SIXTH FRAMEWORK PROGRAMME
PRIORITY [8.1]
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Instrument: SPECIFIC TARGETED RESEARCH PROJECT

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Coordinator name	Dr Anna Korre	Dr Dave Reid
Organisation name	Imperial College London	FRS Marine Laboratory Aberdeen

Revision [1]

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1. General Introduction

CAFÉ - Capacity, F and Effort was a 42 month project designed to investigate the links between fleet capacity, the fishing effort of those fleets and the fishing mortality (F) that results from that effort. Capacity and effort can be seen as linked directly because the effort can be considered as the amount of time a given fishing capacity has been deployed in the fishery. Therefore, engine power in kilowatts could be seen as a capacity measure, and kilowatt hours as the expression of the effort from that capacity. It is often assumed that more capacity and/or more effort will lead to higher fish mortality. However, the existence of capacity does not necessarily predicate the deployment of effort. Many of the fleets examined in CAFÉ did not necessarily expend all or even most of their available "effort". Equally, more effort may not directly result in more fish mortality. So, essentially, the project was designed to test the hypothesis that there was a quantifiable relationship between the capacity and effort by particular fleets and the fishing mortality imposed on the various commercial stocks.

A second key component to the project was *not* to make assumptions about the key variables for describing capacity. Conventionally, and in most management regimes, capacity is taken as some combination of the vessel size (tonnes and length) and its engine power. However there may be many factors that contribute to the fishing power of a vessel beyond these simple size metrics, e.g. sea-keeping ability, the presence of factory systems, and especially the fishers' behaviour. The aim of the CAFÉ project was to identify *meaningful* measures of capacity with definable and robust links to effort via utilization. Ideally these identified capacity and effort metrics could then be used for a more appropriate management strategy. This approach links to the general definition given by the European Commission for fishing effort as *"the sum of means deployed for catching fish in a defined area over a defined period of time*".

To achieve this end, the project examined six different case studies including the North Sea, the Bay of Biscay, and the east and west Mediterranean. It also considered both pelagic and demersal fisheries, and single and multi-species fisheries. The approach involved firstly assembling a harmonised database on all the fisheries to be considered and over a long enough historical period to determine trends. Much of the data needed for this study was considered confidential or covered by data protection legislation by the partner countries. For this reason, CAFÉ did not attempt to construct a single overall database for all the partners. Instead, we defined a data structure, including all desirable variables and data sets, which each of the partners could assemble. This allowed promising analytical approaches to be easily transferred between partners without taking on the onerous task of assembling a single database.

Another key element of the project was that, again, we made no assumptions about the analytical approaches to take. One of the early tasks in the project was to produce a document detailing as wide a range of appropriate analytical techniques as possible, and identifying the expertise in those within the consortium. Partners were then free to apply as many of these as they felt necessary to quantify the capacity, effort and fishing mortality relationships in their study area. As a result, the analyses deployed a wide range of statistical approaches, including; Generalised linear and additive models, Neural networks, Data Envelopment Analysis, Random Utility Models and others. While many of the choices of technique were based on the skills available within each member of the consortium, the project allowed a considerable amount of intellectual transfer, with experts in one field assisting other partners to explore new approaches. The use of Data Envelopment Analysis (DEA) by many of the fishery groups is a good case in point.

The analysis carried out followed a logical progression through the project. Once the databases were assimilated and in a common format, the first step was a basic exploratory description of the fleets, their capacity and effort metrics and the fishing mortality linked to them. On the basis of this, the next step was to carry out initial analyses of the data sets to define a set of metrics that could provide the best links between capacity, effort and mortality for the selected case studies. Historically, both effort and capacity metrics have tended to be chosen independently, often based on convenience or availability. The aim here was to choose variables, from a wide range, which provide good relationships between capacity and effort, and between effort and mortality. The modelling work to determine the appropriate metrics explored many of the different techniques available. As well as determining the appropriate metrics, this step also allowed the analysts to focus on the methods that worked best in the context of each specific case study and fleet.

In the next stage of the research work, we then used the combination of appropriate models and metrics to quantify the links between capacity (now defined from the earlier modelling work), effort (again based on the choice of metric) and the catch or fishing mortality. Essentially this stage of the research was aimed at analysing the behaviour of the fishery in terms of how the available capacity and associated effort were deployed in actual fishing. The approach was to identify what other external factors determined the choices made by fishers; these included biological factors such as the state of the stocks, economic factors (e.g. prices of fish), and management measures (e.g. TACs or closures). The end product here was as full an understanding as possible of meaningful capacity and effort and what drove the choices made by fishers in the deployment of that. The modelling approach used both statistical modelling techniques (i.e. data driven or empirical approaches) and mathematical modelling techniques (i.e. where an *a-priori* understanding of the fishers behaviour was translated into a set of mathematical equations expected to describe the system dynamics).

The final step was then to use the models and the understanding gained through them to examine the response of the system to a range of management measures for controlling capacity and effort. The aim here was basically to run a series of simulations within the model environments to determine how the fishery might react to limitations on capacity (e.g. decommissioning), effort (e.g. days at sea reductions) or other measures (e.g. a discard ban). In the initial concept of the project, this step was envisioned as being carried out within the, now standard, Management Strategy Evaluation approached using FLR. However, many of the modelling approaches taken in CAFÉ were suitable for use in this simulation mode, so the MSE approach was taken for only some of the case studies. The end product was then the expected results, based on the models, of a range of management measures across the various case study fisheries.

As detailed above, in general, the research work was targeted on the data available from one partner country at a time, due to data access problems. However, once the model systems were fully developed, it became possible to deploy these using data from more than one country/fleet combination, while retaining data confidentiality. Several of the models were therefore run again using this multinational data to test the general applicability of the approaches and observe what differences arose between individual countries.

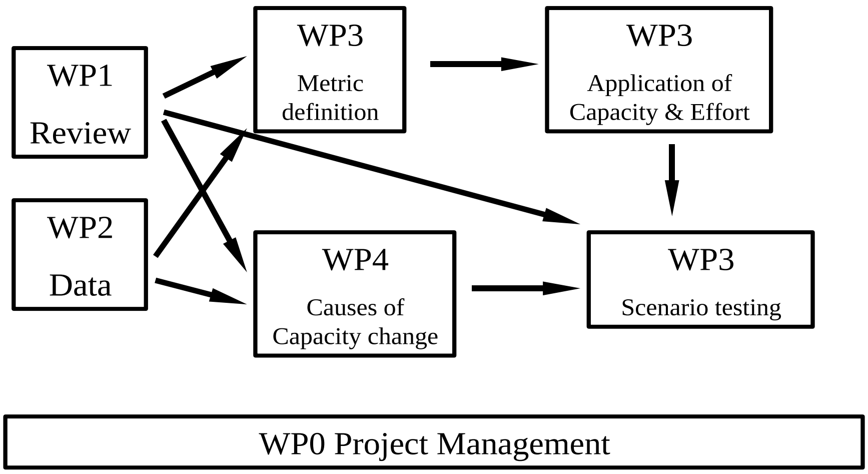
In addition to the analysis sequence detailed above, the project also examined historical approaches to capacity and effort management worldwide, and looked at the basis for investment in capacity by a number of the fleets covered by some of the case studies. The historical review of capacity and effort management was intended to provide the context for the various simulations run using the models, and the outcomes from these. It was also intended to serve as a useful reference to the state of play in this key management area. The analysis of investment was intended to provide an understanding of what drove the development of the capacity of the fleets. The basic CAFÉ approach simply took the capacity that was present as a given, and conducted the analysis using that information. This part of the project set out to determine why that capacity was there in the first place, and why fishermen had chosen to buy, sell or upgrade their vessels.

2. List of Participants

Role	Participant Name	Country	Scientific representative
CR	Imperial College of Science Technology and Medicine	UK	Dr Anna Korre (a.korre@imperial.ac.uk)
CR	Institut Français de Recherche pour l'Exploitation de la Mer	France	Dr Paul Marchal (paul.marchal@ifremer.fr)
CR	Wageningen IMARES	Netherlands	Dr Jan Jaap Poos (janjaap.Poos@wur.nl)
CR	Food and Resource Economics Institute	Denmark	Mr Jesper Andersen (jia@foi.dk)
CR	National Institute of Aquatic Resources	Denmark	Dr Steen Christensen (sc@dfu.min.dk)
CR	Institute for Research in Economics and Business Administration	Norway	Prof. Røgnvaldur Hannesson (rognvaldur.hannesson@nhh.no)
CR	The Centre for Environment Fisheries & Aquaculture Science	UK	Dr Trevor Hutton (t.p.hutton@cefas.co.uk)
CR	Fisheries Research Services Marine Laboratory	UK	Dr Dave Reid (reiddg@marlab.ac.uk)
CO	Centre for the Economics and Management of Aquatic Resources	UK	Dr Premachandra Wattage (Premachandra.Wattage@port.ac.uk)
CR	Instituto Español de Oceanografía	Spain	Dr Begoña Villamor (begona.villamor@st.ieo.es)
CR	Fundacion AZTI-AZTI Fundazioa	Spain	Dr Raul Prellezo Iguaran (rprellezo@suk.azti.es)
CR	Institut de Recherche pour le Développement	France	Dr Nicolas Bez (nicolas.bez@ifremer.fr)
CR	Association pour la Recherche et le Développement des Méthodes et Processus Industriels	France	Dr Jacques Riviorard (jacques.rivoirard@ensmp.fr)
CR	Hellenic Centre for Marine Research	Greece	Dr Christos Maravelias (cmaravel@ncmr.gr)
CR	Joint Research Centre	Italy	Dr Douglas.Beare (douglas.beare@jrc.it)

3. Work package summaries

A graphical representation of the work packages is provided in the figure below. The following sections outline the work undertaken and results obtained in each of the work packages.



3.1. WP1: A review of the current practice in the measurement of fishing capacity and effort, and of methods for applying these in fisheries management

This work package set out to provide the context and tools for the work carried out in the later work packages. The WP had two major deliverables. The first was a review of effort and capacity control regulations world wide, and particularly within the EU. It was intended to provide an overview of the different types of regulations, both proposed and as applied historically.

The second deliverable was a manual on the methods used for capacity and effort measurement. This manual was intended to provide a review and user guide to the range of analytical approaches generally available. Within the consortium we were lucky enough to have acknowledged international experts on all these approaches. The manual was based on inputs from these experts who reviewed the use and execution of these methodologies, and provided guidance on how to carry them out. The intention of this manual was for it to be used as a resource for the consortium, but it will also be of use to any future teams wishing to work in this general area.

The following conclusions were drawn from the work done in WP1:

- In most countries, assessment has been undertaken to determine how physical measure of capacity, primarily gross tonnage, and in some cases engine power relates to the available resources. Accordingly plans have been introduced to balance the level of capacity with the available resources. This is primarily being undertaken through decommissioning, although incentive enhancing mechanisms, such as individual quotas are increasingly being adopted.

- Attempts have also been undertaken in several countries in the region to estimate output-based measures of capacity and capacity utilization such as DEA. In at least one case, this has been used to set targets for future capacity reduction programmes. In the other countries, however, its direct impact on policy was less obvious. In the European Commission, the DEA methodology was considered too complex to provide policy advice that could easily be implemented.

- The countries in the region have coordinated their activities for dealing with issues such as trans-boundary (straddling) stocks, highly migratory species and high seas fisheries through either bilateral agreements or the development of, and cooperation through, regional fisheries organizations.

- A lack of understanding of the production processes in the past was a major contributing factor to the overexploitation of many fisheries throughout the world. Heterogeneity in efficiency and capacity utilisation has substantial implications for measures to reduce overexploitation. For example, removing inefficient vessels from a fleet through a buy-back programme will have a less than proportional impact on catch rates. Further, if the remaining vessels were previously underutilized, then increases in the capacity utilisation of these vessels may offset the reduction in vessels, resulting in no real reduction in fishing mortality.

- Various modelling approaches help to understand the complex production process of fisheries. DEA has some theoretical advantages over stochastic production frontiers. These include the ability to incorporate multiple outputs more readily, and the avoidance of the need to impose a common production technology on all vessels. However, random variation is also captured as inefficiency in DEA. Fisheries are often thought to be subject to high levels of stochasticity; fishers are harvesting an unseen, fugitive resource, and "luck" may play a major role in the final output level. Given this, stochastic production frontiers may be more appropriate for estimating technical efficiency in fisheries, and DEA more appropriate for estimating capacity and capacity utilisation (as the "unbiased" measure reduces the effects of random variation on the measures).

- The importance of seasonality in determining unbiased capacity utilisation suggests that capacity utilisation may be affected by past behaviour. Recent studies on fisher location choices also found that habit forming is a significant factor affecting fisher behaviour. Substantial variation in capacity utilisation was found in the fishery in any given time period under given set of prices, weather and stock conditions. The existence of such variations and the relationship to unbiased capacity utilisation has implications for the effective capacity management in fishery. These impacts can be captured using the Tobit regression estimation of selected variables to the unbiased capacity utilisation.

- In the management of multi-species fisheries through output controls, total allowable catches are set primarily on the basis of biological considerations, usually on a species by species basis. An implicit assumption of capacity management is that fishers are able to adjust their product mix in line with the available quotas. If not, over-quota catch occurs, leading to either illegal landings or discards. In either case, the effectiveness of the total allowable catches in conserving the resource is adversely affected. In the case of multi-species fisheries that experience jointness in production, setting total allowable catches on an individual species basis is inappropriate. In particular, the technical interactions can be quantified through the estimation of a multi-output distance function. The analysis would also provide the potential of substitutability between the main and alternative species. The failure to quantify and integrate these technical interactions in the construction of management instruments for fisheries regulation may result in increased discarding, illegal fishing and potentially lower than expected future yields.

3.1.1. WP1 publications

Pascoe, S., 2007: Capacity analysis and fisheries policy: Theory versus practice. *Marine Resources Economics*, **22**, 83-87.

3.2. WP2: Compilation of a database of capacity, effort and mortality information from the case study fisheries

There were six case study fisheries examined in this project.

- North Sea pelagic fisheries targeting herring and mackerel
- Biscay pelagic fisheries targeting anchovy, sardine, mackerel and horse mackerel
- North Sea mixed demersal fisheries targeting gadoids, flatfish and Nephrops
- Biscay & Celtic Sea mixed demersal fisheries targeting hake and Nephrops
- Eastern Mediterranean pelagic fisheries targeting anchovy, sardine and mackerel.
- North western Mediterranean demersal fishery targeting hake.

3.2.1. Database definition and compilation

In this work package we set out to assemble and collate databases covering as much of the relevant data as possible, including both fleet focused (landings, effort, physical vessel characteristics) and stock focused data (surveys, assessments, biology). As a preliminary to this we carried out a comprehensive review of the data and what were available. Based on this we constructed a common exchange format to define what data should be collected and in which all CAFÉ data would be held. This was based on the approach used in the preceding TECTAC project, but was developed within CAFÉ, and has been used extensively elsewhere. It was also adapted to work within the step wise metier descriptions used in the Data Collection Framework as a future proofing mechanism.

3.2.2. Initial database analysis

The other deliverable for this WP was Deliverable D2.1 (An aggregated international catch and effort database). As discussed above, the databases were maintained in common format but held locally by each partner. As part of this WP, the participants carried out extensive descriptive statistical analyses on the data, providing a comprehensive overview of the fishery, the vessels operating within it and the deployment of the fishing capacity within that fishery.

3.2.3. WP2 publications

Marchal, P., 2008: A comparative analysis of metiers and catch profiles for some French demersal and pelagic fleets. *ICES Journal of Marine Science*, **65**, 674-686.

3.3. WP3: Definition of appropriate metrics for capacity, effort and mortality that are most useful in empirical modelling to elucidate the links between these factors

This WP centred on the analysis of the metrics for capacity and effort, and on which of these were most useful for quantifying the links between these and fishing mortality. For most of these analyses we used catch or catch per unit effort as proxies for fishing mortality, and linked them to mortality at a later stage. A wide range of analytical methods were explored, as well as a wide range of metrics. While it is impossible to generalise on the outcome of these analyses, there were some common themes.

3.3.1. Importance of physical capacity and effort metrics

As might be expected, in terms of physical capacity metrics, the most appropriate were often found to be those most commonly adopted by default; tonnage, length and power. However, in many cases there were other important determinants of capacity, as it impacted on mortality through effort. For instance, the size of the Refrigerated Sea Water tanks was important in some pelagic fisheries. In some of the Biscay fisheries, the age of the vessel, and indeed of the skipper, as well as the hull material were important. It was found that economic metrics may in some cases be more important predicators for fishing mortality than the physical characteristics of the vessel. In terms of effort, the days at sea remained the key determinant.

3.3.2. Importance of economic and social capacity and effort metrics

A great deal of the analysis utilised Data Envelopment Analysis (DEA) which provided details of Technical Efficiency (TE) and Capacity Utilisation (CU). It was notable that in many of the DEA analyses, the most efficient vessels were not necessarily the largest or most modern. Another key finding was that in many cases, while physical and economic metrics could be linked successfully to fishing mortality, there was also what was dubbed a “skipper effect”. Vessels would not necessarily behave as predicted solely on the basis of the vessel and costs, but that decisions on fishing would be modified by a wide range of other, and often social factors. North Sea pelagic vessels would land in harbours for lower prices if that was where they were based. Greek pursers would decide to go to sea as much based on what others were catching and doing than on intrinsic factors. Larger vessels in the Biscay demersal fleet would sail further to fish even when good fishing was available closer to port, possibly to avoid conflict with smaller vessels. The principle point here would be that, while physical and economic factors are important they are not constraining, and there is a major social effect. This has important implications for effort and capacity management as it suggests that the fleets are often highly adaptable in how they deploy their capacity. Currently many of them respond to social pressures, in a more constrained capacity or effort regime, they may feel less willing to do so, and would potentially be able to mitigate the expected effects of any management measure.

3.3.3. WP3 deliverables

There were two deliverables for this WP:

- D3.1 A report detailing the analyses undertaken in each case study fishery relating inputs to capacity and fishing effort
- D3.2 A report detailing the analyses undertaken in each case study fishery relating inputs/effort measures to fishing mortality

3.3.4. WP3 publications

Le Floc’h, P. & Mardle, S., 2008: Excess capacity and fuel consumption - The case of the fishing fleet in Brittany (France) - AMURE PUBLICATIONS. Working Papers Series N° D-21-2007.

Tsitsika, E. V., Maravelias, C. D., Wattage, P. & Haralabous, J., 2008: Fishing capacity and capacity utilization of purse seiners using data envelopment analysis. *Fisheries Science*, **74**, 730-735.

Tsitsika, E. V., Maravelias, C. D. & Haralabous, J., 2008: Fishing capacity assessment in the Eastern Mediterranean purse seine fisheries. *ICES CM 2008/I:16*.

Tsitsika, E. V., Maravelias, C. D. & Haralabous, J., 2007: Modelling and forecasting pelagic fish production using univariate and multivariate ARIMA models. *Fisheries Science*, **73**, 979-988.

3.4. WP4. Determine the factors that drive changes in the capacity of the case study fleets over time

The aim of WP4 was to determine what the drivers were for fishers to invest in vessel capacity. The empirical study of investment across a number of the fleets showed up a number of surprising and sometimes conflicting results. Perhaps most surprisingly, profit did not appear to be a key driver for investment, even though one would expect more investment when profit was high. Also surprising was that interest rates did not appear to have a major effect except in the Danish fishery example. In some fisheries (e.g. Norway) the amount of physical capital (tonnage) and the amount of quota owned appeared to have a negative impact on further investment, while it did not in others e.g. the Danish case study. Variations in the stock levels had an affect on investment in Norway, but not in the Basque country.

The difference in how vessel age affects investment in the Norwegian fishery, on the one hand, and the French and Basque fisheries, on the other hand, is also quite different, probably due to differences in fishery characteristics, and regulatory framework. The recent trend in the Norwegian fleet is a reduction in the total number of vessels, while the average vessel age has been decreasing rapidly and the fishing capacity of the vessels has increased. The fleet has also realised large profits. The situation has been quite different in the French and Basque fisheries. In both fisheries, there has been a decline in the number of vessels in the industry, but the capacity of the average vessel has rather been reduced than increased. Furthermore, these fleets have not realised above normal profits. Owner age has also been shown as a factor in the French fishery.

The overall conclusion was that there was no single factor that consistently drove investment in all fisheries studied. Nonetheless, across all case studies the results show that a few economic variables can significantly affect investment. It was also found that there were other similarities between some of the case studies. The differences in results are most likely due to differences in the characteristics of the fisheries studied, particularly differences in regulatory settings.

3.4.1. WP4 deliverables

The empirical analysis represented one of the deliverables for this WP (Deliverable D4.2: An empirical analysis of the capacity adjustment in the EU/EEA states involved in the project).

As well as the empirical analysis, the WP produced a methodological report on how to carry out this type of analysis. This was produced both as a resource for the consortium, and for others wishing to perform this type of analysis. This report was produced as Deliverable D4.1 (a report discussing the appropriate methodologies for analysing the information available on capacity adjustment and capacity utilisation).

3.4.2. WP4 publications

The following two publications describe some of the work undertaken in WP4:

Eigaard, O. R., 2009: A bottom-up approach to technological development and its management implications in a commercial fishery. *ICES J. Mar. Sci.*, **66**, 916-927.

Goti, L., Prellezo, R., & Iriondo, A., 2008: A study of the economic drivers of investment in capacity applied to Basque fleets in the Western Waters (ICES subareas VII and VIII). *ICES CM 2008/I:14.*

3.5. WP5. To determine what factors (economic and biological) control how fishing capacity and effort are utilized and allocated, and what are the impacts on fishing mortality

The aim of WP5 was to take the models and understanding developed in WP3 and to try and determine what external factors modulate how fishers deploy the capacity and effort that they have potentially available. It is perhaps not surprising that the factors that affect this deployment will differ between fisheries, given that we are dealing with a wide geographical range and widely varied fisheries and metiers. However it is possible to identify some general features.

The management regime will strongly affect effort allocation, and in case of multi-species fisheries the outcomes may become complex. In both the Bay of Biscay and North Sea trawling studies, the output control of (individual) landings quota strongly affected the spatial effort allocation. In the case of the North Sea beam trawl fishery, the levels of plaice quota determined much of where and how fishing effort was located. In turn, this had consequences for the other species in the fishery, especially sole. Decreasing quota can lead to increasing catchabilities for other target species of the affected fleets. In the Bay of Biscay trawl fishery, an increase in hake quota will also increase the probability of fishing in Divisions VIII a, b, d. On the other hand, anglerfish and megrim TACs do not affect area selection.

Input regulations will obviously also affect the total level of fishing effort exerted in the systems. However, input regulations such an overall days at sea regulation will tend to affect the location choice of fishers. For instance, in the Biscay demersal fishery the number of days allowed in Biscay will negatively affect the likelihood of choosing Sub-area VII relative to the Bay of Biscay itself. Similarly, the higher number of fishing rights in Sub-area VI, the higher probability of selecting this area against Biscay.

Economic factors will also affect fishing area choice. In particular, the effects of fuel cost will affect location choice, and may thus affect the relation between nominal effort and fishing mortality. An effect of fuel costs on effort allocation choice was found in several of the Random Utility Models (RUM) analyzing statistical data, and in the mathematical model on trawling fishing effort. Indeed we would expect the effect of fuel costs on effort allocation to be most pronounced in trawling, where fuel costs are high compared to total costs. In the trawling fleet in the Bay of Biscay, increasing fuel costs increased the probability of choosing Sub-areas VI and VII relative to Division VIII a, b, d. The effect of fuel costs on effort allocation is a direct effect of individual fishers optimizing the economic performance of their operation. This economic optimization was found in all RUM studies, although factors such as existing knowledge of fishing grounds or tradition also played a role in the effort allocation. This optimization of economic performance also explains why changes in the prices of different target species in multispecies fisheries can affect the spatial effort allocation, and thus the linkage between fishing effort and fishing mortality.

It is perhaps obvious to observe that management and particularly input controls e.g. days at sea, are a major factor in fishers' choice of where and when to fish. However, it is also clear that other factors are also often important. Economic factors, e.g. price of fish and price of fuel, are important. But a number of studies also indicated that to a considerable extent the choice fishing location at least is based on personal experience by the skipper, and from information from other vessels. To some extent this also applies to choices of when to fish. Many of the analyses indicated that it was probably impossible to account for the fishing mortality produced from a given capacity and associated effort deployment. Even in single species pelagic fisheries the choices made by fishers do not appear to follow from just economics and management. In multi-species fisheries the picture is even more complex. While the fishers may be operating in the same general fishery, e.g. the North Sea Beam trawl fishery, their choice of species to target and area to prosecute will have an impact on the relationship between effort and mortality. This would be true not only for the targeted species but also for others present in the area, even though these are also landed and managed.

3.5.1. WP5 deliverables

The deliverables under this WP were:

D5.1. Evaluation of effects of (historical) management on capacity utilization and effort allocation and their relationship to fishing mortality

D5.2. Scientific publication on;

- The use of mathematical modelling to assess the effects of management on effort allocation.
- Effort allocation studies on each of the case studies
- The synthesis of effort allocation studies.

- The findings and implications of the fine scale studies of fishers behaviour

3.5.2. WP5 publications

There have been several published papers to date covering studies on the various fisheries in the case studies and ranging from Random Utility Models and other statistical methods, through mathematical models of particular fisheries to details of the fine scale behaviour of the North Sea and Biscay pelagic fleets. All pertain to the basis for capacity utilization and effort allocation for the analysed fishery. Several additional manuscripts are currently being prepared for submission.

Prellezo, R., Lazkano, I., Santurtúna, M. & Iriondo A., 2009: A qualitative and quantitative analysis of selection of fishing area by Basque trawlers. *Fisheries Research*, **97**, 24–31.

Haralabous, J., Tsitsika, E., & Maravelias, C., 2009: A Random Utility Model of fishing area choice in the Eastern Mediterranean purse seine fishery. In: Proceedings of the 9th Symposium on Oceanography & Fisheries.

Pout, A., Campbell, N., Beare, D., Clarke, E., Hillary, R., Hölker, F. & Reid, D., 2008: Modelling vessel activity in the Scottish pelagic fleet: the relationship between capacity and effort and the evaluation of a range of possible management plans. *ICES CM 2008/I:08*.

Poos, J. J., Bogaards, J. A., Quirijns, F. J., Gillis, D. M. & Rijnsdorp, A. D., 2009: Individual quotas, fishing effort allocation and over-quota discarding in mixed fisheries. In review at ICES Journal of Marine Science.

Reid, D., Copland, P., Armstrong, E. & Stewart, M., 2008: Small Scale pattern in the allocation of Fishing Effort in the Scottish Pelagic Fishery: A view from different landscapes. *ICES CM 2008/I:25*.

3.6. WP6. Use the understanding and models developed in the project to explore a number of potential capacity and effort management scenarios and make recommendations for future capacity and effort based fisheries management

3.6.1. Introduction

The final work package of the CAFÉ project set out to examine a range of capacity and effort management measures using the understandings developed within the project. As described above, some of these evaluations were carried out using standard MSE approaches, while others used the specific models developed within CAFÉ.

3.6.2. Effort and Capacity management scenarios

The initial step was to decide what scenarios we should test using the models. In fact there are only a small numbers of ways that we can effectively manage the fishery. Each model or approach was tasked to evaluate a range of scenarios within the type of management control available. These were:

- TAC Controls – restriction of catch, and also possible effects of overshoot/undershoot
- Discards – what would be the effect of a discard ban on stocks and fleets?
- Effort controls - Limitation of days at sea, Limitation of period (closed seasons), and Closed areas, selectivity changes
- Capacity controls - Removal of capacity; E.g. Weakest (least efficient) 10%, Random 10% or a Selected 10% (e.g. remove the most efficient, or the greatest catchers)

Not all the models were able to fully evaluate all the scenarios, but all were able to simulate some of them. This list represents Deliverable D6.1 (Candidate effort and capacity-based management strategies for each case study).

3.6.3. Results from Effort and Capacity management scenarios

A range of different effort and capacity control scenarios were tested on North Sea and Biscay pelagic and demersal fisheries, and the eastern Mediterranean pelagic fisheries. These included both MSE style evaluations and evaluations with CAFÉ developed models. For pelagic fisheries in the eastern Mediterranean, a range of both effort and capacity measures were tested, both alone and together.

Broadly, the findings were that, while any reduction will yield some improvement in F, the best performing scenarios involved BOTH capacity and effort reduction. Reducing capacity, without reducing effort performed poorly. In the North Sea pelagic case a 10% reduction in fleet capacity would be expected to reduce mackerel F by at least 10% and herring F by a greater amount. Whereas halving the number of days at sea in the mackerel fishery from the current level (around 60 days) to 30 days would yield a 33% reduction in catches. A closure early in the mackerel season, without a concomitant reduction in effort would not benefit the stock and may actually increase catches. In the Bay of Biscay, simulations suggest that a 10% capacity reduction would probably have almost no impact on fishing mortality but that higher harvest rates might result. Evaluation of closed area scenarios in the Bay of Biscay suggest that at best an MPA along the French coast would have no impact, and could actually have a negative impact depending on the exact response of fishers to the closure.

For the North Sea demersal fisheries a number of scenarios were studied. In the beam trawl fleet, an MSE evaluation incorporating a RUM and imposing a 15% TAC reduction actually led to a future projection of increased plaice landings with a corresponding increase in fleet capacity – with more boats entering the fishery. In the Danish trawl fleet, different approaches to effort control, either by a mechanistic closure after a single species TAC was taken, compared to a dynamic approach allowing re-allocation of effort to other targets. With a TAC constraint retained, it was shown that profitability in the fleet was improved by the dynamic approach without negative impact on stock. Using a combination of English, Dutch and Danish fleets in a GLMM approach it was shown that F can be much better reduced using a management strategy that does not rely on effort alone, but incorporates capacity, area and seasonal effects. In the Biscay hake fishery a series of simulations using different mesh sizes and TAC reductions of 15% were tested for their efficacy. The mesh changes were imposed across different fleets in each of 5 scenarios. The aim was to identify the best way of gaining MSY by 2015. The results suggested that managing by controlling F rather than by TAC would retain a larger, but relatively less efficient fleet by 2015. The effect of the mesh changes proved difficult to evaluate in the presence of excess capacity.

3.6.4. WP6 deliverables

The four deliverables for this Work Package were:

- D6.2. A description of the operating models that will be used to simulate "actual" conditions for each case study.
- D6.3 Evaluation of the performance of all tested management measures with respect to robustness, precision, capability to capture stock trends, stock risks, average yield and interannual variability in yield. Recommendations on which methods perform best for each of the case study species.
- D6.4 Comparison of current management advice from alternative effort and capacity management methods with the actual assessments provided by ICES for case studies, where available.

Extensive descriptions of each of the operating models have been provided along with the scenario testing in each of the case study reports (D6.2). The performance of the tested management measures have been presented in the reports, and conclusions on the best performing discussed

(D6.3). In most of the scenario testing studies, the analysis included the current management and stock situations as the base case, and compared these with the simulations (D6.4).

3.6.5. WP6 publications

None of the pieces of work reported have been submitted for publication at the time of writing. However, in most cases they are eminently suitable for publication. The consortium have agreed to approach appropriate journals to agree a special edition to showcase the innovative work of the CAFÉ project.

4. Overall Conclusion

The models developed in CAFÉ have all proved potentially valuable for evaluating a range of capacity and effort management measures. In most cases the models were able to hindcast reasonably well, and could replicate the current position on effort and fishing mortality. For the scenario manipulation, a number of assumptions had to be made, but results were encouraging and, while probably requiring more development have promise in understanding the effects of capacity and effort control. Probably the most important for any of the models would be as realistic as possible replication of the dynamics involved in fishers' behaviour and response to specific management measures.

5. Dissemination

5.1. Project website

A website was established during the early months of the project to ensure that the appropriate information regarding the work would be widely accessible to facilitate the dialogue with society within Europe. General information, documents and presentations arising from CAFÉ, as well as links to the project partners, are available from the project website:

https://cafe.jrc.ec.europa.eu/

5.2. Publications

Many publications have already arisen through the work done in CAFÉ, as listed under the individual work packages in the preceeding sections. Several more are currently being prepared for submiddion to international journals.

A theme session was set up at the ICES Annual Science Conference that was held in Halifax, Canada in 2008, specifically to disseminate and present the work of the CAFÉ project. The session was very successful, had a significant attendance and was commended on the excellence of the work presented.

The sessionwas entitled 'Theme Session I on "Fishing capacity, effort, and fishing mortality – the understanding of fishery dynamics and their links to management".

Ten presenting authors (from 5 partners: AZTI, IFREMER, SNF, HMRC & FRS) attended the theme session. A list of the papers presented is provided below, and abstracts can be obtained from:

http://www.ices.dk/iceswork/asc/2008/themesessions/Theme%20synopses/I-list-ed.pdf

I:08	Authors: **N. Campbell**, A. Pout, D. Beare, R. Hillary, D. Reid, and F. Hoelker. Title: Capacity and effort metrics of the Scottish pelagic fleet: utility in testing management plans for pelagic fish stocks in the waters around Scotland
I:14	Authors: **L. Goti**, R. Prellezo, and A. Iriondo. Title: A study of the economic drivers of investment in capacity applied to Basque fleets in the Western Waters (ICES subareas VII and VIII)
I:15	Authors: J. Haralabous, **E.V. Tsitsika**, and C.D. Maravelias. Title: Modelling fishers' behavior in the Mediterranean Sea using Random Utility Models
I:16	Authors: **E. V. Tsitsika**, C. D. Maravelias and J. Haralabous. Title: Fishing capacity assessment in the Eastern Mediterranean purse seine fisheries
I:18	Authors: **A. Uriarte**, R. Prellezo, A. Punzón , M. Aranda, and B. Villamor. Title: The Spanish fishery on anchovy in the Bay of Biscay: Analysis of the relationship between fishing Capacity, Effort and mortality
I:19	Authors: **M. Doray**, S. Mahévas, and V. M. Trenkel. Title: Direct estimation of catchability in a combined acoustic-trawl survey, with reference to fish spatial distribution
I:20	Authors: **S. Mahévas**, V. Trenkel,and M. Doray. Title: Small scale estimates of the biological and technical components of catchability
I:21	Authors: **S. Mahévas**, Y. Vermard, T. Hutton, A. Iriondo, A. Jadaud, C.D. Maravelias, A. Punzón , J. Sachi, A. Tidd, and E.V. Tsitsika. Title: Standardising fishing effort according to technical characteristics requires an assessment of the fishermen skill contribution in catchability estimates
I:22	Authors: **Y. Vermard**, S. Lehuta, S. Mahévas, O. Thébaud, P. Marchal, and D. Gascuel. Title: Integrating Random Utility Model fit in ISIS-Fish to simulate the dynamics of the Anchovy fishery of the Bay of Biscay.
I:23	Authors: **J.J. Poos**, J. A Bogaards, D. M. Gillis, and A. D. Rijnsdorp. Title: Modeling spatiotemporal effort allocation and size dependent discarding in a mixed fishery with individual catch and effort quotas
I:25	Authors: **D. G. Reid**, P. J. Copland, F. Armstrong, and M. J. Stewart. Title: Small scale pattern in the allocation of fishing effort in the Scottish pelagic fishery; a view from different landscapes