probability of a fishing vessel to exit from the fishing activity. Our results indicate that some vessels' and skippers' characteristics (i.e. vessel's age, material, owner's age, years of experience, the existence/inexistence in succession, the involvement of the family in the activity), and certain economic variables such as the degree of dependency upon bank mortgage to finance vessel purchase, may significantly determine the decision to abandon the activity, while surprisingly, profit levels seem not to exercise a significant influence.

## 5.7 Precautionary risk methodology in fisheries (PRONE) – Case study development

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Within the field of biological risk analysis progress has been made in evaluating management systems using simulation (Kell et al., in press) and currently effort is being made to integrate economic aspects. However, a systematic approach including biological, economic and social risks is missing in European fisheries management. A strategic approach to risk management is clearly needed and the PRONE project attempts to achieve this.

Further understanding of biological, social and economic consequences of current and alternative actions are required to better manage risks inherent in EU fisheries. The main objective of this study is to investigate the ways of adapting risk analysis theory, as currently developed and applied in a variety of fields, to European fisheries, embracing the full process from stock assessment, projection and advice, via management decisions, to the practical implementation of management measures. This will also include improved communication of such information to stakeholders and fisheries managers making it easier to achieve the long term goals of fisheries management.

Four contrasting case studies are used to evaluate the results of the project through stakeholder interviews: Greece (no TAC), North Sea (TAC), Faroes (ITE) and Iceland (ITQ). This will allow current risk methodologies to be tested and compared to alternative methods. The elements of the fisheries system that have an impact on the overall risk will be identified and the need and the possibility to control them will be evaluated.

The case studies will encompass a wide range of stakeholders from the practical implementation of policy and management measures to those that actually use the resource (e.g. fishermen). It was hoped that this would highlight the perceptions of risk in fisheries from the wider community.

# 5.8 Modelling Economic Response to Combined Harvest and Effort Control in Fishery

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A number of European fishing fleets have been regulated through a combination of quota and effort (sea days) controls since 2004. These two regulation schemes are however interrelated, i.e. a given quota limit will necessarily determine the effort used, and vice versa. A bioeconomic feedback model is presented that takes into account this causality between effort and harvest control, and switches back and forth between these two regulation schemes depending on which is the binding rule. The model is based on biological stock projection, and harvest is modelled via fishing mortality when quotas are binding, and via an economic production function when effort is binding. The economic response of the fleet is modelled through a dynamic investment/disinvestment module that evaluates the change in fleet capacity given the economic outcome of the fishery. A simple example is presented for Danish gillnetters catching cod in the North Sea.

The model has been constructed as part of the 6<sup>th</sup> framework project ‘Operational Evaluation Tools for Fisheries Management Options (EFIMAS)’.

## 5.9 Ecological Benchmarking to Explore Alternative Fishing Schemes: The Danish Demersal Fishery in the North Sea

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The cod stock in the North Sea is threatened by overexploitation. To recover this fishing stock, pressure needs to be reduced. This implies that catch compositions with small amounts of cod are preferred by public policy makers. The present analysis assesses the technological efficiency of fishing trips, considering landings of cod as an undesirable output. A non-parametric frontier technology approach based on directional distance functions is applied to explore alternative fishing activities for Danish gill netters operating in the North Sea with the goal of protecting the cod stock. Since the performance observed on different fishing trips may be under influence of the external operating environment, a four-stage approach introduced by Fried et al. (1999) is applied to correct for such exogenous factors. The corrected directional distance function efficiency scores reveal the behavioural inefficiencies, i.e., prospects for decreasing the catch of cod while catch of other species are increased.

# 5.10 Linear harvest control rules and optimality: The case of the Icelandic cod fishery

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In 1995, the Icelandic government introduced a linear harvest control rule for the cod fishery. According to this rule, total allowable catch (TAC) in each fishing-year (September 1<sup>st</sup> – August 31<sup>st</sup>) is set at 25% of the fishable stock (4 year old fish and older) at the start of fishing year. That stock is calculated as the average of fishable stock in the beginning of that calendar year, and projected stocks at the end of the calendar year. At the time, spawning stock was estimated at 178 thousand tons, but it was hoped that in 12 years time it could be rebuilt to 800 thousand tons, and that catches would double from about 170 thousand tons to 330 thousand tons. In 2005, the spawning stock had only grown to 228 thousand tons, and catches were 215 thousand tons.

In the beginning, the Marine Research Institute (MRI) suggested that the harvest control rule be set as 22-25% of the fishable stock, with the lower limit offering a better chance of success in rebuilding the stocks. In this paper, the performance of the harvest control rule is analysed and the reasons for its relative failure discussed. The harvest control rule is then compared to results obtained using an optimal feedback model. The model allows for various degrees of stochasticity, and can also take into account the interaction between species, e.g. cod and capelin. It is shown that optimal harvests are a non-linear function of stocks and that catches will therefore be greater than optimal under the harvest control rule when stocks are low, but smaller when stocks are large.

## 5.11. Productivity Development in Icelandic, Norwegian and Swedish Fisheries

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Several factors contribute to the productivity of nations' fisheries: (1) The biophysical conditions that determine the abundance of fish stocks, (2) government regulation of fisheries, and (3) innovation and adoption of (i.e. investments in) new fishing technologies. This paper analyzes the long-run total factor productivity performance of three European countries Iceland, Norway and Sweden during the period 1973-2003. In addition to the more traditional labour and capital inputs, fish stock input is included in the analysis. We discuss the productivity performance estimates in light of the various fisheries management regimes in these countries.

## 5.12 The production function approach – estimating linkages between lophelia and redfish on the Norwegian coast

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This paper considers the fishery-habitat value of cold water corals. We employ a production function approach to consider the impact of corals on a commercial fish stock. The model modifies the standard bio-economic fisheries model to account for the effect of a change in coral habitat, specifically *Lophelia*, on (1) the carrying capacity; (2) the growth rate; (3) both the carrying capacity and growth rate of a commercial fish stock. A non-linear relationship between *Lophelia* and the stock is also considered.

Norwegian redfish data and an approximation of coral decline over the period 1984 – 2004 are applied to the models. The Norwegian redfish fishery was open access until recently. This suggests that fishing effort in the next period will adjust to real profits made in the current period. The analysis of fishery-*Lophelia* linkages is conducted by examining the effects of a change in *Lophelia* area on the long-run open access equilibrium of the Norwegian redfish fishery.

If cold water coral can be linked empirically to a commercial species, this is an indication that coral depletion can have a harmful effect on fish stocks, and thereby upon the fishing industry. This is of relevance from a management perspective. For example, by the creation of MPAs to protect cold water coral grounds, the growth and size of a fish stock associated with the coral may also be sustained, benefiting the fishery.

## 5.13 Regulation on Fishing Days: A Principal-Agent Approach

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Fishing effort regulation have been suggested and used in a number of countries. Traditionally it has been proposed to regulate on the number of fishing days. It is well-known that regulation on the number of fishing days causes unknown substitution to other parts of fishing effort due to imperfect information about the input use. In this paper we analyse imperfect information about fishing effort and a productivity parameter with a principal-agent approach. A tax on fishing days is proposed to solve the stock externality problem and the problem with asymmetric information. A low productivity fisherman receives a rent on zero and is allowed a lower effort than under full information. Contrary, a high productivity fisherman obtains a positive rent and must have a larger effort than under full information. This tax structure secures a second-best optimum.

## 5.14 Impact of the use of veil nets on the productivity of UK Crangon vessels operating in the North Sea

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As with many shrimp fisheries, the North Sea brown shrimp (*Crangon crangon*) fishery has been characterised by bycatch and discarding of juvenile fish species that are of value to other fleet segments. To offset this externality, the mandatory use of veil nets or separator panels was introduced in 2003 for all vessels using an aggregate beam length of more than 8m. Sea trials prior to this date suggested that retained catch may be reduced by between 8% and 35%, depending on the area and season. These studies, however, do not consider the behavioural response by fishers to reduce this impact. In this study, the actual impact of the restrictions on the productivity of UK Crangon vessels was estimated using a production frontier approach. The *ex post* analysis suggests a productivity decline of around 14% has been experienced by UK vessels adopting this gear.

## 5.15 A system-ecological-economic model

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Ideally a natural resource management plan is a comprehensive document where there is a hierarchical structure with the objectives for service delivered by the resource at the top of the hierarchy, followed by strategic plans, tactical plans and operational plans. The levels should be logically connected from top to bottom through a chain of ends and means, so that the daily operations are a means to achieve the tactical goals, the strategic goals, and, as the ultimate aim, the overall objectives. Each plan level has different requirements for models. The model needed for strategic planning is a model of properties that are stable in a long time perspective.

This paper considers a system-ecological approach to modeling the marine ecosystem. This is an attempt to model properties of the ecosystem that are stable in a long time perspective. The model is a biomass-spectrum model; a model of the trophic system with the weight of the individual fish as the only characteristic. The model is static and has size as the control parameter, where size refers to the body weight of the harvest. If the harvest is sustainable, the size can be interpreted as the level of ecosystem use. The presented model can be seen as a sketch of a model expedient for strategic planning of a marine ecosystem. Although the presented model is very simple, it indicates that institutions ought to be designed in accordance with the system-ecological approach, as well as the population approach. In other words, a management based only on the traditional population view of the ecosystem will lead to an erosion of the ecosystem.

# 5.16 A bio-economic evaluation of quota for the management of the Australian west coast rock lobster fishery

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The West Coast Rock Lobster fishery is Australia's most valuable commercial fishery. Around 550 vessels harvest 10,500 tonnes of lobster per annum. The fishery is based on input controls (pot numbers), has a variable stock and catches vary significantly from year to year. Predicted catches are based on a puerulus index three years earlier. Using this system, the industry has an enviable track record of biological management.

However, the reliance on input controls has meant that in recent years three significant pot reduction interventions have been required to offset improvements in catch per unit of effort and questions have been raised as to the benefits of moving to ITQs. This paper reports the results from a bio economic model developed to allow evaluation of a range of possible future management regimes, including ITQs.

The integrates the known biological data with cost and revenue information and uses non linear optimization to produce ten year steady state solutions for alternative management options. Key outputs produced for each scenario include: net economic benefits, breeder biomass index, annual catch, annual pot lifts, number of pots and vessel numbers. The model specifically allows for the three biological zones in the fishery. It also allows for the evaluation of the various management options to incorporate specific initiatives such as improved pot design and extended fishing seasons

The particular focus of this paper is the trade-off between variable and fixed quota in terms of the economic benefits and biological risks in such a variable fishery. Although analysis indicates significant economic benefits to a move to quota, it shows the need to assess tradeoffs between maximizing net economic returns and biological risks carefully especially when these specific changes to pot design and fishing season length are considered.

## 5.17 Non-linear relationship between effort and fishing mortality, economic considerations

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It is an accepted theory that economic agents optimize their utility given restrictions on inputs. However, in bio-economic fisheries modelling this is seldom taken into account and as a consequence it is assumed that there is a linear relation between inputs (e.g. sea days) and outputs (e.g. Fishing mortality); for instance, this can be seen in bio-economic models that assume constant catchability. Moreover, errors introduced by this simple linear model become more important as the management of many European fisheries is changed from output restricted management to a combination of output and input restrictions. This paper provides evidence for the possibility of optimizing behaviour from the Dutch beam trawl fishery, provides a methodology for estimating the curvature of a production function, and a simple way of implementing these processes within a bio-economic model. Moreover, it shows the influence of a nonlinear production function in a model of effort management (EU long-term flatfish management plan).

The analyses are based on 6 years of catch and effort data by large Dutch beam trawlers taken at the trip level. An ANOVA on spatial and temporal patterns in output (revenue) per sea day is used to remove random influences. The analyses show that there is large variation in the outcomes of different fishing trips, showing that fishermen can and do adjust their behaviour when confronted with effort restrictions. This anticipation will lead to a non-linear relationship between effort and the fishing mortality, especially for the main target species and thereby leading, in the case of effort restrictions, to a less than proportional decrease in fishing mortality. The impact of this is shown by means of an application to the flatfish bio-economic simulation model developed for the evaluation of the flatfish management plan.

## 5.18 On fisheries and habitats

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This paper analyses the effect of fisheries upon a renewable habitat and how habitat damage in turn can influence the fishery under different management regimes, and under different assumptions regarding the ecological interactions between the habitat and the fish stock. Three cases regarding the ecological interactions are examined; *i)* no interactions, *ii)* habitat size has a positive effect on the fish stock, and *iii)* habitat and fish stock are both positively affected by each other (symbiosis). The management options considered are open access and joint maximization of both fisheries rent and the non-use values of the habitat. Results show that interdependence between habitat and fish stocks works against the protection of habitat when open access is applied in the fishery. In the case of management that maximises both fishery profits and the intrinsic value of habitat, fishing effort will be lower than what is the case when only pure fishery profits are taken into consideration.

## 5.19 The long run supply curve in Fisheries: The case of North Sea Cod

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This paper develops a stepwise means of estimating the long-run supply curve for a fishery using minimal data. Relying heavily on the theory of fishery economics set out in the Gordon-Schaefer model and developed by Copes to explain the form of the supply curve, both the open access average cost supply curve and the economically efficient marginal cost supply curves are calculated. The fishery chosen for this case study is that prosecuted by six nations for North Sea cod. The results present the surprising conclusion that the fleets are operating on the marginal cost curve but at an economically inefficient point governed by exogenous short-run supply constraints. This indicates that recent changes to the management systems in the main countries participating in the fishery have begun to overcome the effects of the market failure which have led to overfishing and overcapacity but that the level of supply is currently governed by short-run constraints in the form of low quotas imposed in an attempt to allow the fish stock to recover.

## 5.20 Capacity and capacity utilization in the Mediterranean small-scale fishing fleet: The case study of the north Sardinia

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Excess capacity is universally recognized as a major problem for fisheries throughout the world. As a consequence, several institutional agreements and/or policies have been focused on reducing the overall fleet capacity. With reference to the European Union (EU), a sustainable balance between resources and the fishing capacity is today one of the main objectives of the Common Fisheries Policy (CFP). In order to promote this finality, the CFP reform has removed the aid for the renewal of the fleet – which contributed to creating overcapacity – since January 2005. Furthermore, the new European Fisheries Fund (EFF) grants more attractive premium for the permanent removal of fishing vessels measure and supports equipment and the modernisation of vessels only under reducing-capacity conditions. Therefore, measuring capacity and capacity utilization in the European fisheries is becoming an important research issue during the last decade. Specific relevance on this theme can be put on the multi-product small-scale fishing fleet such as the Mediterranean fleet because of inherent difficulty to assess technological relationship between catches and production factors. This study aims to estimate productive efficiency (PE), fishing capacity (C) and capacity utilization (CU) – or excess capacity (EC) - in the Mediterranean multispecific vessels.

To be more precise, a multi-output and non-parametric approach using a Data Envelopment Analysis (DEA) model is applied on a sample of small-scale vessels that operate in the North-Sardinian sea. The DEA methodology derives a production frontier for a general technology, with variable factors unconstrained but the fixed factors, the state of technology, and environmental parameters constraining outputs. The data allows estimation of an output-oriented model and the resulting measures correspond to a “primal” technological-economic definition of capacity output and utilization. Furthermore, single-input measures of PE, C and CU are been obtained from the analysis. Some policy implications can be arisen from the findings.

## 5.21 An evaluation and comparison of different restrictive policy scenarios on Belgian fishing fleet dynamics.

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This paper evaluates the effect of three important restrictive Belgian fishery policies which are currently important for Belgian fleet dynamics. These restrictive policies are tested through scenarios in a micro-economic microworld, including sensitivity analysis.

The scenarios are unveiling the effect of: 1) different numbers of licenses (scenario 1), 2) different numbers of maximum fishing days (scenario 2), and 3) different quota (scenario 3) on Belgian fleet dynamics. For this research a micro-economic approach was chosen because it allows policy makers to gain more insight in how their restrictive policies can determine the dynamics of individual boat owners and how this translates into the fleet structure. This emphasis enables evaluating the performance of individual companies and

vessels that follows from the impact of policies on management decisions. (Helu, Anderson, and Sampson 1999) The sensitivity analysis will result in an overview of the 'behaviour over time' of economic efficiency per sub fleet for each scenario. Consequently, informative graphs that represent these scenarios will allow comparing the different restrictive policies more constructively and visually.

In a wider perspective, this micro-economic micro world will play an important role in the process of developing a long-term strategy for the Belgian fishery sector, serving as a laboratory for ex-ante evaluation of possible strategies. (Keys, Fulmer, and Stumpf 1996; De Geus 1997) By visualizing decisions and strategies (Morecroft 1999), insights in fleet dynamics are generated in response to a changing environment and policy changes.

# 6.1. Valuation of management policies for sport-fishing on small rivers in Sweden

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This paper makes, in addition to its empirical results, a distinct contribution to the literature on valuing fishing recreation by stated preference methods. In particular, we propose an approach to analyze visitors as well as potential visitors preferences of angling site characteristics on both a regional and national perspective. The data we use was collected in three mail surveys including the same type of choice experiment, one national and two site specific, performed during the spring of 2007. The choice experiments from the site specific surveys are used for estimating the utility function. We embed the utility functions from the choice-experiments in a trip frequency model, such that we can predict the changes in trip frequency from improved fish management on both a regional and national perspective. Finally, the approach proposed in the paper also provides a step in developing dynamic fish management models, because the policies we analyze may change the age-structure of the stock. Our paper also contributes with new results on anglers' valuations of angling site characteristics. They conform to traditionally obtained results but also show on some unexpected result. In particular, our result does not indicate a difference in the valuation of the species caught. As expected, our application shows that the marginal value of trophy-fish is high but only for catching it and not for bringing it home.

## 6.2 Valuation and demand models of recreational fishing in Sweden

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We present empirical results on fishers' preferences that make it possible to evaluate different fishing conditions with respect to preference and demand. This paper makes, in addition to its empirical results, three distinct contributions to the literature on valuing fishing recreation by the contingent valuation method. Secondly, we embed the preferences, derived from the utility function, for different conditions in a trip frequency model, such that we can predict the changes in trip frequency from improved fish management. Finally, this paper uses an open-ended valuation question where respondents state their willingness to pay as well as their change in visitation frequency in the form of an interval rather than a point estimate. Using intervals for stating changes in visitation frequency has not been done before in this fashion. Allowing the response to be expressed as an interval has advantages compared to traditional valuation and frequency questions: it captures uncertainty and provides a richer set of information. The results suggest that the upper and lower boundaries provide a kind of confidence interval for the willingness to pay and for the change in visitation frequency. The approach proposed in the paper can be integrated in to the development dynamic fish management models. The data was obtained from a new Swedish national survey on recreational fishing commissioned by the Swedish Board of Fisheries in 2007. The study includes all types of recreational fishing in Sweden.

## 6.3 Gone Fishing: A Profile of Recreational Fishing Activities in Canada

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Having the longest shoreline and the largest surface area of freshwater in world, Canada's oceans and freshwater provide an abundance of fisheries resources. With over two million lakes as well as rivers that flow into five major ocean drainage basins, Canada is well-known for its recreational fisheries.

Recreational or sport fishing is a very popular leisure activity among Canadians. It is also one of the country's major tourist activities. The important socio-economic contributions of recreational fishing are felt in all of Canada's provinces and territories, particularly in some of the more remote areas of the country. This paper explores various aspects of the 2005 recreational fishing activities in Canada such as angler profiles, fishing effort and characteristics of recreational fisheries harvest. It also measures the contribution of recreational fishing to the Canadian economy by evaluating the expenditures and investments directly related to recreational fishing activities. Finally, the paper looks at key aspects of Canada's governance structure surrounding recreational fisheries and sharing the resource with commercial and Aboriginal fisheries.

The analysis is based on the results of the 2005 Survey of Recreational Fishing in Canada. The survey is conducted by Fisheries and Oceans Canada since 1975 in cooperation with provincial and territorial licensing agencies. It is the only detailed source of up-to-date information on activity and harvest in recreational fisheries in all regions of the country. The results from the survey are also used to assess changes with respect to pressures on Canada's fisheries resources.

# 7.1 Scientific Networks and Individual Performance in Fisheries and Aquaculture Research

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Scientific research in Aquaculture and Fisheries, as in other fields, has become a highly specialised enterprise that could not function without the collaboration of the geographically dispersed specialists. Using the ISI Web of Science database of all publications related to Fisheries and Aquaculture for the last 15 years, we investigate the collaboration pattern of scientists publishing in that field.

Co-authorship of academic publications is a strong expression of social linkage in science and will therefore be used as an indicator of collaborative research. The decision to collaborate is entirely made by the authors, and in most cases depends on a personal contact before their first collaboration. However, the initialisation of personal contacts can be stimulated by common collaborators. This transitivity in the sense of “your collaborator also is mine” is a strong effect in emergent networks which we can also find in this network. By means of Social Network Analysis, the performance of researchers is measured not only according to their numeric output of publications, but also to the number and characteristics of their collaborators. In Social Network terms, these characteristics are measured by their assortativeness. Assortative mixing of researchers can be observed when authors with many collaborators, tend to collaborate with authors who collaborate much themselves.

For a selection of high-performing researchers, additional career track indicators (i.e. institution of PhD, years since PhD, awards, and current institutional affiliation) are tested for their influence on individual performance in the research area. Using the address information of all publications, we transfer the performance of individual researchers to the institutional level and compile a list of high-performing research institutions for Europe, North America and the rest of the world.

## 7.2 The macroeconomic dependence of developing countries to the EU subsidies of fishing agreements: a game theory approach

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Since 1979, the fishing agreements between EU fleets and ACP (Africa, Caribbean, Pacific) countries is ruled by the European Commission. The accession of Spain to the EU in 1986 and the increasing share of external supply on the EU market tighten the linkage between ACP and the EU. Unfortunately, these agreements are far from being optimally profitable for the developing countries and EU vessels do not pay for the actual access cost. Indeed, the access of European vessels to the ACP exclusive economic zones is highly subsidised by the European Union and the compensatory amount paid to the ACP state represents a relatively low proportion of the fishing rent while reducing the local fishermen's catches.

The ACP dependence to the EU is treble: compensatory funding, access to market, competition and stock externalities between foreign and domestic vessels in their access to internal resources. Because of their macroeconomic dependence, the ACP countries can hardly impose management measures to the foreign fleets. The recent reform of the Common Fishery Policy paying more attention to the management of external resources along with the new EU-ACP agreement pooling the ACP states in the negotiation process and coming into force in January 2008, could improve the bargaining position of ACP countries.

A classical game theory approach (fishwar model) is revisited to take into consideration the macroeconomic dependence of ACP countries and identify the theoretical conditions of the negotiation procedure with respect to the time preferences of countries and the amount of compensatory subsidies. First, the Nash equilibrium between EU and an individual ACP state is compared to the cooperative case. In a second step, the negotiation process between two developing countries and the EU is discussed before looking at the impact of a coalition on the social outcome of the game and the stock level.

## 7.3 Prestige's oil spill and its economic effects in the basque coastal fleet

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The short term consequences of Prestige's oil spill on the fishing activity of the Basque coastal fleet and its economic results are analysed. A "pre and post damage" panel database of selected socio-economic indicators, obtained through a survey made to a representative common sample of vessel-skippers, has been used to contrast the existence and the dimension of such adverse effects. Given the heterogeneity of this fleet, the sample has been subdivided into 3 homogeneous clusters/metiers, on which exhaustive parametric and no parametric statistical procedures have been carried out.

The results show the existence of negative short-run economic effects on the whole fleet, independently of the cluster/metier each belongs, only compensated through the payments obtained from the clean up operations in which this fleet participated and the subsequent compensatory grants. A final discussion on the apparent quick recovery from the disaster and the difficulties to measure the long-term environmental and economic impacts of oil spills is also developed.

## 7.4 Management plans for Natura 2000 sites – nature conservation measures in fisheries regulations

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With the adoption of Council Directive 79/409/EEC (conservation of wild birds) and Council Directive 92/43/EEC (conservation of natural habitats and of wild fauna and flora) the EU Environmental Ministers created an obligation for the EU member states for a net of protected areas. Not originally created with obligations for the marine environment the EU High Court decided that within the 200 mile limit countries must designate areas as SPA (for birds) and FFH sites (habitats and species) – combined the Natura 2000 net. Germany has now declared 10 sites in the North and Baltic Sea as marine protected areas (MPA). In the future management plans have to be adopted. First steps are taken with a debate on the fishing practice in these areas. Main focus is on (possible) negative impacts of fishing methods on species and habitats. Avoidance of negative impacts as external effects of economic activities may lead to opportunity costs which fishermen have to take into consideration. For the nature conservationists acceptance of possible management decisions in the EU council of fisheries ministers is crucial to regulate fisheries in the designated areas. In the paper an overview is given on the overall strategy of the FFH directive, possible measures in the Natura 2000 sites and possible consequences for the fishing sector from the German experience so far.

## 7.5 Applying the Concept of Multi functionality to Fisheries: An Empirical Test

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The concept of multi functionality has been widely used and discussed in the agricultural sector during the last decade. In this context, a particular attention was paid to (1) the link between the prevalence of *multiple roles* and the generation of positive externalities and (2) internalisation of positives externalities and the provision of subsidies (e.g. when transaction costs are high). During the same period, however, the concept hardly diffused to other primary sector such as fisheries, although similar issues are often at stake. While some observers (e.g. Schmidt, 2004) denied the existence of any multiple role in fisheries, other authors (e.g. Gouin et al., 2006) identified general positive outcomes of fisheries regarding food security, provision of high quality products, diversification of fishing activity, contribution to the local economy...

This paper follows a middle line between these two “opposite” views, by looking only at those multiple roles that generate clear positive externalities. Based on the internationally agreed definition of the concept, the paper in particular proposes a “Table of Multi functionality in Fisheries”. The paper then presents the preliminary results of a field survey that are used to test quantitatively each potential multiple effect in the case of selected fisheries in Brittany. When such positive externalities are identified (e.g. maritime security, collection of marine discards, etc...), the paper discusses the internalisation process (i.e. who should pay, and how much).

## 7.6 Prestige oil tanker accident and oil fishers

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This paper is related with the accident of <Prestige> Oil Tanker near the Galician coast in the border of Atlantic Ocean and the Cantabrian Sea in November of 2002. It can be characterized as an organizational accident but at the same time we will analyse that the oil spill over detain and cleaning process can be understood as a part of this organizational malfunction too. The underprovided coordination aspects and the persistence of some less efficient strategies are analysed. In Spanish legislative body there is a general law 27/1992 to affront this kind of accidents and it provides the objectives and the instruments to minimize the impacts. The appliance of this particular law has been different in distinct scenarios and in different regions. The different ways to apply the general law has generated different results in the cleaning process.

A case study in the Basque country of those different applications has consisted in the transformation of artisan professional fishers into oil fishers to attack the capture of oil in the ocean. Thus and in this region, the impact of oil spill over on the coast has been basically minimized. The study of this case has permitted to analyse the global response to accident, the way to organize the fisher's participation in the complex system of capture and storage of oil in land and the influence on the results of different forms to organize the cleaning.

## 7.7 Pathways to Vocational Training for Fisheries Development Agents

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This paper presents Mare Nostrum project aims, structure and intermediate provisional results. The project is a pilot program for a homogeneous design of a basic professional training in the U.E. to face the need of creation of a Fishing Development Agent in order to achieve its common recognition and to get better quality of the systems and practices in the professional training.

## 7.8 The probability of collapsing of a renewable resource under climatic uncertainties

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Some renewable resources have a critical stock level, below which the resource cannot recover without serious economic losses to the related harvesting industry. This is, an action that causes the resource to collapse, has an (almost) irreversible effect on this stock. That collapse and even extinction of fish resources is a serious problem is documented in e.g. Hutchings and Reynolds (2004), who report that data for more than 230 marine fish populations reveal a medium reduction of 83 % in population size from historical levels. Uncertainty, however, prevails to the reasons for this observation. Myers et al (1997) argue that two main hypothesis have put forward for possible explanations. One is high fish mortality due to high level of harvesting and the other is (temporary) unfavourable (environmental) conditions.

Hilborn et al (2001) claim that political and economic motives re-enforces the problem given uncertainty. The reason is that fishermen stress that the cause is not overfishing but temporary unfavourable conditions and that the policy makers, afraid of implementing costly policies that might ex post turn out wrong, support the fishermen's demand for higher quotas (a behaviour known as "minimax regret" strategy). Hilborn et al (2001) further argue that while this may appear to be an adequate response to short-term socioeconomic pressure, it may only result in a more acute crisis later on. The aim of this paper is to answer the following questions: Given uncertainty about the true level of this lower bound and uncertainty about how future climate change will affect the growth rate of the resource, what is the effect of different policy action that determine the harvesting level on the probability of collapse of the resource, and the expected profits to the harvesting industry.

Three different policy actions will be analysed. The first is a safety first policy, which aims to secure that the probability of extinction will not exceed a pre-determined level. Such an approach is inspired by the precautionary principle. The second policy is one that neglects the possibility that climate change might negatively affect the growth rate of the resource (inspired by myopic policymakers and stakeholders, and in line with the behavioural claim made by Hilborn et al, 2001) and finally a fully optimal approach, which aims at maximizing expected profits from harvesting the resource. Four different cases regarding the information structure is analysed. One where no learning, two where only information is only partially disclosed, and finally one where all information is revealed before second-period policy has to be determined.

# 8.1 Management of fisheries in the Vistula Lagoon: history and current status – the way to EU standards

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The current problems of commercial fisheries in Vistula Lagoon have been discussed against the background of previous legal, political, economic and social conditions. From 1945 to 1963 fishing in Vistula Lagoon was regulated by the Act on Fisheries of 1919, which did not put any limits of the size and power of a fishing vessel or the number of fishing tools used. The legal regulations binding during that time specified only areas and time periods when fish were protected from catching, protection zones in spawning areas, size of net mesh, acceptable volume and guidelines for handling by-catches, and prohibition of certain fishing tools. Until 1963 the commercial fisheries included two sectors: cooperatives and state-owned companies. Fishermen had open access to fishing grounds, which in conjunction with lack of limits on fishing effort and volumes of fish caught as well as increasing pollution of water in Vistula Lagoon were the main reason why in the early 1980s volumes of fish obtained from that reservoir began to decline and collapsed rapidly in the early 1990s. The years 1990-2004 were a time when fisheries industry in Vistula Lagoon was being adjusted to a responsible and sustainable fisheries model. During that time the EU standards were emulated, both in terms of organisation of fisheries and technical solutions. In 2004, when Poland accessed the European Union, fisheries in Vistula Lagoon reached the standards set for EU-member countries. The fishing effort was substantially reduced and fish harvest limits were established. Financial measures from UE made possible effective monitoring and running compliance control of adopted principles of fishery resources management. In this range there is also good cooperation of the Russian side.

## 8.2 Employment of a bioeconomic model supporting management processes of small pelagic fishery in the Northern Adriatic Sea, north-eastern Italy

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In this paper we attempt to verify the sustainability of the small pelagics fishery in the Northern Adriatic sea, north-eastern Italy by means of a bioeconomic simulation model. The objective of applying a bioeconomic model was to reproduce the biological and economic conditions in which the fisheries occur. Starting from an initial condition, the simulation model incorporates the known trajectory of the resources and the fishing fleet and allows to compute the most probable future trajectory when some parameters in the model are changed. We analysed the projection of selected indicators (biomass, recruitment, spawning stock biomass, catches, profit and capital) under four different management scenarios, based on effort control, and we assessed the performance of these management measures against the current situation.

The four scenarios were: i) increase in the fuel price, ii) reduction in the fuel price, iii) limit the number of the days at sea, iv) extend the fishing period. Management event was introduced in the third year of the simulation. For each scenario a deterministic simulation was carried out and the stock recruitment relations of Beverton-Holt are applied. Our results show that the impact of every management measure tested is not homogeneous across the fleet, in particular, small vessels are more weak and sensible to change, reinforcing the idea that management measures should be calibrated by stratifying the fleet before implementation.

## 8.3 Estimate of Resource Rents in Pacific Saury Stick-held Dip Net Fishery in Japan

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Resource rent is a key concept in the management of fisheries as it refers to a source of considerable wealth, potentially or actually available to society. Many Japanese fisheries have a low level of profitability because much of the potential rent is dissipated in supporting the economies of coastal fishing communities and preserving fishing livelihoods. A case study on estimating resource rents in Pacific saury stick-held dip net fishery in Japan has been carried out using a bioeconomic model. A comparison was made between the actual rent generated under the current fisheries management regime and the potential rents when the fishery is managed to give a maximum economic yield (MEY).

## 8.4 Paradoxes in Iceland's Herring fishery - Stock and Catch and Fleet Dynamics

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Fishermen had caught herring along the Norwegian coast for centuries before they discovered large shoals in the summertime north and east of Iceland in the second half of the 19th century. After a climatic setback in the 1880s successful fishing was resumed with purse seine nets in the beginning of the 20th century and continued for almost 70 years. Later it was discovered that the largest stock of the so called Atlanto-Scandian herring, Norwegian spring-spawners, migrated across the ocean to Icelandic waters for feeding and overwintering. Icelanders soon learned the technique to catch and process this abundant species which became the backbone of their newly industrialized economy and sometimes the most important export commodity.

The poster first displays the Icelandic fleet's historical catch statistics 1904-2004, showing a boom in the mid 1960s while the stock declined and collapsed before 1970. This paradox can be understood by the shoaling behaviour of the species and revolutionary fishing technology. Then the model:  $\Delta E/E = k(P - P_0)$  is specified, where E is present year's effort,  $\Delta E$  annual change in effort, k a constant, P past year's profit and  $P_0$  some threshold value. By using sample data on effort and profit from available annual accounts in the period 1955-1969 the parameters k and  $P_0$  were estimated with moderate significance. Surprisingly, the value of  $P_0$  was found to be negative. This paradox can be explained by peculiarities of the monetary policy in Iceland at that time: government intervention, inflation, negative real interest, subsidized funds and controlled foreign exchange rate. Favourable markets promoted investment in new vessels with sonar and power blocks which resulted in increasing catch despite decreasing stock. In the short-run it was an economic benefit but may have contributed to the collapse of the stock and a long-run crisis in the Icelandic economy.