

Studies and support services related to the common fisheries policy

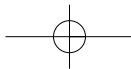
DISSEMINATION OF THE RESULTS OF BIOLOGICAL STUDIES 1997-2000

October 2004

DG FISH



European Commission



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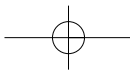
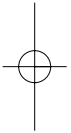
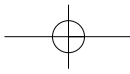
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Foreword

Decisions under the Common Fisheries Policy are taken on the basis of scientific advice. The supply of that advice demands sustained effort from fisheries research organisations in order to obtain as precise information as possible on the state of the fish stocks. This in turn requires adequate co-ordination in order to focus research activities on the right areas, as most stocks are distributed in more than one Economic Exclusive Zone.

One of the main preoccupations of the Directorate General for Fisheries in the past decade has been to promote the development of joint action in fisheries research involving the most relevant fisheries research institutes from all over Europe, by offering financial support to such co-operation. Beyond the provision of this financial support, the Directorate General has played an important role in ensuring the co-ordination and co-operation at the right level by establishing permanent liaison with the relevant players. Particular attention has been devoted to support studies on data collection, either by direct methods (research surveys) or by indirect methods (market sampling, statistical analysis, biological sampling), and also to other subjects such as gear selectivity, discards, fishing effort or control and monitoring.

The Directorate General for Fisheries has also sought to make available the results of these studies to a wider public by presenting them, as far as possible, in a non-technical language.

Given our aim of sharing with as wide a public as possible the knowledge generated by these actions, I welcome the present document which summarises, the main findings of the scientific studies supported by the Directorate General for Fisheries during the 1997 — 2000 budgetary exercise. A total of 182 studies were undertaken during this period at a EU Contribution of €76 million.

In order to reach the widest possible audience, these findings have also been made available on the DG Fisheries web site <http://europa.eu.int/comm/fisheries/>.



Jörgen Holmquist
Director-General
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European Commission

ACKNOWLEDGEMENTS

Acknowledgement is due to Minna Epps whose report on “*Classification and analysis of the scientific domains covered by the Biological Studies 1997-2000 in support of the CFP*” written during her stage at DG Fisheries (October 2003 — March 2004) has served as a basis for this synopsis.

Particular acknowledgements are due to Koen Eeman, Annemie Van Vaerenbergh and Guillaume Stucker for collecting the information and preparing the synopsis and Jacques Fuchs and Tore Jakobsen for the technical supervision of the document.

NOTA BENE

Every care has been taken in the preparation of this synopsis and the information is provided in good faith. This synopsis is a compilation of abstracts of the biological studies. Certain abstracts were corrected to create a more uniform presentation. Nevertheless, the contents cannot be guaranteed to be accurate or complete, and remains under the responsibility of the co-ordinators of these studies. Neither the European Commission nor any person acting on behalf of the Commission can be held responsible for the contents or for the use which might be made of them. In all cases where up-to-date information is sought regarding a particular study, contact should be made with its coordinator.

SUMMARY

Fisheries, including aquaculture, provide a vital source of food, employment, recreation, trade and economic well-being for people throughout the European Union. Decisions under the Common Fisheries Policy are taken on the basis of scientific advice provided by fisheries advisory bodies such as the International Council for the Exploration of the Sea, the International Commission for the Conservation of Atlantic Tunas and the General Fisheries Commission for the Mediterranean, which provide the best available information on the state of fisheries resources.

Following the Council decision (EEC) No 3760/92 in 1992, €25 million per year was allocated by the European Commission (hereafter the Commission) to Biological studies in the light of the relevance of the proposals to the objectives and priorities described in each *Call for proposals*.

The over-exploitation of fish stocks has had a significant negative effect on fishermen's income, the balance of marine ecosystems and the supply of fish to the EU market. Reliable scientific advice is necessary to achieve sustainable fisheries. To improve the basis for advice, particular attention has been devoted to support studies on data collection by direct measures (research surveys) and indirect methods (market sampling, statistical analysis, biological sampling) and other areas such as gear selectivity, discards, CPUE, monitoring and control.

The Community Financial Support provided by DG FISH for the biological studies during the 1997-2000 period amounted to nearly €76 millions, corresponding to 182 RDT projects, selected on a yearly basis.

The selection of proposals in response to the calls for proposals was carried out by independent experts. The scientific quality of the research, the relevance to the call and the potential impact for the CFP were considered in priority allowing a certain degree of innovation in the proposals.

This synopsis has been set up following a comprehensible classification of the 182 biological studies into scientific domains. The studies are allocated into 10 different domains (sections) according to the methods employed and their primary objectives. Each domain is then divided into sub-domains.

| | |
|-----------------------------------------------------------|------|
| 1. RESEARCH SURVEYS | (39) |
| 2. SAMPLING OF COMMERCIAL FISHERIES | (53) |
| 3. TECHNICAL MEASURES | (21) |
| 4. MISCELLANEOUS DATA COLLECTION | (7) |
| 5. FLEET STUDIES | (10) |
| 6. FISH STOCK POPULATION STUDIES | (21) |
| 7. INTEGRATION OF ENVIRONMENTAL REQUIREMENTS INTO THE CFP | (17) |
| 8. MONITORING AND CONTROL | (1) |
| 9. SOCIO-ECONOMIC DIMENSIONS OF FISHERIES ACTIVITY | (7) |
| 10. DISSEMINATION OF INFORMATION | (6) |

The classification used is mainly based on the Calls for proposals.

The biological studies funded during the period 1997-2000 were diverse which is demonstrated by the ten different domains that emerged. Basic data collection (Domain 1: Research surveys and Domain 2: Sampling of commercial fisheries) constituted 50 % of the biological studies and 62 % of the allocated budget. Technical measures (Domain 3) and fish stock population studies (Domain 6) were well represented, highlighting technical innovation and research on the biology of species. However, other domains such as dissemination of information (Domain 10) and the socio-economic dimension of fisheries activities (Domain 9) were not as well addressed although these topics were listed as a priority in each *Call for proposals*. Furthermore, studies on inspection, monitoring and control (Domain 8) were almost absent, as well as studies on legal provisions in the fishery sector.

During the period (1997-2000), the data collection was only supported by biological studies, limiting the capacity to collect all necessary data to improve scientific advice. Thus, there was no guarantee of receiving the necessary scientific data for the assessment of the most important stocks. However, the studies helped identifying data needs and, in addition, provided the Commission with results of diverse and sometimes innovative studies.

Under the new Data collection regulation, entered in force in 2001, Member States are obliged to collect data in accordance with a Minimum and an Extended Programme. It is expected that this new regime will be more efficient in obtaining the data required. Studies and pilot projects are also promoted through Calls for Tenders. The *Call for Tenders* is produced yearly¹.

In conclusion, biological studies funded during the period 1997-2000 have upgraded European scientific knowledge, spurred innovation, and increased the co-operation and coherence between research organisations, which will continue to contribute to meeting the goals and objectives of the reformed Common Fisheries Policy.

¹ In accordance with the Council decision 2000/439/EC (see appendix II) under article 9.

OVERVIEW of the Biological Studies 1997-2000

Yearly Breakdown of the Biological Studies

182 projects in the field of fisheries are presented in the synopsis of the present analysis. The Community Financial Support for the biological studies during the 1997-2000 period amounted to nearly €76 million (see table 1. below).

Table 1 — Yearly breakdown of projects and EU financial support.

| Year | No of projects | Total cost (€) | CFS (€)* |
|--------------|----------------|--------------------|-------------------|
| 1997 | 66 | 36 408 817 | 19 501 624 |
| 1998 | 49 | 47 468 885 | 26 068 247 |
| 1999 | 44 | 36 781 619 | 20 893 548 |
| 2000 | 23 | 15 976 504 | 9 094 242 |
| Total | 182 | 136 635 825 | 75 557 661 |

* CFS= Community Financial Support

The Council regulations (EEC) No 3760/92 community system for fisheries included fisheries resources and aquaculture. Nonetheless, the calls for 1997, 1998 and 1999 (97/C 205/08, 98/C 159/09, and 99/C 122/14, respectively) did not address aquaculture under any subject area or priority². Consequently no aquaculture research proposals were received during this period.

OVERVIEW of the Scientific Domains

Below is a summary table of the ten scientific domains followed by a brief description of each of the ten domains and a summary table of their sub-domains. The scientific component, as well as geographical area and species covered, varied greatly between the different domains.

Table 2 — Number of projects and EU financial support by scientific domain.

| Scientific Domain | No of Projects | Total cost (€) | CFS (€) ¹ | (%) ² |
|-------------------------------------|----------------|--------------------|----------------------|------------------|
| 1. Research Surveys | 39 | 43 532 251 | 22 699 887 | 30 |
| 2. Sampling of Commercial Fisheries | 53 | 41 909 409 | 23 055 418 | 32 |
| 3. Technical Measures | 21 | 10 540 824 | 6 074 887 | 8 |
| 4. Miscellaneous Data Collection | 7 | 4 823 805 | 2 639 445 | 3 |
| 5. Fleet Studies | 10 | 3 920 198 | 2 392 501 | 3 |
| 6. Fish stock population Studies | 21 | 12 564 870 | 6 898 255 | 9 |
| 7. Environmental Integration | 17 | 8 434 073 | 6 019 218 | 8 |
| 8. Monitoring and Control | 1 | 564 694 | 282 347 | 0 |
| 9. Socio-economic dimensions | 7 | 2 924 383 | 1 647 960 | 2 |
| 10. Dissemination of Information | 6 | 7 421 318 | 3 847 743 | 5 |
| Total | 182 | 136 635 825 | 75 557 661 | 100 |

¹ CFS= Community Financial Support

² Percentage of the total community budget allocated to the Biological Studies 1997-2000

² The 2000 Call for Proposals (2000/C 177/08) included exploratory data collection projects in the area of aquaculture, the relationship between aquaculture and fisheries (influences of fish farming on the coastal environment, and environmental hazards on fisheries and fish farming), and the capacity of fishing and aquaculture industries to create jobs (see Annex I).

Overview of the Scientific Domains

The relative proportion of each scientific domain by number of projects and by Community funding, respectively, is illustrated in Figures 1 and 2.

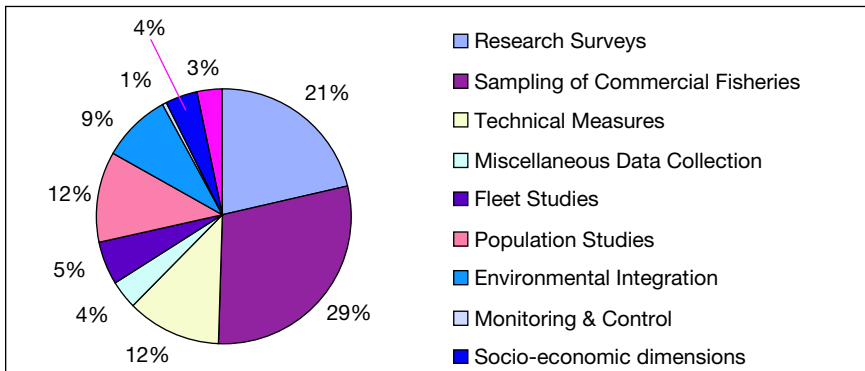


Figure 1 — Relative proportion of each scientific domain by number of projects.

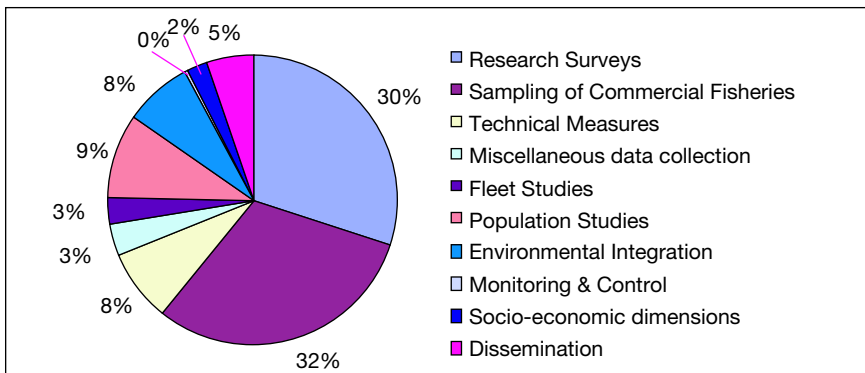


Figure 2 — Relative proportion of each scientific domain by percentage Community Financial Support.

Research Surveys (Domain 1) and Sampling of commercial fisheries studies (Domain 2) alone constitute 50 % of the Biological Studies and 62 % of the allocated budget. Of the 92 projects in these scientific domains, 19 projects (21 %) were studies aimed at improving and standardising basic data collection methods.

After these two domains, fish stock population studies (Domain 6) received the third largest proportion of the budget allocated (9 %) to the biological studies. The dissemination of information (Domain 10) received 5 % of the total budget despite only containing six study projects. This was reflected by each call giving high priority to the improvement of dissemination of information.

The histogram below shows the Community Financial Support (CFS) by scientific domain and sub-domain.

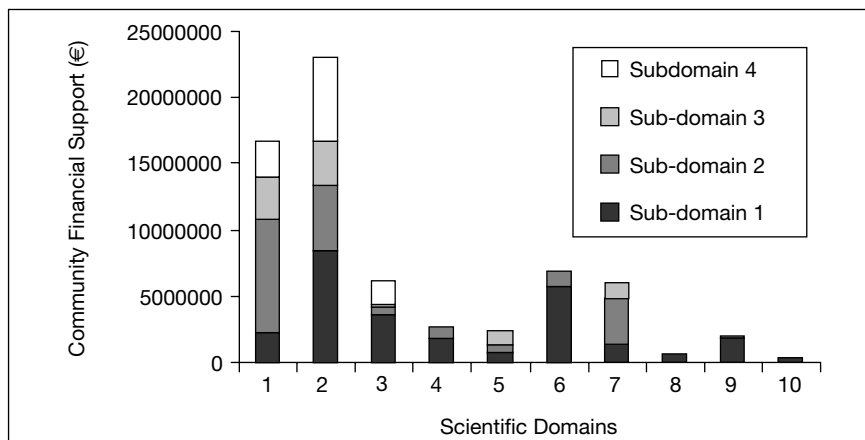


Figure 3 — Community Financial Support by scientific domain and sub-domain.

Domain 1. Research Surveys

The mode of collecting the data in this domain was through scientific research surveys. Studies were allocated into sub-domains depending on the survey method used:

1.1 Hydroacoustic Surveys, 1.2 Trawl Surveys, and 1.3 Egg-production based Biomass Surveys. These annual surveys often formed a part of a continuous programme. The studies that involved a mixture of the above methodologies were allocated to the **1.4 Multipurpose Surveys** sub-domain. The latter sub-domain also included aerial surveys and a combination of other fisheries data. Studies aimed at evaluating, improving and standardising survey design and methods were subsequently allocated to the **1.5 Improvement of Survey Design and standardisation of methods**³ sub-domain.

The breakdown of projects by sub-domain is presented in Table 3.

Table 3 — Summary table of the Sub-domains

| Sub-domains | No of projects | Total Cost (€) | CFS (€) |
|------------------------------------------------------------------------|----------------|-------------------|-------------------|
| 1.1 Hydroacoustic Surveys | 5 | 4 113 513 | 2 260 258 |
| 1.2 Trawl Surveys | 16 | 17 337 341 | 8 548 501 |
| 1.3 Egg-based Biomass Surveys | 4 | 5 232 106 | 3 247 845 |
| 1.4 Multipurpose Surveys | 4 | 6 382 602 | 2 688 255 |
| 1.5 Improvement of Survey design and Standardisation of Methods | 10 | 10 466 689 | 5 955 028 |
| Total | 39 | 43 532 251 | 22 699 887 |

Domain 2. Sampling of Commercial Fisheries

The main objective of the biological studies in this domain was to collect data from commercial fisheries³ from landings and at sea for stock assessment. The data collected in this scientific domain were dependent on fisheries catch data. The biological studies under

³ Estimates of the total volume of catches per stock, including discards. Data on landings and discards including estimate catch composition and biological parameters like; growth, sex, maturity and fecundity.

this category were allocated to the following sub-domains; **2.1 Biological Sampling, 2.2 Discard Sampling and Analysis, 2.3 Catch and Effort, and 2.4 Improvement and Standardisation of Methodologies**. Biological studies which collected data from commercial landings (e.g. length-frequency distributions, sex ratios, otoliths for age determination) through observer programmes and logbooks, were allocated to the biological sampling sub-domain. Studies under this sub-domain regularly contained a mixture of research methods (e.g. Market sampling and surveys) including genetic analysis. Biological Studies estimating and analysing discards⁴ were grouped together in the *Discard Sampling and Analysis* sub-domain. Studies that investigated catch effort of specific fisheries and factors effecting catch effort were subsequently allocated to the *Catch and Effort* sub-domain. The *Improvement and Standardisation of sampling methodologies* sub-domain included studies that aimed to improve the methodologies through supplementary techniques and information such as historical data, modelling, and establishing databases for dissemination of the data collected.

The breakdown of projects by sub-domain is presented in Table 4.

Table 4 — Summary table of the Sub-domains

| Sub-domains | No of Projects | Total Cost(€) | CFS(€) |
|--------------------------------------------------------------|----------------|-------------------|-------------------|
| 2.1 Biological Sampling of Commercial Fisheries | 20 | 15 537 093 | 8 436 150 |
| 2.2 Discard Sampling and Analysis | 12 | 8 965 590 | 4 957 650 |
| 2.3 Catch and Effort | 12 | 5 759 520 | 3 334 204 |
| 2.4 Improvements and Standardisation of Methodologies | 9 | 11 647 206 | 6 327 414 |
| Total | 53 | 41 909 409 | 23 055 418 |

Domain 3. Technical Measures- and alternative uses of fishing techniques

Technical measures such as gear selectivity⁵ and seasonal closures are aimed at reducing by-catch and protecting juveniles. As a consequence of the Council Decisions on technical measures the four calls for proposals addresses 'gear selectivity' and gave priority to the development of selective gear and techniques for reducing by-catch of juveniles. Studies with the objective to eliminate or mitigate incidental catches of porpoises and other non-targeted species through technical measures are listed under the **3.1 Fishing methods and gear selectivity to reduce by-catches of marine mammals, non-target species and undersized fish** sub-domain⁶. Studies comparing and evaluating the outcome⁷ for different fishing gear are listed under the **3.2 Gear evaluation and the influence of the features of the gear** sub-domain. Technical innovation and alternative uses of techniques studies are listed under **3.3 Seasonal and spatial closures** and **3.4 Alternative Fishing Techniques**. Studies assessing the environmental impact of different fishing gear were allocated to the Environmental Integration domain.

The breakdown of projects by sub-domain is presented in Table 5.

⁴ Discard sampling and analysis in this context is mainly concerned with quantification for stock assessment.

⁵ Towed gear and passive gear (net and mesh size, and number of hooks).

⁶ The sub-domain also incorporates improving and estimating gear selectivity.

⁷ Quantification and species composition.

Table 5 — Summary table of the Sub-domains

| Sub-domains | No of Projects | Total Cost(€) | CFS(€) |
|-------------------------------------------------|----------------|-------------------|------------------|
| 3.1 Fishing Methods and Gear Selectivity | 14 | 5 749 837 | 3 627 522 |
| 3.2 Gear Evaluation | 3 | 1 226 673 | 639 842 |
| 3.3 Seasonal and Spatial Closures | 1 | 122 406 | 61 203 |
| 3.4 Alternative Fishing Techniques | 3 | 3 564 314 | 1 807 523 |
| Total | 21 | 10 540 824 | 6 074 887 |

Domain 4. Miscellaneous Data Collection

The calls for proposals emphasise the need for scientific information on not previously researched species or subject areas, and optimisation and standardisation of data collection in general. The studies under this scientific domain are divided into two sub-domains; **4.1 Data Collection of poorly studied species and areas** (exploratory studies collecting data on poorly studied areas and species such as deep-sea species and elasmobranchs), and **4.2 Optimisation and Standardisation of Data Collection for Management Models** — assessment and development of fisheries management models in general (revising and updating information, and development of new software).

The breakdown of projects by sub-domain is presented in Table 6.

Table 6 — Summary table of the Sub-domains

| Sub-domains | No of Projects | Total Cost(€) | CFS(€) |
|----------------------------------------------------------------|----------------|------------------|------------------|
| 4.1 Data Collection of Poorly studied Species and Areas | 3 | 3 054 280 | 1 775 259 |
| 4.2 Optimisation of data collection | 4 | 1 769 525 | 864 186 |
| Total | 7 | 4 823 805 | 2 639 445 |

Domain 5. Fleet Studies (fleet behaviour)

This domain includes studies on the relationship between fishing effort, capacity, mortality, examination of trends in catch capability and fishing power, and economic analysis of fisheries.

5.1 Economic Performance and Analysis — includes data on economic performance of specific fisheries (fleets, resources and fishing activities).

5.2 Fleet Capacity — evaluates and estimates the capacity of fishing industries.

5.3 Assessment and Development of Fishing Power — involves technical analysis of fishing power/effort (tonnage, engine power, and fuel consumption of fishing vessels).

The breakdown of projects by sub-domain is presented in Table 7.

Table 7 — Summary table of the Sub-domains

| Sub-domains | No of Projects | Total Cost(€) | CFS(€) |
|--------------------------------------------------------|----------------|------------------|------------------|
| 5.1 Economic Performance/Analysis | 1 | 1 452 823 | 733 998 |
| 5.2 Fleet Capacity | 4 | 1 027 357 | 605 139 |
| 5.3 Assessment and Development of Fishing Power | 5 | 1 440 018 | 1 053 364 |
| Total | 10 | 3 920 198 | 2 392 501 |

Domain 6. Fish stock population Studies

The aim of the studies under this scientific domain was to enhance the biological knowledge of commercial and non-commercial species and their habitats. The domain was divided into the following two sub-domains:

6.1 Biological Studies on reproductive biology, spawning, migration patterns of commercial and non-commercial species, and population dynamics (modelling and simulations)

6.2 Genetic Studies (includes a genetic characterisation of the stocks/species).

The breakdown of projects by sub-domain is presented in Table 8.

Table 8 — Summary table of the Sub-domains

| Sub-domains | No of Projects | Total Cost(€) | CFS(€) |
|---------------------------------|----------------|-------------------|------------------|
| 6.1 Reproductive biology | 18 | 10 271 386 | 5 735 963 |
| 6.2 Genetic studies | 3 | 2 293 484 | 1 162 292 |
| Total | 21 | 12 564 870 | 6 898 255 |

Domain 7. Integration of Environmental Requirements into the CFP

The calls during the period concerning the present analysis stipulate the importance of integrating environmental requirements into the CFP by funding studies that estimate and assess the environmental impacts of fisheries activities on marine ecosystems. The Integration of Environmental requirements into the CFP was further split into three sub-domains:

7.1 Incidental by-catches and strandings — assesses the impacts of fisheries on small cetaceans and other marine mammals, and includes observer studies to monitor by-catch.

7.2 Impact of Fishing Activities on Marine Ecosystems — this sub-domain mainly includes studies assessing and comparing the environmental impacts of towed gear on benthic communities.

7.3 Effect of Environmental Variables on Fisheries Resources — physical factors determining the annual variation in spatial and temporal distribution of stocks.

The breakdown of projects by sub-domain is presented in Table 9.

Table 9 — Summary table of the Sub-domains

| Sub-domains | No of Projects | Total Cost(€) | CFS(€) |
|---------------------------------------------------------------------|----------------|------------------|------------------|
| 7.1 Incidental By-catch and Strandlings | 4 | 1 803 212 | 1 331 746 |
| 7.2 Impact of Fishing on Marine Ecosystem | 10 | 4 622 547 | 3 497 134 |
| 7.3 Effect of Environmental Variables on Fisheries Resources | 3 | 2 008 314 | 1 190 338 |
| Total | 17 | 8 434 073 | 6 019 218 |

Domain 8. Monitoring and Control

8.1 Application of modern techniques — Development of satellite technology such as VMS and ArcGIS for recording and reporting of data on fishing activities (including future potential applications).

The breakdown of projects by sub-domain is presented in Table 10.

Table 10 — Summary table of the Sub-domains

| Sub-domains | No of Projects | Total Cost(€) | CFS(€) |
|--------------------------------------------------------|----------------|---------------|---------|
| 8.1 Incidental Application of Modern Techniques | 1 | 564 694 | 282 347 |

Domain 9. Social and Economic Dimensions of Fisheries Activity

This domain incorporates review and evaluation studies of fisheries in an economic and social context and was divided into the two following sub-domains:

9.1 Social and Economical Implications of policies and technical measures — this sub-domain includes studies on small coastal fisheries within an economical and social framework, as well as the applicability and effectiveness of technical measures.

9.2 Recreational Fisheries — includes biological, economic, social and demographic data to portray the state of recreational fisheries, and the creation of data bases for present and future monitoring needs for recreational fishing activities.

The breakdown of projects by sub-domain is presented in Table 11.

Table 11 — Summary table of the Sub-domains

| Sub-domains | No of Projects | Total Cost | CFS |
|------------------------------------------------------------------------------|----------------|------------------|------------------|
| 9.1 Social and Economic Implications of Policy and Technical measures | 6 | 3 154 347 | 1 762 942 |
| 9.2 Recreational Fisheries | 1 | 334 730 | 167 365 |
| Total | 7 | 2 924 383 | 1 647 960 |

Domain 10. Dissemination of Information

The studies in this domain aim to increase the flow of scientific information and to improve communication between fisheries research and the industry to ensure effective implementation of the CFP. In addition, they include methodological studies to optimise and to standardise the collection of data and communication through data bases.

The breakdown of projects by sub-domain is presented in Table 12.

Table 12 — Summary table of the Sub-domains

| Sub-domain | No of Projects | Total Cost | CFS |
|----------------------------------------------------------------|----------------|------------|-----------|
| 10.1 Dissemination of Scientific Data and communication | 6 | 7 421 318 | 3 847 743 |

LIST of projects funded by DG Fisheries between 1997-2000 — by Scientific Domain

This section lists the study projects by scientific domain and sub-domain.
The project/contract numbers are written in the left margin and the titles are followed by
an English translation where necessary.

1. Research Surveys:

1.1 Hydroacoustic Surveys

| | | |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 97/001 | Hydroacoustic survey for Atlanto-scandian herring in the Norwegian Sea in 1997 | 4 |
| 97/005 | Hydroacoustic Survey of Atlanto-Scandian Herring in the Norwegian Sea, 1998-2000 (ASH — II) | 5 |
| 98/085 | Surveying the pelagic fish resources and establish an acoustic database in the Baltic Sea | 7 |
| 99/053 | Hydroacoustic Survey of Atlanto-Scandian Herring in the Norwegian Sea, 1999-2000 | 8 |
| 00/005 | MEDIANE (MÉDiterranée ANchois Evaluation). Analyse de l'abondance et de la répartition de l'anchois et des petits pélagiques dans le golfe du Lion. (Analysis of the abundance and distribution of anchovy and small pelagic fish in the Gulf of Lion). | 10 |

1.2 Trawl Surveys

| | | |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 97/013 | International bottom trawl survey in the Mediterranean (Spain): MEDITS ES | 12 |
| 97/025 | International bottom trawl survey in the Mediterranean (France): MEDITS FR | 13 |
| 97/041 | International Bottom trawl survey in the Mediterranean (Greece): MEDITS GR | 14 |
| 97/069 | International Bottom trawl survey in the Mediterranean (Italy): MEDITS IT | 16 |
| 98/058 | Campagnes d'évaluation des ressources halieutiques en Mer du Nord et Manche Orientale, (Evaluation Survey of Fisheries Resources in the North Sea and the Orientale Channel) | 20 |
| 98/086 | Scottish Bottom Trawl Surveys in the North Sea | 21 |
| 99/014 | International bottom trawl survey in the Mediterranean (Spain): MEDITS ES | 23 |
| 99/026 | International bottom trawl survey in the Mediterranean (France): MEDITS FR | 24 |
| 99/038 | International bottom trawl survey in the Mediterranean (Greece): MEDITS GR | 26 |
| 99/046 | International bottom trawl survey in the Mediterranean (Italy): MEDITS IT | 28 |
| 99/047 | Stock Assessment in the MEDiterranean (SAMED) | 31 |
| 00/006 | International bottom trawl survey in the Mediterranean (France): MEDITS FR | 33 |
| 00/008 | Monitoring of Stocks in the North Sea and Skagerrak | 35 |
| 00/010 | International bottom trawl survey in the Mediterranean (Greece): MEDITS GR | 36 |
| 00/028 | Study of exploited fish stocks on the Flemish Cap III | 38 |
| 00/041 | International bottom trawl survey in the Mediterranean (Italy): MEDITS IT | 40 |

1.3 Egg- production based Biomass Surveys

| | | |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 97/017 | Ichthyoplankton-based indices of spring spawning commercial fish population in Western European Waters | 44 |
| 98/040 | Estimation of the Mediterranean anchovy (<i>engraulis encrasicolus</i>) biomass by the daily egg production method in the Thracian Sea (Greece) and South Western Adriatic Sea (Italy) | 46 |
| 00/013 | Population estimates of the Bay of Biscay anchovy by the daily egg production method in 2001 | 48 |
| 00/038 | Mackerel and Horse Mackerel Egg Survey 2001 | 49 |

1.4 Multi-purpose Surveys

| | | |
|--------|-------------------------------------------------------|----|
| 97/008 | Herring surveys in the North Sea and West of Scotland | 52 |
| 97/048 | Evaluation of the Southern Greek anchovy stocks | 54 |
| 98/077 | Research vessel surveys for stock assessment (ASSUR3) | 56 |
| 99/006 | Herring surveys in the North Sea and West Scotland | 57 |

1.5 Improvement of Survey design and Standardisation of Methods

| | | |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 97/009 | The use of Multivariate Data for Improving the Quality of Survey-Based Stock Estimation in the North Sea (MIQES) | 60 |
| 97/097 | Evaluation and development of spatio-temporal models and survey designs for efficient assessment of mackerel and horse mackerel | 62 |
| 98/029 | Survey-based abundance indices that account for fine spatial scale information for North Sea stocks (FINE) | 64 |
| 98/057 | International program of standardized bottom trawl surveys of North-western Europe | 66 |
| 98/062 | Thons échantillonnage systèmes statistiques (TESS). (Tuna sampling statistical system) | 67 |
| 98/090 | Development and validation of egg-production based biomass estimates, using cod and plaice stocks in the Irish Sea | 69 |
| 98/099 | Improvement of stock assessment and data collection by continuation, standardisation and design improvement of the Baltic international bottom trawl surveys for fishery resource assessment (ISDBITS) | 71 |
| 99/010 | Direct abundance estimation and distribution of pelagic fish species in North East Atlantic Waters. Improving acoustic and daily egg production methods for sardine and anchovy (PELASSES) | 73 |
| 99/011 | Calibration of abundance indices estimated from south-western Atlantic and western Mediterranean ground fish surveys. | 75 |
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| 97/004 | Sampling of 8 German Commercial Fisheries | 82 |
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| 97/066 | Mediterranean landings pilot project (MEDLAND) | 86 |
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| 97/076 | Market sampling of Dutch landings of commercial species (MARSAM2) | 92 |
| 97/078 | By-catch species in the North Sea flatfish fishery (dab, turbot, brill): preliminary assessment (DATUBRAS) | 93 |
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| 97/065 | Discards from the Adriatic small pelagic fishery | 116 |
| 97/087 | Analysis of Fisheries Discards from the south coast of Portugal (DISCARDS — Portugal II) | 117 |
| 97/098 | Monitoring of Scottish landings and discards from the North Sea | 118 |
| 97/103 | Creation of a Scottish Multi-species Discard Data Base | 119 |
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| 98/095 | Monitoring of discarding and retention by trawl fisheries in Western Waters and the Irish Sea in relation to stock assessment and technical measures | 121 |
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| 00/019 | Collection and management of data from commercial fisheries in Greece | 147 |
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| 97/034 | The optimization of the sampling strategies of the biological sample surveys and surveys of discards of the commercial catches in Greece and definition of their efficiency expressed in terms of costs: accuracy ratio | 153 |
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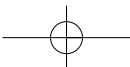
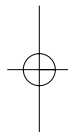
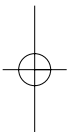
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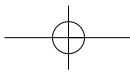
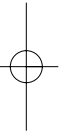
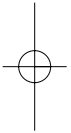
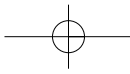
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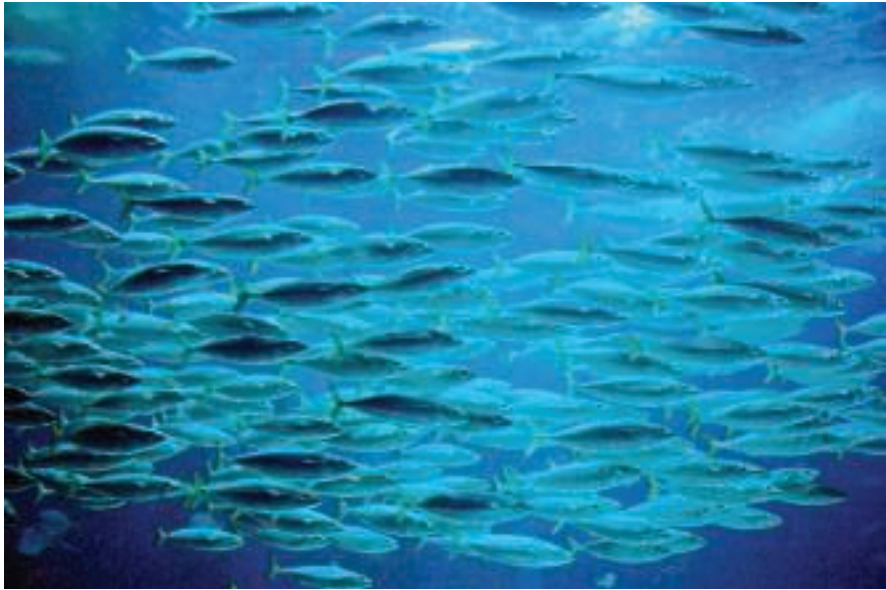
Summary of Biological Studies

1997-2000

By area and sub-area



Domain 1: Research Surveys



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Sub-domain 1.1:

Hydroacoustic Surveys

PROJECT N° 97/001: HYDROACOUSTIC SURVEY FOR ATLANTO-SCANDIAN HERRING IN THE NORWEGIAN SEA IN 1997

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SUMMARY

The main purpose of the study was to assess the recovering stock of the Atlanto-Scandian herring (*Clupea harengus*, or more precise the Norwegian spring spawning herring) in the North Atlantic and to support the Common Fisheries Policy (CFP) in the context of 13 nations assessing the stock. The CFP will be used to support a more accurate background for the International Council for the Exploration of the Sea (ICES) assessment on the state of the herring stock in the Norwegian Sea. The Study was financed by the European Commission, Directorate-General XIV, Fisheries. The Swedish RN Argos was employed and manned with scientific personnel from Denmark, Germany, The Netherlands, Scotland and Sweden. The duration of the project was one year and the effective commencement date of the project was 1/3-1997 (signature of the declaration 17/11-1997).

The distribution of Atlanto-Scandian herring in the Norwegian Sea in May was mapped during coordinated surveys carried out by Faroese, Icelandic, Norwegian and EU research vessels.

After spawning at the banks of the Norwegian coast in February-March, most of the herring migrated out in the Norwegian Sea. In May, 6 and 7 year old herring, which form the younger part of the spawning stock, were distributed in small schools or scattered layers at 25-100 m depth over a large area of the central Norwegian Sea. Older and large herring formed large schools, generally at 250-400 m depth near the cold front along the eastern part of the Icelandic Exclusive Economic Zone (EEZ).

The total abundance of herring from the four surveys was calculated in an evaluation meeting in Reykjavik in August 1997. It was estimated to about 45 billion individuals or about 9 million tonnes. The total age-structured estimate, obtained by the combined acoustic data from the May surveys, deviated by less than 5 % from 1997 ICES Northern Pelagic and Blue Whiting Working Group (WGNPBW) assessment of the Norwegian spring spawning herring.

Finally, the survey results from RN Argos were considered satisfactory. However, there were some slight problems with hydroacoustic equipment but these did not appear to affect the efficiency and the results of the survey.

PROJECT N° 97/005: HYDROACOUSTIC SURVEY OF ATLANTO-SCANDIAN HERRING IN THE NORWEGIAN SEA, 1998-2000 (ASH — II)**AUTHORS**

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SUMMARY

Since recovery of the Norwegian spring spawning herring stock in the early 90ies, an international fishery has started again in 1994. The catches in the Norwegian Sea and along the Norwegian Coast exceeded 1.4 mill. t in 1997 and 1.3 mill. t in 1998. Along with the recovery of the stock and the fishery, the stock development is under close inspection and relatively stringent management control. As a part of this the stock is surveyed and assessed annually. Two winter surveys are carried out by Norway on the over-wintering grounds of the stock, and additionally one summer survey yields a biomass estimate and the distribution pattern of the stock during its migration throughout the north-east Atlantic.

Due to the paramount economical importance of this stock for the fisheries of a number of nations, increased effort into surveying the stock has been invested not only by Norway and Russia, but also by the Faeroese Islands and Iceland. Partly, these nations have contributed to the entire survey with more than only one cruise per year. In addition, the EU has decided to contribute to the yearly summer survey by participating with one cruise. For this purpose a EU-study was created in 1997 (ASH-I) and the Swedish research vessel "Argos" took part in the programme with Dutch, Swedish and German participation on board and in the study. Following this, a continuation of the effort was granted by the EU for the next two years (ASH-II). The project now commenced again with Dutch (RIVO-DLO, IJmuiden), Swedish (IMR, Lysekil) and German (BFA-Fi) contribution. For the project in 1998 the Swedish research vessel "Argos" again sailed for the EU with Dutch, Swedish and German scientific participants. In 1999 the German vessel "Walther Herwig III" took over and surveyed the area in close co-operation with the Norwegian vessel.

The main objectives of the survey and the international cooperation of the series of individual cruises from end of April until late August, was planned by the ICES "Planning Group on Surveys on Pelagic Fish in the Norwegian Sea" (PGSPFN). During these meetings the specific survey strategies were fixed and the work distributed amongst the partners. Moreover, during the annual PGSPFN meetings also the results from the previous surveys were analysed and the results documented in ICES reports. Apart from the individual cruise reports of the EU vessel for the time sailed for the EU-study, the scientific results were presented for the ICES community in the ICES documents.

These results, however, are naturally not solely a product of the EU study ASH-II but of course the summary of the results of the entire survey programme. The scientific results of the EU study have merged into the overall results and can not be specifically disentangled. In 1998 a total of 11 single cruises contributed to the survey programme and 10 in 1999. The distribution of the stock, its migration through the Norwegian Sea and North Atlantic

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and the total biomass of the stock was determined in both years by means of hydroacoustic integration. For this purpose survey tracks were steamed at a steady speed and the hydroacoustic signals recorded. These signals were subsequently filtered and analysed, then the abundance of fish was interpolated for the adjacent areas to both sides of the vessel. Frequently control hauls were made to verify the signals and to record the specific length and age composition of the fish recorded hydroacoustically.

In addition, the surveys were used to collect a great number of hydrographical data, down to depths of more than 500 m. The data provide information on the specific hydrographical conditions in the area of the distribution of the Norwegian spring spawning herring. Moreover, plankton samples were taken during the cruises to gain insight into the feeding conditions of the herring. It could be demonstrated that the feeding conditions for herring in the north Atlantic region were very different from year to year. The situation was rather unfavourable for herring in 1997 but improved much in the following year. In 1999 the feeding situation for the herring was again less favourable.

However, in 1999 the situation was different. The plankton samples taken during the cruises revealed that the feeding conditions were fairly poor again in 1999, though not as severe as in 1998. Consequently, the herring were found to be lean and of poor condition. The hydrographical data showed, that in 1999 large amounts of very cold water had passed from north of Iceland into the southern Norwegian Sea and have caused the herring to migrate in May less south than usual and in the previous years. At greater depths (+300 m) these water masses have even reached the Norwegian and Scottish continental shelf and have effectively created a barrier for the Norwegian spring spawning herring. For this reason, in May and June, the mass concentrations of herring were found to be much further north than in the previous year and stayed far away from the EU zone.

The SSB estimate of the surveys indicated an SSB in 1998 of about 8 Mill. t and in 1999 a decrease to 6.4 Mill t. In addition, the age composition of the stock and the distribution of the juveniles in the Barents Sea showed low abundances of the younger year classes. These findings confirmed clearly the pessimistic perception of the stock development.

In addition, the biomass and distribution of the blue whiting stock in the North Atlantic area was recorded.

**PROJECT N° 98/085: SURVEYING THE PELAGIC FISH RESOURCES
AND ESTABLISH AN ACOUSTIC DATABASE IN THE BALTIC SEA**

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SUMMARY

The reported study forms part of a co-ordinated project financed by the EU (Study project, No. 98/085, "Surveying the pelagic fish resources and establish an acoustic database in the Baltic Sea"). The duration of the project is two-year and the effective commencement date of the project was 1/4-1999. One aim of the project was to conduct annually hydroacoustic surveys in specific sections of the Baltic proper during the month of October to cover the stocks of Baltic herring and sprat. These surveys provide necessary background for the relevant International Council for Exploration of the Sea (ICES) Assessment Working Group with fishery-independent data on the state of the Baltic herring and sprat stocks in the central Baltic. The aim was also to update an internationally agreed preliminary manual for survey methodology and biological sampling.

The assessment of Baltic herring in the Bothnian Sea and the Bothnian Bay is only based on catch data and revised catch-per-unit effort (CPUE) series from pelagic and bottom trawls. The CPUE indices used may not be very suitable measures of the development of the fishery and they are giving conflicting information on the development of the stock abundance. Thus the stock size estimates have very low precision. Since late 1980s there has been a substantial increase in pelagic trawl effort in terms of trawling hours and trawl size and at present the total effort is estimated to be about at least threefold compared to that in late 1980s. This increase, however, is not very well reflected in the present assessments. Therefore, the acoustic estimates for the surveys in the Bothnian Sea and the Bothnian Bay can then be used together with catch-per-unit-of-effort as a basis for stock assessment by the ICES Assessment Working Group.

The creation and availability of all acoustic survey data in an international database will make historical survey data accessible for studies on development of the Baltic Sea herring and sprat stocks over a number of years, their interactions with other fish stocks in the Baltic Sea, and the effects of environmental changes on the stocks. The progress of the creation and evaluation of the historical acoustic and biological data from the different participating countries are presented in the report.

PROJECT N° 99/053: HYDROACOUSTIC SURVEY OF ATLANTO-SCANDIAN HERRING IN THE NORWEGIAN SEA, 1999-2000

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SUMMARY

Since the recovery of the Atlanto-Scandian herring (Norwegian spring spawners) in the early nineties, an international fishery has started again in 1994. The catches in the Norwegian Sea exceeded in 1997 1.4 million tonnes and are at present still at a level of approximately 1.2 million tonnes. Along with the recovery of the stock and the fishery, the stock development is under close inspection and stringent management control. The stock is surveyed and assessed annually. At present the wintering area is covered by Norwegian surveys in December. Surveys in the nursery area in the Norwegian coastal areas and in the Barents Sea are carried out by Russia in May/June. In April a larvae survey is carried out by Norway. Since 1996 the feeding area in the Norwegian Sea is surveyed in May/June by Norway, Iceland and Faroe. From 1997 onwards, the EU contributes to this survey with one cruise. For this purpose EU studies ASH I (covering 1997) and ASH II (covering 1998 and 1999) were created. The present study covers participation of the Dutch vessel RV "Tridens" in 2000 with a scientific crew from the Netherlands, Germany and Denmark and the German vessel RV "Walther Herwig III" in 2001 with German and Dutch scientists. All EU cruises took place in close cooperation with the Norwegian vessel.

The objectives and the cooperation of a series of national cruises from April to until late August, was planned by the ICES "Planning Group on Surveys on Pelagic Fishing the Norwegian Sea" (PGSPFN). During the annual PGSPFN meetings also the results from the previous surveys were analysed and the results were documented in ICES reports. Apart from the individual cruise reports of the EU vessels, the scientific results were presented for the ICES community in ICES documents. These results are naturally not solely a product of the present EU study only, but of course the summary of the results of the entire survey programme. The scientific results of the EU study have been merged into the overall results and can not be specifically disentangled.

In 2000 and 2001 a total of 8 and 10 single cruises respectively contributed to the survey programme coordinated by the PGSPFN. The distribution of the stock, its migration through the Norwegian Sea and the North Atlantic and the total biomass of the stock was determined in both years by means of hydro acoustic integration. Control trawl hauls were made to verify the signals and to record the specific length and age composition of the acoustic recordings allocated to fish.

During the surveys a great number of hydrographical data were collected, down to depths of more than 500 m. The data provide information on the hydrographical conditions in the area of the distribution of Atlanto-Scandian herring. Also, plankton samples were taken during the cruises to obtain insight into the feeding conditions of the herring. It could be

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demonstrated that the feeding conditions for herring in the north Atlantic region were very different from year to year.

Hydrography. Two main features of the circulation in the Norwegian Sea, where the herring is feeding in the period April-July, are the Norwegian Atlantic current (NWAC) and the East Icelandic Current (EIC). The NWAC carries relatively warm and salty water into the Norwegian Sea. The EIC carries arctic waters and flows into the south western Norwegian Sea where its water subduct under the Atlantic waters to form an intermediate layer. This Arctic influence in the Norwegian Sea has become much stronger in the last years, compared to the 1950s and 1960s. As a result the warm Atlantic water is less accumulated in the central part of the Norwegian Sea and instead heats more northerly adjacent areas.

Zooplankton. The total zooplankton biomass in 2000 is the highest in the time series since 1997, latter being known to be exceptionally low. In 2001 the total zooplankton mass has decreased again.

Herring. The total stock biomass according to the acoustic survey in May was 5.8 million tonnes in 2000 and 4.7 million tonnes in 2001. The total biomass of the stock has decreased since 1997 when the stock estimate was 9.3 million tonnes.

The stock was in 2001 more northerly distributed than in 2000. The distribution patterns found confirm the observed trend of a shift northwards from 1997 onwards. In addition the migration of the herring has changed. In 1997, the herring migrated during the May survey in (south) westerly direction to feed at the Arctic front on zooplankton, from there the herring migrated in northern direction in June/July. In the 2000 and 2001 it seemed that the herring started to migrate in northern direction right after spawning along the Norwegian coast (February/March).

The relationship between herring distribution, hydrographical conditions and distribution of zooplankton is not yet fully understood. However, it is believed that the extreme northerly distribution in the last years is related to the influx of Arctic water in the southwestern part of the Norwegian Sea.

PROJECT N° 00/005: MEDIANE (MEDITERRANÉE ANCHOIS EVALUATION). ANALYSE DE L'ABONDANCE ET DE LA REPARTITION DE L'ANCHOIS ET DES PETITS PÉLAGIQUES DANS LE GOLFE DU LION

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SUMMARY

For some decades in the Golfe du Lion, fishing fleet modernization contributed to an appreciable rise in the level of catches of small pelagics (anchovies and sardines). Nowadays these catches represent a very important economic and social contribution. For the year 2000, landed quantities are respectively 18000 t and 10000 t for small pelagic and groundfish species.

To estimate this exploitation, it was necessary to study the evolution of the biomass of the small pelagic stock, more especially the one of anchovy, and to provide the administrations and the profession with opinions allowing them to manage this fishery better.

The evaluation of the pelagic biomass is achieved by acoustic surveys using the echo-integration technique. Yearly campaigns at sea, titled PELMED (Pelagic Mediterranean), have been carried out since 1993. These allow the estimation of the size and variations of resources in anchovy, sardine and other commercial pelagic species in the Golfe du Lion. The PELMED01 campaign is in line with these works. The methodology remained the same during all these years, (ship, sounders, period, plan of sampling, strategy...)

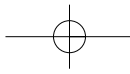
The total coverage of the Golfe du Lion is done by a network of radials, in which the acoustic information of several sounders are acquired and stocked by the software MOVIES+, developed by IFREMER. For every new structure of shoal, an identification trawling is executed in order to identify their composition in terms of fauna. Some structures of the most characteristic shoals are presented in an echogramme.

The assessment of the biomasses begins with the defining of homogeneous zones. The energies studied by the structures corresponding with the pelagic shoals are classified under the D2 denomination and serve, together with the information of the identification trawling, to calculate of the biomass. Their representations are visualized by a georeferenced cartography software (ARCVIEW) and the calculations of biomass are achieved by the software FISHVIEW, developed by IFREMER.

The results of the assessment of the anchovy and sardine stock are 112 000 and 70 500 t respectively, it is near the coast that densities are the highest, inversely the biomasses are more important in the open sea.

The assessment of the biomass of the pelagic shoals close to the coast is problematic, on the one hand because of the difficulty, for security reasons, of the oceanographical ships to reach a shallow sector, which covers 1/10 of the surface of the continental shelf, and on the other hand because of the problem of getting trawl hauls in zones with a strong human activity (nets of fishing, conchylicole concessions, various amenities...).

Finally, the boat and dragnet's avoidance of beds in this shallow sector affects the results of the assessment of the biomass. The biomass of anchovy has been increasing for several years, but in spite of that, the level of captures remained steady by 6000 to 7000 t. The market seems determined by the level of captures.



Sub-domain 1.2:

Trawl Surveys

**PROJECT N° 97/013: INTERNATIONAL BOTTOM TRAWL SURVEY
IN THE MEDITERRANEAN (SPAIN): MEDITS ES**

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SUMMARY

The MEDITS-ES survey took place from the 3rd of May to the 5th of June 1999. A total of 117 hauls were carried out with the RN "Cornide de Saavedra" from the Strait of Gibraltar to Cape Creus: 39 hauls in the Alboran sea and gulf of Vera, 33 in the Alicante area and 45 in the Catalan sea. All hauls were valid.

Participant scientists came from the laboratories of the IEO of Malaga, Murcia and the Balearic Islands, from the ICM-CSIC of Barcelona, from the University of Alicante and from the University of Barcelona. The scientific team was composed of biologists and technicians. D. Slimani, scientist from Morocco (INRH laboratory), and Edoardo Mostarda, from the Rome University, stayed on board during two weeks. For the Spanish part, Maria Gonzalez (Malaga IEO) participated in the MEDITS-FR survey on board of the research vessel "Europe".

Sampling activities were conducted without important difficulties. The geometry of the trawl was monitored during the whole survey using a Scanmar system, and the temperature, salinity and oxygen concentration at different depths was taken with a CTD measurement system. No haul was new. As in other years great catches of pelagic species were observed.

A total of 370 species were identified: 156 fishes, 88 crustaceans, 66 molluscs including 32 cephalopods and 60 other invertebrate species. A systematic inventory of waste products present in the catch was made. Determination, numbering and weighting of each species, biological examination of the principal species, introduction of the data (characteristics of each haul, weight and number of the caught species, length and maturity index of the principal species) in the CAMP and Dame programs was made on board the vessel. The checking of the data and the calculation of the abundance indices and length frequencies with the Checkmed2 and Indmed4 programs were made in the laboratory.

**PROJECT N° 97/025: INTERNATIONAL BOTTOM TRAWL SURVEY
IN THE MEDITERRANEAN (FRANCE): MEDITS FR**

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SUMMARY

The MEDITS-FR survey took place from the 5th of May to the 7th of June 1999. The first part of the survey (05/05 — 12/05) was conducted on the eastern coast of Corsica and the second part (14/05 — 07/06) in the Gulf of Lions. During the whole survey, the weather conditions were very good except for two or three windy days.

Observations on the behaviour of the gear

The geometry of the trawl was monitored during the whole survey using the Scanmar. As far as possible the rigging accorded with the latest version of the "Manuel des protocoles". In general, the gear specifications, as indicated in the "Manuel des protocoles", lead to a good efficiency of the trawl. At each haul it is however important to wait until the trawl geometry is well stabilised before deciding on the beginning of the haul.

Survey's progress:

This year no damages to the gear occurred during the survey except in one haul in Corsica with a wreck of an aeroplane wing. As previously, the shallowest strata in Corsica (13101 and 13106, between 10 and 50 m) have been considered as not trawlable due to very large quantities of algae, sea urchins and eel grass (*Posidonia sp.*). Furthermore, and as explained in the last year report, for practical purposes the trawlable parts of the northern most strata in Corsica have been reduced and their northern limit have been set at 10 miles north of Bastia, but it does not affect the total surface of these strata for the analysis. In the Gulf of Lions, the deepest haul (700 m) was not sampled, due to weather conditions in the last day of the survey. There has been no haul in the stratum 500-800 m in the western part of the Gulf.

During the '99 survey, 91 hauls have been made: 66 in the Gulf of Lions and 25 in Corsica.

Other observations

For all hauls, the Micrel ichthyometer was used, together with the Dame program written by G. Delmas. It should be noted that this program will not go beyond the year 2000. A new one is currently under development under Access in the IFREMER laboratory in Boulogne-sur-Mer (author Franck Coppin). The data files have been checked and when necessary corrected immediately after the survey.

In addition to the normal biological observations, a systematic inventory of waste products present in the codend (glass, plastic, metal, etc.) has been made. This inventory showed the importance of waste concentration near the biggest harbours (Marseille, Bastia), and on the ferry routes between Corsica and the mainland.

PROJECT N° 97/041: INTERNATIONAL BOTTOM TRAWL SURVEY IN THE MEDITERRANEAN (GREECE): MEDITS GR

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SUMMARY

Technical report for Greece — area G1 (North Aegean Sea) by A. Kallianiotis, K. Sophronidis, P. Vidoris and A. Adamidou

The MEDITS GR1 survey for 1999 was carried out from the 18th of June to the 27th of July in the North Aegean Sea (north of 38 N), using “Kapetan Paraschos”, the same commercial trawler as the one used the previous years for the sampling operation. The research cruise lasted 40 days, 32 of which were spent on fishing and 6 days on stop due to bad weather conditions.

During the research cruise 62 hauls were carried out successfully. One haul (the 34th) lasted 10 min. less because of the presence of hauled gill nets near the coasts and in the open sea.

The Scanmar equipment was not available also this year. Temperature, salinity, and oxygen concentration have been recorded with a CTD measurement system. A Minilog instrument has also been used to collect continuous data on temperature and depth during the hauls. This sensor was broken and lost in the sea at the 42nd haul.

One Italian student took part in the research cruise. Mr. M. Torre participated for 22 days as part of the “Leonardo da Vinci” programme.

Weight and length measurements as well as maturity of the sampled fish were carried out on board. The maturity stage of *Galeus melastomus*, *H. perlo*, *Raja asterias*, *Raja clavata*, *Raja miraletus*, *Raja montagui*, *Raja naevus*, *Raja oxyrinchus*, *Raja radula*, *Raja rondeleti*, *Scyliorhinus canicula*, *Squalus acanthias* and *Torpedo torpedo* was not estimated.

In the laboratory, data were recorded in a computer using the Indmed program and checked using the Checkmed program.

Abundance indices were calculated for target species and for some of the reference species. The species from the reference list, which were most abundant in weight this year were, in the following order: *S. pilchardus*, *M. poutassou*, *E. encrasicolus*, *M. merluccius*, *I. coindetii*, *A. sphyraena*, *R. clavata*, *L. caudatus*, *P. longirostris*, *S. canicula*, *L. budegassa*, *T. minutus*, *capelanus*, *S. flexuosa*, *L. piscatorius* and *M. barbatus*. Comparatively, in '98 survey the most abundant species in weight were: *E. encrasicolus*, *M. merluccius*, *S. pilchardus*, *R. clavata*, *L. budegassa*, *T. trachurus*, *P. longirostris*, *A. sphyraena*, *S. canicula*, *M. poutassou*, *M. barbatus*, *D. annularis*, *S. flexuosa*, *I. coindetii*, *E. cirrhosa*.

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Considering the number of individuals, the most abundant species were in order: *S. pilchardus*, *E. encrasicolus*, *A. sphyraena*, *M. poutassou*, *P. longirostris*, *T. minutus capelanus*, *T. trachurus*, *M. merluccius*, *S. flexuosa*, *I. coindetii*, *C. linguatula*, *M. barbatus*, *L. cavillone*, *S. notata* and *S. canicula*. In comparison, the most abundant species in number of individuals, in the previous year survey were: *E. encrasicolus*, *T. trachurus*, *P. longirostris*, *A. sphyraena*, *S. pilchardus*, *T. minutus capelanus*, *M. barbatus*, *D. annularis*, *S. flexuosa*, *M. merluccius*, *T. mediterraneus*, *M. poutassou*, *S. smaris*, *S. notata*, *L. cavillone*.

The most widely distributed species were, in decreasing order, *M. merluccius* (53 of 62 hauls), *L. budegassa* (49 of 64 hauls), *P. longirostris* (43 hauls), *S. canicula* (35 hauls), *T. trachurus* (35 hauls), *S. elegans* (32 hauls), *R. clavata* (31 hauls), *N. norvegicus* (30 hauls), *T. minutus capelanus* (27 hauls), *E. encrasicolus* (24 hauls). In MEDITS'98, the order of the most wide distributed species was: *M. merluccius* (60 of 64 hauls), *L. budegassa* (53 of 64 hauls), *I. coindetii* (51 of 64 hauls), *P. longirostris* (41 hauls), *E. cirrhosa* (37 hauls), *P. blennoides* (35 hauls), *S. canicula* (35 hauls), *T. trachurus* (34 hauls), *R. clavata* (33 hauls), *A. sphyraena* (32 hauls), *L. boschii* (30 hauls).

Technical report for Greece — area G2 (Ionian Sea and Argosaronikos) by C.-Y. Politou

In zone G2 (Argosaronikos and Ionian Sea), the sampling cruise started the 8th of June 1999 and ended the 7th of July 1999. Similarly to 1998, the commercial trawler Demetrios was used. Before the beginning of the cruise, the assemblage of the fishing gear was inspected by the regional co-ordinator, in order to assure the observance of the MEDITS protocol. The functioning of the gear was tested in Saronikos Gulf and it was checked by a Scanmar system.

A total of 53 hauls were made (21 in Argosaronikos and 32 in the Ionian Sea). The weather conditions were generally good with some exceptions in the Ionian Sea.

As in the previous years, during the 1999 sampling period, a Scanmar system was used to observe the following parameters: fishing depth, horizontal and vertical opening of the gear and clearance. This system was connected with a GPS, which recorded the hauling speed and the track of the hauls.

The temperature during hauling and the hauling depth were also recorded using a Minilog device. Finally, as in the previous years, the temperature and salinity profiles were recorded by means of a CTD.

Technical report for Greece — area G3 (South Aegean Sea)

The MERITS G3 survey took place from the 7th of June to the 21st of July 1999, in the southern Aegean and the Cretan seas. The survey in the G3 area was carried out with the commercial trawler "Nautilus". The functioning of the gear was tested in the Gulf of Iraklion on the 5th and 6th of June.

Bad weather conditions, caused by strong winds (meltemi) which commonly affect the Aegean Sea during the summer months, and an engine problem, resulted in an extension of the expected survey duration for about 15 days.

The gear showed a generally homogeneous performance and the trawling speed ranged from 2.7 to 3.1 knots. Trawling with the highest speed was realized mostly in the deeper hauls and (or) on muddy bottoms. The electronic observation and recording of the track of the hauls was conducted by means of a GPS and a plotter. In this way, there was a complete representation of the haul (beginning, end, and change of direction). The temperature was monitored during the hauls by a Minilog TDR sensor.

During the 1999 survey a total of 60 valid hauls were accomplished: 16 around the islands of the Cyclades complex, 28 in the area of the Dodecanesian and southeastern Aegean islands and 16 in the Cretan Sea.

**PROJECT N° 97/069: INTERNATIONAL BOTTOM TRAWL SURVEY
IN THE MEDITERRANEAN (ITALY): MEDITS IT**

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SUMMARY**Technical report for Italy — area MI (Ligurian, Northern and Central Tyrrhenian Seas)
by G.D. Ardizzone and A. Belluscio**

In the MI region the 1999 Maus survey was carried out from 17th of May to the 10th July using the professional trawler "Francesco Padre". A total of 155 hauls were carried out among which 153 were valid. A total of 46 fishing days, 2 days of bad weather brake and 7 days of technical break were spent.

No particular technical problems were met during the survey. As far as possible, all stations have been made at the same positions as in the previous years.

Scientific participants came from the laboratories of the "Consorzio Interuniversitario di Biologia Marina" of Livorno, from the "Agenzia Regionale per la Protezione Ambientale della Toscana" of Livorno, from the University of Genoa and from the University of Rome "La Sapienza".

A Minilog instrument was used to collect data on surface and bottom water temperature. Water temperature close the bottom ranged from 13.8°C (slope hauls) to 17.2°C (shelf hauls).

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The data were input on computer on board using the Dame program and checked using the Checkmed2 routines. Abundance indices and length frequencies have been calculated using the Indmed4 program.

The species of the reference list which were most abundant in weight were, in order: *Merluccius merluccius*, *Trachurus trachurus*, *Galeus melastomus*, *Mullus barbatus*, *Trachurus mediterraneus*, *Eledone cirrhosa*, and *Phycis blennoides*.

An increase in the catches of *Merluccius merluccius*, *Micromesistius poutassou*, *Mullus barbatus*, *Phycis blennoides*, *Spicara flexuosa*, *Trachurus mediterraneus*, *T. trachurus*, *Trisopterus capelanus*, *Octopus vulgaris*, *Parapenaeus longirostris* and a decrease of *Citharus macrolepidotus*, *Helicolenus dactylopterus*, *Eutrigla gurnardus*, *Pagellus bogaraveo*, *Aristaeomorpha foliacea*, *Nephrops norvegicus*, *Eledone cirrhosa* and *Illex coindetii* was evident during the 1999 survey.

Technical Report for Italy — area M2 (Sardinia) by M. Murenu, D. Cuccu, M. C. Follesa, A. Sabatini and A.Cau

The MEDITS ITM2 survey for 1999 was carried out from the 17th of May to the 2nd of July around the Sardinian coasts. The commercial trawler "Nuovo Splendore" was used for sampling operations as in the previous years. A total of 48 fishing days, 12 days of technical breaks and 4 days of bad weather brakes were spent. During the research program 124 hauls were carried out, 123 of which were valid.

The weather conditions were not very good. During the whole survey for sixteen days conditions were bad and for 4 days it was impossible to carry on our survey.

No particular technical problems were met during the survey. During some hauls, especially near the coast, where the substrata were irregular and hard, our gear was damaged to a certain extent. When the damage was not serious, some parts of the net were changed; in other cases the reserve net was utilised.

A GPS system was connected with a nautical plotter where the hauls track log of the '98 survey were recorded and, as far as possible, all stations were set at the same positions as in the previous years. Sometimes due to the presence of hauled gill nets and long lines near the coasts and in the open sea, we slightly changed the co-ordinates of some of the hauls, while remaining in the same bathymetric level.

Unfortunately, Scanmar equipment was not available. Following the recommendations of the MEDITS protocol, the horizontal and vertical openings of the gear were estimated indirectly.

The surface and bottom water temperature and the fishing depth during hauling were also recorded using a Minilog device.

Weight and length measurements as well as estimation of the maturity of the sampled fish were carried out on board. In the laboratory, the data were recorded on the computer using a database program. The data were later checked and processed using the Checkmed2 and Indmed4 routines.

Abundance indices and length frequencies were calculated for target species and for some of the reference species.

Often in the shallower waters, large quantities of sea urchins, eelgrass (*Posidonia oceanica*) and algae were encountered. Not many waste products were fished.

This year the most abundant species in weight from the reference list were in the order: *Merluccius merluccius*, *Octopus vulgaris* and *Spicara smaris*. Important biomass values (BI>30) were also obtained for *Raja clavata*, *Scyliorhinus canicula*, *Zeus faber* and *Mullus barbatus*.

With regards to the number of individuals, the highest value of abundance was recorded for *M. merluccius* (DI= 3494, CV=14.4). The other target species that showed high density values (more than 500 N/km²) were, in decreasing order: *Trisopterus minutus capelanus*,

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Sardina pilchardus, *M. barbatus*, *Parapenaeus longirostris*, *Trachurus trachurus*, *S. canicula* and *Aspitrigla cuculus*.

Species such as *Pagrus pagrus*, *Trigla lucerna*, *Spicara maena*, *Eutrigla gurnardus* and *Squilla mantis* showed very low abundance indices ($BI < 1.0$, $DI < 6$) in the whole region and at all bathymetric levels.

An increase in the catches of most of the target fishes (particularly *M. merluccius*), of some cephalopods (especially *O. vulgaris*), and of *Parapenaeus longirostris* was evident during the 1999 survey.

Technical Report for Italy — area M3 (Central and Southern Tyrrhenian Sea, Strait of Sicily)

The 1999 MEDITS (hereby MEDITS '99) survey in the M3 region was carried out from 3rd May to 10th June using the professional stern trawler "Sant'Anna". The first sub-region covered was the northern side of the M3 study region (M3a), i.e., the grounds of Central and Southern Tyrrhenian Sea facing Campania (Volturno river) and Calabria (Capo Suvero) regions, respectively. This sub-region was surveyed, from 3rd May to 18th May, by the scientific staff of the "COISPA — Tecnologia and Ricerca" of Bari.

The second sub-region covered was the central part of M3 study region (M3b), i.e., the grounds of Southern Tyrrhenian Sea off Calabria (Capo Suvero) and the Northern coasts of Sicily (Capo S. Vito). This sub-region was surveyed, from 19th May to 25th May, by the scientific staff of the "Istituto Talassografico — CNR" of Messina.

The third M3 sub-region, the region known as the Strait of Sicily (M3c), was surveyed from 26th May to 10th June, by the scientific staff of the "Istituto di ricerche sulle Risorse Marine e l'Ambiente, IRMACNR" (formerly ITPP-CNR) of Mazara. The MED'99 ended on June 10th.

An overall of 140 hauls were performed in the M3 region; in particular, 57, 27 and 56 hauls were realised in the first (M3a), second (M3b) and third (M3c) sub region, respectively.

In the M3b region, it was not possible to complete the total number of 28 hauls, given to the damage of the gear. Some damaged parts were substituted or repaired onboard during the survey.

In all hauls (with the exception of few tows for hardware problems) a miniature data logger (Minilog-TD), recording both temperature and depth, was mounted on the head rope of the gear. It was not possible monitoring directly the gear performance (a Scanmar equipment was not available), but haul duration was recorded according to average effective time on bottom and the horizontal opening of the gear in each haul was estimated on the base of the formula derived from previous trials carried on by IRPEM-CNR technicians using Scanmar equipment.

Both haul registration and processing of biological samples were accurately performed according to MEDITS protocol.

On the base of the experience gathered in more than 15 years of bottom trawl surveys, as in the previous years, the gear operative validity was confirmed, at depth within 200 m whereas some doubts still remain for the deeper waters where relatively scarce catches of crustaceans were observed.

Technical Report for Italy — area M4 (South Adriatic Sea) and Albania

The Maus-IT & ALB 1999 survey was carried out from the 6th of May to the 31st of August, but it was interrupted from the 5th of June to the 20th of July because of war event in the Adriatic Sea (Kosovo war). For the just mentioned reason many organising and bureaucracy problems were overcome (we remember also the presence of war surplus on the bottom). Notwithstanding the difficulties the survey was successfully concluded within August.

Total number of operative days was 72 (including MEDITS net setting, stand-by and transferring). The survey lasted 29 days in Ionian areas from Cape Passero to Cape of Otranto (3 Vessel and MEDITS net setting days, 3 transferring day, 23 full working days),

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26 days for south-western Adriatic areas from Cape of Otranto to Vieste (1 day of stand-by and 25 full working days) and 17 days for south-eastern Adriatic areas from S. Johan to Saranda (4 transferring days, 1 day of stand-by and 12 full working days).

During the survey 186 hauls were carried out (74 in the Ionian areas, 72 in the southwestern Adriatic areas, and 40 in the southeastern Adriatic areas). The vessel "Pasquale e Cristina" was utilised by MEDITS-It M4 Unit in the whole research area.

During this survey a larger number of days than for the 1998 survey was used, mostly because of the bad weather in the last May and the mentioned problems due to the Adriatic "war ban".

During this survey the trawler didn't suffer any noticeable damages: some net bowls were damaged at maximum trawled depths.

Biological data were recorded following MEQ TS protocol options and formats; some temporary trouble were born because of malfunction of Dame and Checkmed software (our copy) but the data files were later on successful checked and corrected.

Technical report for Italy — area M5 (North and Centre Adriatic Sea), Slovenia and Croatia

The general situation of trawling activity in the Adriatic Sea was very particular during 1999. The presence of a big number of bombs on the bottom after the war in the Balkan area had led the decision of trawling ban in the Adriatic during the months of June, July and August. For this reason the survey was delayed in time. Furthermore, the duration of the survey in 1999 has been longer than for the previous yearly surveys. Actually, the seasonal decreasing of diurnal period implied a reduction of the time available for daylight hauls per day. Finally, the MEDITS '99 survey had been carried out from August 4th to October 14th. It had covered the Italian, Slovenian and International waters, excluding the Croatian territorial waters. A total of 86 hauls were executed (2 in the Slovenian waters).

The vessel "Andrea" used for the survey is a new research vessel of the marine biology and fishery laboratory of Fano.

After a training of the MEDITS trawl handling, the survey started from the area in front of Fano, where the bombs had been removed early. It continued in the North Adriatic, in the Slovenian area and lasted in the Central Adriatic Sea.

Scientists of three laboratories (Split, Ljubljana and Fano) took part in the survey. Generally 5 to 6 scientists worked at the same time aboard the vessel.

The computer recording of hauls and a first biological processing were performed on board; the more detailed biological analyses and computer data input were made in laboratory according to the MEDITS protocol.

**PROJECT N° 98/058: CAMPAGNES D'ÉVALUATION DES RESSOURCES
HALIEUTIQUES EN MER DU NORD ET MANCHE ORIENTALE****AUTHORS**

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SUMMARY

The IFREMER Fisheries laboratory of Boulogne-sur-Mer participates in the International Bottom Trawl Survey (IBTS) program since 1976, co-ordinated by the ICES (International Council for Exploration of the Sea) and organises every year in February, a survey in the southern part of the North Sea on the Research Vessel Thalassa. Since 1988, the laboratory leads the "Channel Ground Fish Survey" program (CGFS) also in the English Channel and in the southern part of the North Sea, on the Research Vessel Gwen Drez.

The common objective of these two surveys is the estimation of the recruitment and the abundances by age of the main commercial species. Data collected allow to follow the evolution of the stocks abundance and are essential in the evaluation of the exploited stocks.

Seven other countries bordering the North Sea participate also in the IBTS program, and the data collected are directly used for the evaluation of the resources. As the English Channel is connected to the North Sea for the assessment of demersal stocks, the CGFS survey is also useful for these evaluations. So, by the way of these two surveys France contributes to the working groups "Assessment of Demersal Stocks in the North Sea and Skagerrak" and "Herring Assessment Working Group for the area south of 62°N".

PROJECT N° 98/086: SCOTTISH BOTTOM TRAWL SURVEYS IN THE NORTH SEA

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SUMMARY

Fish stocks in waters fished by Scottish fishermen have become depleted by the heavy exploitation by a number of European nations. This exploitation has resulted in a significant reduction in the number of older fish that are available for spawning and which also provide some inherent stability in the size of the stock. The current situation, which has existed for a number of years, is that the amount of fish that are available to fishermen in any one year is heavily dependent on the success, or otherwise, of recruitment to the stock in the immediately preceding years. The amount of fish that successively recruits to the established stock fluctuates between years and scientists have still to establish why a particular stock may have a good or bad recruitment in any particular year. The figure below plots the amount of 1 year old haddock entering the North Sea fishery in every year since 1975. Casual observation shows that 1988 was the worst year whilst 1995 was nearly fifteen times better; between these two marks there are many wild fluctuations.



This variation in recruitment is of major concern to fisheries scientists as an accurate estimate of the size of the recruiting year classes is essential when undertaking stock assessments. Because of the fluctuations illustrated above arrangements have to be made to undertake annual surveys of the juvenile fish stocks ie. those fish too small to be caught by commercial fishermen.

Fish stocks do not recognise national boundaries and are to be found spread across the waters belonging to a variety of European nations and in acknowledgement of this fact national institutes co-ordinate their activities as far as possible. Most of this co-ordination is done under the aegis of the International Council for the Exploration of the Seas (ICES) and permits the most efficient use of an expensive resource to survey the widest possible area. In general terms the various nations deploy fishery research vessels in pre-defined areas of the North Sea and to the west of Scotland in a time period which remains constant in every year. Fishing tows are made at selected sites with standardised gear which is fitted with an

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exceptionally fine mesh net so that all juvenile fish are retained; the catches are analysed for quantity of each species and many biological parameters obtained including the length and age of each fish for the main commercial stocks. All the data are standardised to an agreed international format and the results exchanged between the various institutes and with ICES Working Groups that undertake stock assessment.

During the period of this contract The Marine Laboratory, Aberdeen deployed the research vessel Scotia III on two surveys in the North Sea (one in January/February and one in August) in both 1999 and 2000. During these surveys Scotia made 275 fishing trawls, with environmental sampling, and 182 trawls for pre-metamorphosing herring larvae. Further details can be found in the main report but tabled below (table 1) is a summary of the indices of abundance (the numbers of recruiting fish) for a number of commercial important stock for the August survey in the North Sea. The data from the first quarter of the year are not listed as they form a sub-set of data released by ICES (see ICES CM1998/D:12 etc. for examples). It must be emphasised that these results should not be viewed in isolation as they only pertain to data collected by Scotland; in order to obtain a balanced view of the numbers recruiting to the adult stock the results from other nations must also be studied. On their own the Scottish data are indicative but not finite.

| Table 1. Number of 0 group fish per 10 hours — August Survey | | | | | |
|--------------------------------------------------------------|------|---------|---------|--------|---------|
| Year/Species | Cod | Haddock | Whiting | Saithe | N. Pout |
| 1999 | 11.8 | 54072 | 13409 | 0.0 | 36030 |
| 2000 | 0.5 | 10375 | 19058 | 0.0 | 20942 |

**PROJECT N° 99/014: INTERNATIONAL BOTTOM TRAWL SURVEY
IN THE MEDITERRANEAN (SPAIN): MEDITS ES**

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SUMMARY

The MEDITS ES survey took place from the 21st of May to the 24th of June 2000. A total of 117 hauls were carried out with the RN “Cornide de Saavedra” from the Strait of Gibraltar to Cape Creus: 38 hauls in the Alboran sea and gulf of Vera, 27 in the Alicante area and 46 in the Catalan sea. 3 hauls were not valid.

Participant scientists came from the laboratories of the IEO of Malaga and Madrid, from the ICM-CSIC of Barcelona, from the University of Alicante, University of Barcelona, Gerona and University Autonoma of Madrid. The scientific team was composed of biologists and technicians. Teresa Bottari and Florinda Damele scientists from Italy (C.N.R. of Messina and University of Cagliari), and Eloumari Najib, from the I.N.R.H. of Nador (Morocco) stayed on board during two weeks.

Sampling activities were conducted without important difficulties. The geometry of the trawl was monitored during the whole survey using a SCANMAR system, and the temperature, salinity and oxygen concentration at different depths was taken with a CTD measurement system. No haul was new. As in other years great catches of pelagic species were observed.

A total of 448 species were identified: 162 fishes, 87 crustaceans, 98 molluscs including 30 cephalopods, 40 echinoderms and 61 other invertebrate species. A systematic inventory of waste products present in the catch was made. Determination, numbering and weighting of each species, biological examination of the principal species, introduction of the data (characteristics of each haul, weight and number of the caught species, length and maturity index of the principal species) in the CAMP and DAME programs was made on board the vessel. The checking of the data and the calculation of the abundance indices and length frequencies with the CHECKMED3 and INMED5 programs were made in the laboratory.

**PROJECT N° 99/026: INTERNATIONAL BOTTOM TRAWL SURVEY
IN THE MEDITERRANEAN (FRANCE): MEDITS FR**

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SUMMARY

The MEDITS FR survey took place from the 30th of May to the 3rd of June 2000. The first part of the survey (30/05 — 07/06) was conducted on the eastern coast of Corsica and the second part (08/05 — 03/07) in the Gulf of Lions. During the whole survey, the weather conditions were very good. One day (10/06) was lost due to technical problems.

Observations on the behaviour of the gear

The geometry of the trawl was monitored during the whole survey using the SCANMAR. As far as possible the rigging accorded with the latest version of the “Manuel des protocoles”. Due to difficulties encountered in the previous years to make the trawl reach the contact with the bottom in biggest depths (more than 500 m), a trial was made at the biggest depth (750 m) using bridles of 200 m instead of 150 m. The results were very decisive and the trawl was well established after a relatively short time (around 30 min).

In general, the gear specifications, as indicated in the “Manuel des protocoles”, lead to a good efficiency of the trawl. At each haul it is however important to wait until the trawl geometry is well stabilised before deciding on the beginning of the haul.

Related with some difficulties met by different teams to put and/or to hold the MEDITS trawl in good contact with the sea bottom in deep waters, some technical trials were carried out during the 2000 MEDITS cruise on board the French vessel L'Europe.

These trials, conducted in the gulf of Lions on depths close to 750 m (haul n° 89), concerned together sweep length, depth / warp length ratio, and warp shooting speed. They were made using a Scanmar system, with a permanent real time observation on board. Due to available time and cost, it was not possible to test separately each one of these three parameters. All the other parameters were kept at their standard value, as recommended in the MEDITS “Manuel des protocoles D”.

With some slight adjustments, positive results were obtained in July 2000, 23 different species (around 39 kg in total) being caught during that haul (1h). In comparison, the same haul carried out in 1998 had no result at all, the trawl continuously flying above the bottom, in spite of three attempts to put it on the same soundings and area (during 1999, no haul was achieved in this area, due to heavy weather).

Sweep length

On soundings deeper than 200 m, a sweep length of 150 m is normally used, according to the Manuel des protocoles D.

A sweep length of 200 m has been successfully used during the 2000 trials (main result is indicated above).

It could be useful to consider, for the next cruises, the possible use of 200 m sweeps for depths deeper than 500 m.

Warp length /depth ratio

It seems important to remember that, for this ratio, the working depth to be taken into account is the one of the MEDITS trawl, and not the sounding underneath the vessel.

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The warp length MEDITS protocol has been established for mean values of steel wire weight per length unit. Due to wire manufacturer, some variations around that weight mean value can have a noticeable effect in deep waters, the warp weight in water being sometimes much less (or more) important than specified.

Some adjustments can consequently be useful, in order to facilitate the descending motion of the trawl (particularly in case of a lighter weight per length unit) and its good contact with the bottom. Some allowance is therefore possible in deep waters, with regard to the mean curves and tables given in the Manuel des protocoles D.

During our trial on board L'Europe, conducted on a relatively falling slope (around 730 to 850 m), we have successfully shot regularly 50 additional metres (16 mm in diameter), to put as fast as possible, and correctly, the trawl on the bottom.

Warp shooting speed

When shooting additional warp length, on several occasions (on a falling bottom), some different shooting speeds were tested, to estimate their effect. There is a strong evidence that the faster the shooting speed, the faster and better the trawl contact with the bottom is.

Conclusions

Every one of the three complementary adjustments have played a part in the results obtained in 2000. The effect of the adjustments lay more in the good and continuous contact of the trawl with the sea bottom (real length of the swept area) than in the mean MEDITS trawl shape.

Looking at these results, we may suggest to the MEDITS group to consider, for the future, the possibility of a slight adjustment for two of the present protocol standards (warp length/depth ratio and sweep length, the warp shooting speed being not standardized). This could lead towards a best efficiency of the MEDITS trawl in deep waters, without very noticeable effect on the net geometry itself.

Survey's progress

This year no damages to the gear occurred during the survey. As previously, the shallowest strata in Corsica (13101 and 13106, between 10 and 50 m) have been considered as not trawlable due to very large quantities of algae, sea urchins and eel grass (*Posidonia* sp.).

During the '2000 survey, 92 hauls have been made: 69 in the Gulf of Lions and 23 in Corsica.

Other observations

For all hauls, the MICREL ichthyometer was used, together with the DAME program written by G. Delmas. It should be noted that this program has not gone beyond the year 2000. A new one is currently under development under Access in the IFREMER laboratory in Boulogne-sur-Mer (author Franck Coppin). This software was not ready for the survey but we were able to circumvent this difficulty. The data files were checked and when necessary corrected immediately after the survey. It is remembered that the coding of the year in the files records and the files names have been changed accordingly to the Steering Committee meeting held in Genoa in May 2000. Some trials have been made to compare the temperature from the SCANMAR device and from the MINILOG one. They showed a systematic difference of 0.8°C but some further experiment in controlled tanks showed also that these differences are not linear in case of increasing temperature. Although the MINILOG probe was broken during the haul n°43, the study of this experiment will be continued.

In addition to the normal biological observations, a systematic inventory of waste products present in the codend (glass, plastic, metal, etc.) has been made. This inventory showed the importance of waste concentration near the biggest harbours (Marseilles, Bastia) and on the ferry routes between Corsica and the mainland.

PROJECT N° 99/038: INTERNATIONAL BOTTOM TRAWL SURVEY IN THE MEDITERRANEAN (GREECE): MEDITS (GR)

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SUMMARY

The MEDITS GR1 survey for 2000 was carried out from 21 June to 28 July in the North Aegean Sea (North of 38 N), using "Evagelistria" (see Vessels reference below), a newly constructed commercial trawler that was used for the first time for the sampling operation. The research cruise lasted 38 days, 31 of which were spent on fishing and 7 days on stop due to bad weather conditions.

During the research cruise 65 hauls were carried out successfully. The SCANMAR equipment was not available also this year. The temperature, salinity, and oxygen concentration have been recorded with the CTD measurement system. A minilog instrument has also been used to collect continuous data on temperature and depth during the hauls.

Three Greek Post-graduate students, Scarpelis G., Baxevanis A. and Arsenoudi P., have been participating for 3 days in the research cruise.

Weight and length measurements as well as maturity of the sampled fish were carried out on board.

In the laboratory, data were recorded in the computer using the INDMED program and checked using the CHECKMED program.

Abundance indices were calculated for target species and for some of the reference species. The species from the reference list, which were most abundant in weight this year were, in the following order: *I. coindetti*, *S. pilchardus*, *E. encrasicolus*, *A. sphyraena*, *M. merluccius*, *M. barbatus*, *P. longirostris*, *M. poutassou*, *R. clavata*, *L. caudatus*, *S. flexuosa*, *T. trachurus*, *P. blennoides*, *L. piscatorius* and *S. acanthias*. Comparatively, in '99 survey the most abundant species in weight were: *S. pilchardus*, *M. poutassou*, *E. encrasicolus*, *M. merluccius*, *I. coindetti*, *A. sphyraena*, *R. clavata*, *L. caudatus*, *P. longirostris*, *S. canicula*, *L. budegassa*, *T. minutus capelanus*, *S. flexuosa*, *L. piscatorius* and *M. barbatus*.

Considering the number of individuals, the most abundant species were in order: *A. sphyraena*, *S. pilchardus*, *E. encrasicolus*, *P. longirostris*, *I. coindetti*, *M. barbatus*, *T. trachurus*, *T. minutus capelanus*, *S. flexuosa*, *M. merluccius*, *M. poutassou*, *C. linguatula*, *S. smaris*, *D. annularis* and *P. blennoides*. In comparison, the most abundant species in number of individuals, in the MEDITS'99 survey were: *S. pilchardus*, *E. encrasicolus*, *A. sphyraena*, *M. poutassou*, *P. longirostris*, *T. minutus capelanus*, *T. trachurus*, *M. merluccius*, *S. flexuosa*, *I. coindetti*, *C. linguatula*, *M. barbatus*, *L. cavillone*, *S. notata* and *S. canicula*.

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The most widely distributed species were, in order: *I. coindetti* (present in 54 of 65 hauls effectuated), *M. merluccius* (52 hauls), *L. budegassa* (48 hauls), *P. longirostris* (43 hauls), *T. trachurus* (41 hauls), *S. canicula* (36 hauls), *T. minutus* cape/anus (32 hauls), *R. clavata* (31 hauls), *P. blennoides* (31 hauls) and *E. cirrhosa* (28 hauls). In MEDITS'99 the order of the most wide distributed species were: *M. merluccius* (53 of 62 hauls), *L. budegassa* (49 of 64 hauls), *P. longirostris* (43 hauls), *S. canicula* (35 hauls), *T. trachurus* (35 hauls), *S. elegans* (32 hauls), *R. clavata* (31 hauls), *N. norvegicus* (30 hauls), *T. minutus capelanus* (27 hauls), *E. encrasicolus* (24 hauls).

In zone G2 (Argosaronikos and Ionian Sea), the sampling cruise started the 14th of June 2000 and ended the 8th of July 2000. Similarly to 1998 and 1999, the commercial trawler Demetrios was used.

A total of 53 hauls were effected (22 in Argosaronikos and 31 in the Ionian Sea). The weather conditions were generally good with some exceptions mainly in Argosaronikos.

As in the previous years, during the 2000 sampling period, a SCANMAR system was used to observe the following parameters: fishing depth, horizontal and vertical opening of the gear and clearance. This system was connected with a GPS, which recorded the hauling speed and the track of the hauls.

The temperature during hauling and the hauling depth were also recorded using a Minilog device. Finally, as in the previous years, the temperature and salinity profiles were recorded by means of a CTD.

The MEDITS G3 survey took place from the 9th of June to the 14th of July 2000, in the southern Aegean and the Cretan seas. The survey in the G3 area was carried out with the commercial trawler "Nautilus". The functioning of the gear was tested in the Gulf of Iraklion on the 7th and 8th of June.

The gear showed a generally homogeneous performance and the trawling speed ranged from 2.8 to 3.0 knots. Trawling with the highest speed was realized mostly in the deeper hauls and (or) on muddy bottoms. The electronic observation and recording of the track of the hauls was conducted by means of a GPS and a plotter. In this way, there was a complete representation of the haul (beginning, end, and change of direction). The temperature has been monitored during the hauls by a Minilog TDR sensor.

During the 2000 survey a total of 55 valid hauls were accomplished: 16 around the islands of the Cyclades complex, 24 in the area of the Dodecanesian islands and 15 in the Cretan Sea.

PROJECT N° 99/046: INTERNATIONAL BOTTOM TRAWL SURVEY IN THE MEDITERRANEAN (ITALY): MEDITS (IT)

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SUMMARY

In the MI region the 2000 MEDITS survey was carried out from May 23 to 27 July 2000 using the professional trawler "Francesco Padre". A total of 153 valid hauls were carried out. A total of 45 fishing days, 8 day of bad weather brake and 13 days of technical break were spent.

No particular technical problems were met during the survey. As far as possible, all stations have been made at the same positions as in the previous years.

Scientific participants came from the laboratories of the "Consorzio Interuniversitario di Biologia Marina" of Livorno, from the "Agenzia Regionale per la Protezione Ambientale della Toscana" of Livorno, from the University of Genova and from the University of Rome "La Sapienza".

A Minilog instrument has been used to collect data on surface and bottom water temperature. Water temperature close the bottom ranged from 13.8°C (slope hauls) to 17.2°C (shelf hauls).

The data were insert on board in a PC using the DAME program and checked using the CHECKMED2 routines. Abundance indices and length frequencies have been calculated using the INDMED4 program.

The species of the reference list which were most abundant in weight were, in order: *Trachurus mediterraneus*, *Merluccius merluccius*, *Micromesistius poutassou*, *Galeus melastomus*, *Spicara smaris*, *Mullus barbatus*.

An increase in the catches of *Citharus macrolepidotus*, *Helicolenus dactylopterus*, *Spicara smaris*, *Galeus melastomus*, *Trachurus mediterraneus*, *Nephrops norvegicus*, *Parapenaeus longirostris*, *Eledone cirrhosa*, *Illex coindetii* and a decrease of *Lophius piscatorius*, *Merluccius merluccius*, *Micromesistius poutassou*, *Mullus barbatus*, *Mullus surmuletus*, *Pagellus erythrinus*, *Phycis blennoides*, *Raja clavata*, *Solea vulgaris*, *Trigloporus lastoviza*, *Octopus vulgaris*, *Aristaeomorpha foliacea* was evident during the 2000 survey.

From the 29th of June to the 24th of August a total of 123 hauls were carried out with the fishing vessel "Nuovo Splendore" in seas surrounding Sardinia. Few shallower hauls (stratum 13316) have been considered as not trawlable due the presence of gill nets and for this reason cancelled.

This year the fishing activity has been conducted without particular problems, excepted for the bad weather condition. During the whole survey for twenty days sea conditions were bad and for 10 days it was impossible carry on the scheduled hauls. A total of 31 fishing days, 10 days of bad weather brake and 14 days of technical break were spent.

During some hauls, especially near the coast, where the substrata were irregular and hard, the gear was damaged to a certain extent. When the damage was not serious, some parts of the gear were changed; in other cases the reserve gear was utilised.

Unfortunately, SCANMAR equipment was not available. Following the recommendations of the MEDITS protocol haul duration was recorded according to the average effective time

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on bottom as from previous trials with SCANMAR by IRPEM-CNR technicians and the horizontal and vertical openings of the gear were estimated indirectly.

MINILOG instruments was only available at the end of the survey due its damage occurred at the beginning of the survey.

A GPS system was connected with a nautical plotter where the hauls track log of the '98 survey were recorded and, as far as possible, all stations were set at the same positions as in the previous years. Sometimes due to the presence of hauled gill nets and long lines near the coasts and in the open sea, we slightly changed the co-ordinates of some hauls, while remaining in the same bathymetric level.

Often in the shallower waters, large quantities of sea urchins, eel grass (*Posidonia oceanica*) and algae were encountered. Not many waste products were fished.

On board biological parameters were accurately performed according to the MEDITS PROTOCOL. At the end of the survey, in the laboratory, all data collected were recorded on the computer using a database program. The data were later checked and processed using the CHECKMED2 and INDMED4 routines. Abundance indices and length frequencies were calculated for target species and for some of the reference species.

A total of one hundred and seventy-nine species were identified: 130 fishes, 23 crustaceans and 26 cephalopods.

The species from the reference, which showed the highest biomass, were in the order: *Octopus vulgaris*, *Merluccius merluccius* and *Scylliorhinus canicula* (30<BI<60). Important biomass values (BI>20) were also showed for *Raja clavata* and *Eledone cirrhosa*.

As regards the number of individuals, the highest densities were recorded for *Trisopterus minutus capelanus* (DI= 3636,CV=42.5). The other target species that showed high density values (more than 500 N/km²) were in decreasing order: *Trachurus mediterraneus*, *M. merluccius*, *Sardina pilchardus*, *M. barbatus* and *Trachurus trachurus*.

In comparison with the previous year a decrease in the catches of *M. merluccius*, *Mullus barbatus*, *M. surmuletus* and *S. smaris* was evident.

The 2000 MEDITS (hereby MED2000) survey in the M3 region was carried out from 25th May to 1st July 2000 using the professional stern trawler "Sant'Anna". In ED2000 for the first time also the Maltese waters (herein defined as sub-region M3d) were included in the survey. The first M3 sub-region, the region known as the Strait of Sicily (M3c), has been surveyed, from 25th May to 5th June, by the scientific staff of the "Istituto di ricerche sulle Risorse Marine e l'Ambiente, IRMA-CNR" of Mazara. Subsequently, the waters around Malta (M3d) were explored from 6th to 8th of June.

The second sub-region covered was the central part of M3 study region (M3b), i.e., the grounds of the Southern Tyrrhenian Sea off Calabria (Capo Suvero) and the Northern coasts of Sicily (Capo S. Vito). This sub-region has been surveyed, from 12th June to 18th June, by the scientific staff of the "Istituto Talassografico — CNR" of Messina.

Finally, the trawler moved to the northern side of the M3 study region, i.e., the grounds of the Central and Southern Tyrrhenian Sea facing Campania (Volturno river) and Calabria (Capo Suvero) regions respectively. This sub-region (M3a) has been surveyed, from 19th June to 1st July, by the scientific staff of the "COISPA — Tecnologia and Ricerca" of Torre a Mare (Bari).

An overall of 147 hauls were performed in the whole M3 region; in particular, 57, 28 and 56 hauls were performed along the Italian coasts (M3a, M3b and M3c respectively) whereas 6 hauls (1 not valid) were realised in Maltese waters (M3d). Some problems rose during the survey around the Maltese waters, due to the poor knowledge related to the trawlable bottoms. This required a preliminary exploration of the substrate and more than one trial in performing the tow. Notwithstanding, severe damage of the gear resulted in the invalidated haul (North of the Gozo Island, in the 200-500 m stratum). An attempt to recover this tow in the same stratum, but in a different zone (SSW Malta Island), failed after few minutes, due to the breakage of the footrope.

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In all hauls, a miniature data logger (MINILOG-TD), recording both temperature and depth, was mounted on the head rope of the gear. It was not possible monitoring directly the gear performance (a SCANMAR equipment was not available), but haul duration was recorded according to average effective time on bottom and the horizontal opening of the gear in each haul was estimated on the base of the formula derived from previous trials carried on by IRPEM-CNR (Ancona, Italy) technicians using SCANMAR equipment.

Both haul registration and processing of biological samples were accurately performed according to MEDITS protocol.

The MEDITS-IT & ALB 2000 survey was carried out from 29/04 to 10/07.

Total number of operative days was 73 (including MEDITS net setting, stand-by and transferring); the survey lasted 29 days in Ionian areas from Cape Passero to Cape of Otranto (2 Vessel and MEDITS net setting days, 3 transferring day, 24 full working days), 25 days for south-western Adriatic areas from Cape of Otranto to Vieste (2 days of stand-by and 23 full working days) and 19 days for south-eastern Adriatic areas from S. Johan to Saranda (4 transferring days, 1 day of stand-by and 14 full working days).

During the survey 186 hauls were carried out (Ionian areas = 74; south-western Adriatic areas = 72; south-eastern Adriatic areas = 40); the vessel "Pasquale e Cristina" was utilised by MEDITS-It M4 Unit in the whole research area.

Bad weather conditions affected the survey mostly between the end of May and June.

During the survey 2000 the trawler didn't suffer any noticeable damages: a net and some net bowls were damaged at maximum trawled depths.

Biological data were recorded following MEDITS protocol options and formats; new version of CHECKMED and INDMED software were utilised successfully.

The MEDITS 2000 survey in the northern and central Adriatic Sea has been conducted on board the same vessel, "Andrea", both in international waters and in the national waters of each concerned country.

The survey took place between the 5th of June and the 3rd of August. The survey lasted more for the formation of the mucilage in the Adriatic Sea.

Scientists of three laboratories (Split, Ljubljana and Fano) took part in the survey, with in general 3-4 scientists on board at the same time.

A total of 136 hauls were carried out: 86 in international and Italian territorial waters, 2 in the Slovenian waters and 48 stations located in the Croatian waters.

A SCANMAR equipment was not available and the haul duration was recorded following the recommendation of the MEDITS protocol.

Haul registrations and first biological processing were performed on board; the more detailed biological analysis and computer data input were made in laboratory according to the MEDITS protocol.

PROJECT N° 99/047: STOCK ASSESSMENT IN THE MEDITERRANEAN (SAMÉD)

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SUMMARY

In many Mediterranean areas the trawl surveys represent the main source of data for acquiring biological knowledge on demersal species and evaluating the status of these resources. Thus, many research programs, focused on the assessment of demersal resources by direct methods, were undertaken in the different Mediterranean countries, at national level.

The MEDITS project started in 1993 aimed at the standardisation of the survey methodology among the different countries. Within the frame of the MEDITS project 7 trawl surveys have been carried out since 1994 to 2000. Therefore, a time series of 7 years is available for the French, Spanish, Italian and Greek coasts of Mediterranean. Since 1996 also data from the East Side of the Adriatic Sea (Slovenia, Croatia and Albania) are available (Bertrand et al., 1997).

The research effort within MEDITS program, at present, represents an important background for a more advanced development of both, the knowledge on the dynamic of the demersal resources at Mediterranean level and the collaboration established among the European scientists involved in the MEDITS program.

Since now, the data of the MEDITS trawl surveys have been mainly utilised to estimate abundance indices and length frequency distributions of the species of fishery interest, as indicators of the status of resources. Indeed, the current database has the potentiality to be also employed for estimating the demographic pattern of the main demersal resources and for performing prediction processes aimed at the management of the fishery resources.

The general purpose of the SAMÉD project was, namely, to derive indications on the level of exploitation of the main target species of the MEDITS project.

The SAMÉD specific tasks can be summarised as follows:

1. Exploratory data analysis.

Re-classification of the MEDIT data-base, taking into account the geographical sub-areas (Management Units) provisionally considered during the 24th Session of the GFCM held in Alicante, Spain on July 1999;

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2. Characterisation of the sub-areas
 - Abundance Indices in number (N/km^2) and weight (kg/km^2), for the continental shelf, the slope and the total area, according to the swept area method (Pauly, 1983);
 - Length frequency distributions and median lengths;
 - Sex ratio (females on the total sexed individuals);
 - Maturity ratio (as percentage of mature females on the total adult females);
 - Average size at maturity (50 % according to the logistic model);
 - Slope of multispecies size spectra, as an indicator of the effect of fishing on the whole community as opposed to single species.
 - Estimation of demographic parameters
 - Average size (length) and strength of the different age classes from length frequency distribution analysis, applying techniques such as Bhattacharya (1967);
 - Growth parameters according to the VBGF;
 - Total mortality (Z) according to the length converted catch curve as implemented in FISAT;
 - Natural mortality (M) according to the available empirical relationships such as those reported by Chen & Watanabe (1989), Alagaraja (1984), Beverton & Holt (1957);
 - Fishing mortality (F) calculated as $Z-M$;
 - Exploitation rate (E) as F/Z .
3. Estimation of demographic parameters and production under non-equilibrium approach
 - (At an exploratory level, in two selected sub-areas)
 - Growth coefficients of the different identified cohorts;
 - Total mortality coefficient for the different identified cohorts;
 - Effects of different management scenarios by simulation, following discrete predictive model, such as Thompson & Bell in the Sanders' approach (1995).

**PROJECT N° 00/006: INTERNATIONAL BOTTOM TRAWL SURVEY
IN THE MEDITERRANEAN (FRANCE): MEDITS (FR)**

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SUMMARY

The MEDITS FR survey took place from the 15th of June to the 4th of July 2001. The first part of the survey (01/06 — 09/06) has been conducted on the eastern coast of Corsica and the second part (10/06 — 04/07) in the Gulf of Lions. During the whole survey, the weather conditions were very good except for one and half day.

Observations on the behaviour of the gear

The geometry of the trawl has been monitored during the whole survey using a SCANMAR device. As far as possible the rigging accorded with the latest version of the "Instruction manual". Due to difficulties encountered in the previous years to make the trawl reach the contact with the bottom in biggest depths (more than 500 m) and according with trials made in 2000, we have used bridles of 200 m at the biggest depth (750 m) instead of 150 m. The results have been very decisive and the trawl was well established after a relatively short time (around 30 mn).

Nevertheless and in general, the gear specifications, as indicated in the "Instruction manual", lead to a good efficiency of the trawl. At each haul it is however important to wait that the trawl geometry be well stabilised before to decide the beginning of the haul. All the other parameters were kept at their standard value, as recommended in the MEDITS "Instruction manual". The results of this haul were identical to those in 2000, which has to be compared with the previous years in which the trawl did simply not reach the bottom.

Warp length / depth ratio

It seems important to remember that, for this ratio, the working depth to be taken into account is the one of the MEDITS trawl, and not the sounding underneath the vessel.

The warp length MEDITS protocol has been established for mean values of steel wire weight per length unit. Due to wire manufacturer, some variations around that weight mean value can have a noticeable effect in deep waters, the warp weight in water being sometimes much less (or more) important than specified.

Some adjustments can be consequently useful, in order to facilitate the descending motion of the trawl (particularly in case of a lighter weight per length unit) and its good contact with the bottom. Some allowances are possible in deep waters, with regard to the mean curves and tables given in the "Instruction manual".

During our trial on board L'Europe, conducted on a relatively falling slope (around 730 to 850 m), we have successfully shot regularly 50 additional metres (16 mm in diameter), to put as fast as possible, and correctly, the trawl on the bottom.

Warp shooting speed

When shooting additional warp length, on several occasions (on a falling bottom), some different shooting speeds have been tested, to estimate their effect. There is a strong evidence that the faster is the shooting speed, the faster and best the trawl contact with the bottom is.

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Conclusions

Every one of these complementary adjustments have play a part in the results obtained in 2001 as well as in 2000. The effect of the adjustments lay more in the good and continuous contact of the trawl with the sea bottom (real length of the swept area) than in the mean MEDITS trawl shape.

We can simply repeat what we said in the 2000's report, which is to think carefully, inside the MEDITS group, to some amendments to the "Instruction manual" to improve the efficiency of the gear.

Survey's progress

This year no damages to the gear occurred during the survey. As previously, the shallowest strata in Corsica (13101 and 13106, between 10 and 50 m) have been considered as not trawlable due to very large quantities of algae, sea urchins and eel grass (*Posidonia* sp.).

During the '2001 survey, 89 hauls have been made: 67 in the Gulf of Lions and 22 in Corsica.

Other observations

For all hauls, the MICREL ichthyometre has been used, together with the DAME program written by G. Delmas. It should be noted that this program has not gone over the year 2000 but, due to some "astuteness", it has been possible to use it again, waiting that the new software could be finalised in the IFREMER laboratory in Boulogne-sur-Mer. The data files have been checked and when necessary corrected immediately after the survey. It is remembered that the coding of the year in the files records and the files names have been changed accordingly to the Steering Committee meeting held in Genoa in May 2000. Some trials have been made to compare the temperature from the SCANMAR device and from the MINILOG one. They showed a systematic difference of 0.8°C but some further experiment in controlled tanks showed also that these differences are not linear in case of increasing temperature.

In addition to the normal biological observations, a systematic inventory of waste products present in the codend (glass, plastic, metal, etc.) has been made. This inventory showed the importance of waste concentration near the biggest harbours (Marseilles, Bastia) and on the ferries routes between Corsica and the mainland.

PROJECT N° 00/008: MONITORING OF STOCKS IN THE NORTH SEA AND SKAGERRAK

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SUMMARY

Study CFP 00/008, "Monitoring of stocks in the North Sea and Skagerrak" (MOSNAS), is a continuation of several previous contracts. Six fisheries research institutes participated in the contract. Research vessels from five countries carried out the ICES co-ordinated quarter 1 International Bottom Trawl Survey in the North Sea, Skagerrak and Kattegat, two institutes participated in the quarter 3 IBTS. The Netherlands carried out the Beam Trawl Survey in the southern and central North Sea, and Scotland a Sandeel Survey around the Shetland Islands. Three institutes carried out biological sampling of landings and discards: Belgium, Denmark and Scotland. The results of these survey and sampling programs are used by several ICES assessment working groups, which finally results in management advice provided by ICES to the EU and the different member countries of ICES. The contract period was from 1st January to 31st August 2001.

PROJECT N° 00/010: INTERNATIONAL BOTTOM TRAWL SURVEY IN THE MEDITERRANEAN (GREECE): MEDITS GR

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SUMMARY

The MEDITS GR1 survey for 2001 was carried out from 1 June to 13 July in the North Aegean Sea (North of 38 N), using "Evagelistria", a newly constructed commercial trawler that was used also on last year survey. The research cruise lasted 43 days, 36 of which were spent on fishing and 7 days on stop due to bad weather conditions.

During the research cruise 65 hauls were carried out successfully. The SCANMAR equipment was not available also this year. The temperature, salinity, and oxygen concentration have been recorded with the CTD measurement system. A minilog instrument has also been used to collect continuous data on temperature and depth during the hauls. However it was lost in one haul and so data has been taken only on the shallow hauls where a second minilog for depths <100 m was used.

Sixteen scientists, staff of Fisheries Research Institute was participated in the Medits'01 campaign. Furthermore two Greek Post-graduate students of University of Thessaloniki, Mrs. Aligisaki K., and Anastasiadou C., participated for 5 days in the research cruise.

Weight and length measurements as well as maturity of the sampled fish were carried out on board. The maturity stage of *Galeus melastomus*, *Heptranchias perlo*, *Raja asterias*, *Raja clavata*, *Raja miraletus*, *Raja montagui*, *Raja naevus*, *Raja oxyrinchus*, *Raja radula*, *Raja rondolei*, *Scyliorhinus canicula*, *Squalus acanthias* and *Torpedo torpedo* was not estimated.

In the laboratory, data were recorded in the computer using the INDMED program and checked using the CHECKMED program.

Abundance indices were calculated for target species and for some of the reference species. The species from the reference list, which were most abundant in weight this year, in the following order: *M. merluccius*, *I. coindetti*, *S. smaris*, *P. longirostris*, *S. canicula*, *R. clavata*, *L. budegassa*, *M. poutassou*, *M. barbatus*, *S. flexuosa*, *E. moschata*, *C. linguatula*, *P. bogaraveo*, *N. norvegicus* and *O. vulgaris*. Comparatively, in '00 survey the most abundant species in weight were: *I. coindetti*, *S. pilchardus*, *E. encrasicholus*, *A. sphyraena*, *M. merluccius*, *M. barbatus*, *P. longirostris*, *M. poutassou*, *R. clavata*, *L. caudatus*, *S. flexuosa*, *T. trachurus*, *P. blennoides*, *L. piscatorius* and *S. acanthias*.

Considering the number of individuals, the most abundant species were in order: *P. longirostris*, *S. smaris*, *I. coindetti*, *M. poutassou*, *T. trachurus*, *C. linguatula*, *T. minutus*, *capelanus*, *M. barbatus*, *M. merluccius*, *S. flexuosa*, *T. mediterraneus*, *S. canicula*, *N. norvegicus*, *L. boscii*, and *P. blennoides*. In comparison, the most abundant species in number of individuals, in the Medits'00 survey were: *A. sphyraena*, *S. pilchardus*,

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E. encrasicolus, *P. longirostris*, *I. coindetti*, *M. barbatus*, *T. trachurus*, *T. minutus*, *capelanus*, *S. flexuosa*, *M. merluccius*, *M. poutassou*, *C. linguatula*, *S. smar*, *D. annularis* and *P. blennoides*.

The most widely distributed species were, in order: *M. merluccius* (present in 57 of 65 hauls effectuated), *I. coindetti* (56 hauls), *L. budegassa* (48 hauls), *P. longirostris* (44 hauls), *S. canicula* (38 hauls), *T. trachurus* (35 hauls), *A. sphyraena* (31 hauls), *C. linguatula* (31 hauls), *A. media* (30 hauls) and *P. blennoides* (30 hauls). In MEDITS'00 the order of the most wide distributed species were: *I. coindetti* (54 hauls), *M. merluccius* (52 hauls), *L. budegassa* (48 hauls), *P. longirostris* (43 hauls), *T. trachurus* (41 hauls), *S. canicula* (36 hauls), *T. minutus capelanus* (32 hauls), *R. clavata* (31 hauls), *P. blennoides* (31 hauls) and *E. cirrhosa* (28 hauls).

In zone G2 (Argosaronikos and Ionian Sea), the sampling cruise started on the 30th of May 2001 and ended on the 24th of June 2001. Similar to 1998, 1999 and 2000, the commercial trawler Demetrios was used.

A total of 52 hauls were effected (21 in Argosaronikos and 31 in the Ionian Sea). From these 52 hauls, two were considered invalid because of serious net damage (1 in Argosaronikos and 1 in the Ionian Sea). The weather conditions were generally good with some exceptions (one day of bad weather in Argosaronikos and one in the Ionian Sea).

As in the previous years, during the 2001 sampling period, a SCANMAR system was used to observe the following parameters: fishing depth, horizontal and vertical opening of the gear and clearance. This system was connected with a GPS, which recorded the hauling speed and the track of the hauls.

The temperature during hauling and the hauling depth were also recorded using a Minilog device. Finally, as in the previous years, the temperature and salinity profiles were recorded by means of a CTD.

One of the problems we confronted was that on the 14th day of the survey the sensor of the vertical opening was damaged. Also, on the 15th day the computer we used onboard was out of operation. Consequently, there were no data recorded from the SCANMAR sensors and Minilog since that day. The problem of the computer was solved on the 22nd day and it started recording the data from the SCANMAR system (except that of the damaged sensor), but still then we could not get the Minilog data.

The MEDITS G3 survey took place from the 30th of May to the 26th of June 2001, in the southern Aegean and the Cretan seas. The survey in the G3 area was carried out with the commercial trawler "Nautilus". The functioning of the gear was tested in the Gulf of Iraklion on the 28th and 29th of May.

The gear showed a generally homogeneous performance and the trawling speed ranged from 2.7 to 3.0 knots. Trawling with the highest speed was realized mostly in the deeper hauls and (or) on muddy bottoms. The electronic observation and recording of the track of the hauls was conducted by means of a GPS and a plotter. In this way, there was a complete representation of the haul (beginning, end, and change of direction). The temperature has been monitored during the hauls by a "Minilog TDR" sensor.

During the 2001 survey a total of 54 valid and 1 invalid hauls were accomplished: 14 around the islands of the Cyclades complex, 23 in the area of the Dodecanesian islands and 17 in the Cretan Sea.

PROJECT N° 00/028: STUDY OF EXPLOITED FISH STOCKS ON THE FLEMISH CAP III

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SUMMARY

Flemish Cap has been a traditional fishery for cod, American plaice and redfish. At present, cod and American plaice suffer from a lengthy failure in recruitment in the most recent years, and the NAFO Fisheries Commission maintains fishing moratoria on both stocks. At the same time other active fisheries were established, for Greenland halibut and shrimp, in particular. The objective of this Study was to obtain, handle and use the necessary data for the analysis of the fish stocks on Flemish Cap. Although the reasons for those stocks decline or increase in Flemish Cap are still under analysis, a comprehensive description of the changes is now available.

The more substantial action in this Study was the Flemish Cap survey, carried out from 26th June to 26th July on board R/V Cornide de Saavedra. Even all target stock were analysed or review in the past NAFO Scientific Council meeting in June 2001, survey results agree with the views and prognosis on all of those analyses. Survey results also show that no new good recruitment took place for cod and American plaice, the two most depleted stocks; but shrimp stock maintains a high abundance level and Greenland halibut shows signals of good recruitment.

The cod stock is collapsed: both stock biomass and spawning stock biomass at the beginning of 2001 remain at the lowest observed level. Results from the 2001 survey corroborate these views, and no signal of some good recruitment was observed. With the current age structure of the population it is unlikely that there will be a recovery of the stock in a short or medium terms, even with a moratorium for fishing cod.

The American plaice stock is also collapsed. The stock is currently at a very low level and there is no signal of recovery, due to the persistent year-to-year recruitment failure since the beginning of the 1990s. The 2001 survey corroborates these views and shows no signal of some new good recruitment.

Three species of redfish are present in Flemish Cap: *Sebastes marinus*, *S. mentella* and *S. fasciatus*. Recent analyses indicate that the fishable stock experienced a steep decline from the second half of the eighties till 1994-1996, with some recovery since 1997, resulting in a discrete growth of the biomass and female spawning biomass. Survey results indicate an upward trend in the long-term mean in spite the low result of the 2001 survey.

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The Greenland halibut in the Flemish Cap is considered to be part of a biological stock complex distributed through Subareas 0 to 3. The EU survey only partially covers its distribution range, and Flemish Cap is considered a nursery area. The occurrence of an above normal abundance at age 1, as observed in the 2001 survey, is a good signal for future good recruitment.

The occurrence of shrimp in Flemish Cap has been known for many years, but the concentrations observed were so poor that were never attractive for the commercial fleets up to 1993, when an active fishery started. The 2001 survey results indicate the permanence of shrimp stock at a high biomass level.

Roughhead grenadier is a deepwater species, mainly taken as by-catch in the Greenland halibut fisheries. Survey results indicate a quite stabilized stock, showing some variability attributed to the sampling process.

**PROJECT N° 00/041: INTERNATIONAL BOTTOM TRAWL SURVEY
IN THE MEDITERRANEAN (ITALY): MEDITS IT**

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SUMMARY

In the MI region the 2000 MEDITS survey was carried out from May 23 to 27 July using the professional trawler "Francesco Padre". A total of 153 valid hauls were carried. A total of 41 fishing days, 8 day of bad weather brake and 15 days of technical break were spent. No particular technical problems were met during the survey. As far as possible, all stations have been made at the same positions as in the previous years.

Scientific participants came from the laboratories of the "Consorzio Interuniversitario di Biologia Marina" of Livorno, from the "Agenzia Regionale per la Protezione Ambientale della Toscana" of Livorno, from the University of Genova and from the University of Rome "La Sapienza". A Minilog instrument has been used to collect data on surface and bottom water temperature. Water temperature close the bottom ranged from 13.9°C (slope hauls) to 17.0°C (shelf hauls).

The data were insert on board in a PC using the DAME program and checked using the CHECKMED2 routines. Abundance indices and length frequencies have been calculated using the INDMED4 program.

The species of the reference list which were most abundant in weight were, in order: *Trachurus mediterraneus* Merluccius merluccius, *Micromesistius poutassou* Ga/eus melastomus, *Mullus barbatus*.

From the 4th of June to the 19th of July a total of 123 hauls were carried out with the fishing vessel "Nuovo Splendore" in seas surrounding Sardinia. Two shallower hauls (stratum 13316) have been considered as not trawlable due the presence of gill nets and for this reason cancelled.

During the whole survey weather conditions were very good except for some windy days. A total of 29 fishing days, 5 days of bad weather brake and 12 days of technical break were spent. Trawling some hauls, especially near the coast, where the substrata were irregular and hard, the gear was damaged to a certain extent. When the damage was not serious, some parts of the gear were changed; in other cases the reserve gear was utilised.

Unfortunately, SCANMAR equipment was not available system on board. Following the recommendations of the MEDITS protocol haul duration was recorded according to the average effective time on bottom as from previous trials with SCANMAR by IRPEM-CNR technicians and the horizontal and vertical openings of the gear were estimated indirectly. Fishing depths were recorded by an echo sounder. A GPS system was connected with a nautical plotter where the hauls track log of the 2000 survey were recorded and, as far as possible, all stations were set at the same positions as in the previous years. Sometimes due to the presence of hauled gill nets and long lines near the coasts and in the open sea, we slightly changed the co-ordinates of some hauls, while remaining in the same bathymetric level.

Using a MINILOG device temperature and hauling depth were recorded in almost all hauls. At the end of the survey it was damage and out of order in the last two days.

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On board biological parameters were accurately performed according to the MEDITS protocol. At the end of the survey, in the laboratory, all data collected were recorded on the computer using a database program. The data were later checked and processed using the checked and indmed routines. Abundance indices and length frequencies were calculated for target species and for some of the reference species.

No particular technical problems were met during the survey. During some hauls, more often in the shallower waters, large quantities of sea urchins, eel grass (*Posidonia oceanica*) and algae were encountered. Although during the whole survey not many waste products were fished. A total of one hundred and ninety species were identified: 140 fishes, 26 crustaceans and 24 cephalopods.

Merluccius merluccius was the most abundant either in biomass (152 kg/km²) and in density (6760 N/km²). As regards biomass important values were also observed for *Octopus vulgaris*, *Raja clavata* and *Scylliorhinus canicula* (50<61<65).

In comparison with the previous year an increase in the catches of most of the target fishes (particularly *Pagellus bogaraveo*, *Aspitrigla cuculus*, *M. merluccius*, *Citharus linguatula* and *Raja clavata*) and of some cephalopods (especially *Eledone moschata*) was shown. Worth of note was the decrease in the catches of *Spicara smaris* and *Sardina pilchardus* among fishes and of *Nephrops norvegicus* and *Sepia officinalis* among crustaceans and cephalopods respectively.

The 2001 Medits survey (hereby MED'01) in the M3 region commenced on April 23rd with the loading of equipment. This survey started earlier than the previous one due to the earlier deadline of the programme.

The MED'01 was carried out using the professional stern trawler "Sant'Anna". As in MED'00, the Maltese waters (herein defined as sub-region Mad) were included in the survey. Initially, the northern side of the M3 study region had been surveyed, i.e. the grounds of the Central and Southern Tyrrhenian Sea facing Campania (Volturno river) and Calabria (Capo Suvero- regions respectively). This sub-region (M3a) has been investigated, from April 26th to May 8th, by the scientific staff of the "COISPA — Technologiae a Ricerca" of Torre a Mare (Bari).

The second sub-region covered was the central part of M3 study region (M3b), i.e., the grounds of the Southern Tyrrhenian Sea off Calabria (Capo Suvero) and the Northern coasts of Sicily (Capo S. Vito). This sub-region has been surveyed, from May 9th to May 16th, by the scientific staff of the "Istituto Talassografico — CNR" of Messina.

Finally, the trawler moved to the region known as the Strait of Sicily (M3c), which was surveyed from May 19th to June 1st by the scientific staff of the "Istituto di ricerche sulle Risorse Marine e l'Ambiente, IRMA-CNR" of Mazara. During this period, the waters around Malta (M3d) were explored in collaboration with the Malta Centre for Fisheries Sciences from May 24th to May 25th.

The MED'01 ended with the unloading of the equipment in Mazara del Vallo on June 2nd.

An overall of 150 valid hauls were performed in the whole M3 region; in particular, 57, 28 and 56 hauls were performed along the Italian coasts (M3a, M3b and Mac respectively) whilst 9 hauls were performed in Maltese waters (M3d). Some problems arose during the survey in the M3b subregion: in particular one set of gear equipped with MINIOLOG -TD was lost. Furthermore, 7 hauls were not considered to be valid: 1, 4 and 2 in M3a, M3c and M3d respectively.

In almost all hauls, a miniature data logger (MINIOLOG -TD), recording both temperature and depth, was mounted on the head rope of the gear. Due to the malfunctioning of the spare MINIOLOG, it was not possible to record these data in the M3b subregion. The gear performance was not directly monitored; however, haul duration was recorded according to average effective time on bottom and the horizontal opening of the gear in each haul was estimated on the basis of the formula derived from previous trials carried out by IRPEM-CNR (Ancona, Italy) technicians using SCANMAR equipment.

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Both haul registration and processing of biological samples were accurately performed according to MEDITS protocol.

The MEDITS-IT & ALB 2001 survey was carried out from 02/05 to 15/07.

Total number of operative days was 75 (including Medits vessel and net setting, stand-by and transferring); the survey lasted 30 days in Ionian areas from Cape Passero to Cape of Otranto (1 vessel and Medits net setting days, 3 transferring day, 26 full working days), 29 days for south-western Adriatic areas from Cape of Otranto to Vieste (1 vessel setting day, 1 transferring day and 27 full working days) and 16 days for south-eastern Adriatic areas from S. Johan to Saranda (Vieste (1 vessel setting day, 3 transferring days and 12 full working days).

During the survey no 186 hauls were carried out (Ionian areas = no 74; south-western Adriatic areas = no 72; south-eastern Adriatic areas = no 40); the vessel "Pasquale a Cristina" was utilised by MEDITS-It M4 Unit in the whole research area.

Bad weather conditions affected the survey mostly in May and June. During the survey 2001 a net door has been lost in the southern Adriatic waters. Moreover the nets suffered some lacerations and some net bowls were damaged at maximum trawled depths.

Biological data were recorded following Medits protocol options and formats. CHECKMED and INDMED softwares have been utilised for data control and elaboration.

The Medits 2001 survey, like the 2000 survey, has been conducted in the Northern and Central Adriatic Sea on board the same vessel, "Andrea", both in international waters and in the national waters of each concerned country.

The survey took place between the 22th of May and 6 July. During the first three days the net working was tested.

Scientists of three laboratories (Split, Ljubljana and Fano) took part in the survey, with in general 3-4 scientists on board at the same time

A total of 136 real hauls were carried out: 48 stations located in the Croatian waters, 86 in international and Italian territorial waters and 2 in the Slovenian waters.

Haul registrations and first biological processing were performed on board; the more detailed biological analysis and computer data input were made in laboratory according to the Medits protocol.

Sub-domain 1.3:

Egg-production based Biomass Surveys

PROJECT N° 97/017: ICHTHYOPLANKTON-BASED INDICES OF SPRING SPAWNING COMMERCIAL FISH POPULATION IN WESTERN EUROPEAN WATERS

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SUMMARY

The main objective of this project is the assessment of the abundance of eggs and larvae of commercial fish populations other than mackerel and horse mackerel from the samples collected during the ICES 1998 International Egg Survey.

The ICES Working Group of Mackerel/Horse Mackerel Egg Surveys (MHMEG WG) met at Lisbon in February 1997 set the 1998 triennial egg survey design and plan (Anon., 1997).

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The survey will be carried out from January to July 1998 and will cover western European waters from Portugal to Western Scotland. The main aim of the survey will be the assessment of the European mackerel and horse mackerel populations using the Annual Egg Production Method. This means that the extensive set of plankton samples collected in the 1998 survey will only be processed for mackerel and horse mackerel eggs. The current proposal is exclusively aimed to get further information from this set of egg samples regarding the abundance of other commercially valuable fish species which spawn totally or partially in similar areas and periods than mackerel and horse mackerel.

The project intends to start building up a time series of abundance indices of the early life history stages of commercial species with a view in the management of the target species. The target species mainly are Mackerel and Horse Mackerel larvae, Sardine eggs and larvae, Hake eggs and larvae, Megrin eggs and larvae, Blue whiting larvae, Anchovy eggs and larvae. The suitability of the survey results to provide abundance indices of eggs and larvae of other species will also be assessed.

The participants in the survey will make the samples available to the Institutes interested in further processing them, as already accepted by the ICES MHMEG WG.

It is expected that a total of 1000 samples will be collected during the survey. After an initial sorting out of samples for mackerel and horse mackerel eggs at the original laboratories, partially sorted samples or vials containing fish eggs and larvae will be sent to a series of designated laboratories, where eggs and larvae of commercial species will be worked out.

The results of the laboratory processing will yield egg and larval abundance and distribution maps for the target species. The figures obtained will be processed by means of spatial techniques in order to obtain abundance indices of the target species. All the results obtained through the processing will be introduced to a common electronic database. The database will be open to all participants and the results of the project will be made available to the relevant scientific community through technical and scientific publication.

One of the project tasks will be devoted to the evaluation of the capabilities of CUFES (Continuous Underwater Fish Egg Sampler) for sampling fish eggs. The sampler will be deployed in one of the cruises of the 1998 triennial survey (AZTI, 10-25 May 1998), and its performance and comparability to traditional samplers regarding fish eggs will be assessed.

Finally, the project will try to get an estimate of the maturity ogive for western horse mackerel as it is one of the basic requirements for the assessment of the stock when using egg surveys.

PROJECT N° 98/040: ESTIMATION OF THE MEDITERRANEAN ANCHOVY (*ENGRAULIS ENCRASICOLUS*) BIOMASS BY THE DAILY EGG PRODUCTION METHOD IN THE THRACIAN SEA (GREECE) AND SOUTH WESTERN ADRIATIC SEA (ITALY)

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SUMMARY

This final report illustrates the results of the work carried out in the framework of the project DG-XIV 98-040. The objective of this project was to estimate the biomass of the anchovy in the Thracian Sea (N. Aegean, Greece) and the Lower Adriatic Sea, from Vieste to Bari (Italy), using the Daily Egg Production Method. The two areas are considered among the most important fishing grounds for the Mediterranean anchovy in the two countries. Survey cruises for collecting egg samples and adult specimens were carried out simultaneously during peak spawning periods in both study areas. The main spawning grounds of anchovy appeared to be located relatively offshore, at locations characterized by comparatively high temperature and low salinity values, highlighting the relationship between patterns of water masses/temperature fronts and the distribution-abundance of anchovy. Data analysis of the developmental stages of the anchovy eggs suggested that the daily peak spawning period was around midnight and incubation appeared to take place about 33 hours after egg fertilization. Two major incidences of egg mortality seemed to exist; one coincided with early developmental stages (stages I and II) and the other with the time when transformation of germinal layers into various organs of the embryo was initiated. The estimation of daily egg production in the two areas yielded respectively $P_o = 91$ eggs/m² in the Thracian Sea and $P_o = 34$ eggs/m² in the lower Adriatic. The batch fecundity estimate (F) of anchovy in the Thracian Sea was found to be 4912 eggs per spawning event per mature female, while a slightly higher batch fecundity value was found in the Adriatic (F= 6379 eggs). The latter, taking into account the positive relationship between batch fecundity and size/weight of specimens, appeared to be related to the relatively larger anchovy that were collected in the Adriatic, where the mean weight of mature females in the population was found to be $W=16.97$ g, while in the Thracian it was $W=15.7$ g. Spawning fraction (8) differences might be possibly related to either sampling biases resulting by behavioral reactions of hydrated females that tend to aggregate while laying their eggs and hence are usually oversampled, and/or to the sampling period when specimens were collected. Sex-ratio values, expressed in terms of weight of mature females in the anchovy population of the two areas, reflected the dependence of this parameter on size of specimens; in smaller sizes, males usually dominate and hence in the Thracian Sea, where relatively small specimens were collected sex-ratio was $R=0.379$, while among larger specimens collected in the lower Adriatic females were encountered more frequently, which had a positive effect on the sex-ratio value that was found to be $R=0.529$. Thus, the spawning biomass of anchovy in the two study areas estimated using the DEPM equation relating the daily egg production and the daily fecundity of the adults was found to be 13180t in the Thracian Sea and 10361t in the Lower Adriatic. Both values are comprised in a relatively narrow range of estimates provided for the anchovy spawning biomass during previous studies conducted in the two areas in 1990s, suggesting possibly

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the existence of a certain stability of the anchovy populations in the Thracian, as well as in the Lower Adriatic, which might reflect the stability of the overall anchovy stock in the eastern Mediterranean region during the last decade.

PROJECT N° 00/013: POPULATION ESTIMATES OF THE BAY OF BISCAY ANCHOVY BY THE DAILY EGG PRODUCTION METHOD IN 2001

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SUMMARY

The project 00/013 entitled "Population estimates of the Bay of Biscay anchovy by the daily egg production method for 2001" presented an International project of collaboration between Spain and France to evaluate in 2001 the biomass of this anchovy by the Daily Egg Production Method (DEPM). The first purpose of these evaluations was to assist with them to ICES in the assessment of this species. Two surveys were conducted in May 2001 to implement the DEPM on this anchovy: The egg cruise "BIOMAN 01" was conducted on board the R/V "INVESTIGADOR" by AZTI and the specific adult cruise (called PEL2001) was conducted on board the R/V "THALASSA" by IFREMER, which was at the same time an acoustic survey on pelagics in this area. Preliminary estimates of the spawning stock biomass of anchovy were submitted to ICES in September 2001 and more completed estimates are provided in this report. The full DEPM methodology has been applied, except in what concerns the estimation of the spawning frequency which, as planned at the beginning of the project, has been set so far equal to its historical average value. The total spawning biomass of the Bay of Biscay anchovy estimated for the cruise time in May 2001 is about 134,500 t (CY = 0.199). From an historical perspective, this biomass is the highest ever recorded. This is due to two reasons: first a strong recruitment to the spawning population of anchovies at age 1 is recorded, and second there has been a strong presence of two year old anchovies in the population (the highest estimate of the series). The spawning population was basically composed of 1 year old anchovy (4,160 millions, CY= 23.25 %), mainly located in the coastal area and more secondarily in the remainder regions, and 2 year old anchovy (about 1,792 millions, CY 21.36 %), followed by a small amount of three or older age groups (125.9 millions CY= 27.38 %). The 2 and 3 years old anchovy were mainly placed at the mid south and/or offshore areas.

The current estimate of the Biomass depends upon the validity of the assumed value for the spawning frequency, and this value will be actually estimated before the end of the year, so revised estimates of the spawning biomass will be by then available. The estimates of the population at age heavily depend upon the correct weighting factor procedures of the samples and correct interpretation of the spatial structuring of the population.

PROJECT N° 00/038: MACKEREL AND HORSE MACKEREL EGG SURVEY 2001

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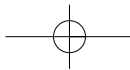
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SUMMARY

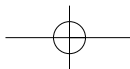
The reported surveys are the central part of the ICES-coordinated international effort in the Eastern North Atlantic to assess the status of the Mackerel and Horse Mackerel stocks. This investigation takes place triennially since the late seventies and is organised by the ICES Working Group for Mackerel and Horse Mackerel Egg Surveys (WGMEGS). The 2001 egg survey was co-financed by the European Commission by means of the study "Mackerel and Horse Mackerel Egg Surveys 2001" (00/0038).

The main objective of the series of individual cruises from February until August is to produce both an index and a direct estimate of the biomass of the north east Atlantic mackerel stock and the southern and western horse mackerel stocks. The mackerel and horse mackerel egg survey is the only source providing fishery independent information of these stocks. The general method is to quantify the freshly spawned eggs in the water column on the spawning grounds and to relate these quantities to the number of parental fish having produced these. To be able to establish such a relationship, the fecundity (potential and realised fecundity) of



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the females must also be determined. This is done by sampling sufficient numbers of gonads before, during and after spawning. The ovaries are then histologically analysed. In combination, the realised fecundity of the females and the actual number of freshly spawned eggs in the water render an estimate of the spawning stock biomass.



Sub-domain 1.4:

Multi-purpose Surveys

PROJECT N° 97/008: HERRING SURVEYS IN THE NORTH SEA AND WEST OF SCOTLAND

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SUMMARY**Coordination of the annual acoustic and larval surveys in the North Sea and Division VIa**

The herring surveys are coordinated by the International Council for the Exploration of the Sea (ICES). At annual meetings in Planning Group for Herring Surveys, the timing, area allocation and methodologies are coordinated for herring acoustic and larval surveys in the North Sea, Division VIa and IIIa, and the western Baltic. The data from the acoustic surveys were sent to the Marine Laboratory, Aberdeen, Scotland and the data from the larval surveys were sent to Institute für Meereskunde, Kiel University, Germany following the surveys and combined to give preliminary results for both years and final results for 1999. The results will be presented for the Herring Assessment Working Group in March 2000.

Acoustic surveys in the North Sea and Division VIa

An acoustic survey of the North Sea was carried out by 5 vessels during June to August 1998, and June to July 1999. The survey track was selected to cover the whole area at 15Nmi spacing with the exception of a section east and west of and a section in the Kattegat and Skaggeirak with spacing between 5 to 10Nmi. Pelagic trawling was carried out on observed fish traces during the survey for most of the North Sea, and at night in the Kattegat and Skaggeirak. The results from all cruises fully combined for 1998 and 1999.

The total spawning stock of autumn spawning herring from the North Sea in 1999 was 1,500,000 tonnes and for the West of Scotland stock was 419,000 tonnes. The spawning stock for Baltic spring spawning herring was 115,000 tonnes. These estimates of spawning stock show a steady recovery from the low levels of 1993/4. The results from the 1998 survey have been used in the ICES assessment of the herring stocks.

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Larvae surveys in the North Sea 1998-1999

Within the scope of the International Council for the Exploration of the Sea (ICES) Since 1967 a continuous research on distribution and abundance of herring larvae has been undertaken in the North Sea and adjacent waters within the scope of the International Council for the Exploration of the Sea (ICES). In this frame, seven units and time periods were covered in the North Sea during 1998 and 1999 survey periods. The results will be presented for the Herring Assessment Working Group in March 2000.

Revision of historical database for larvae surveys

Informations from the International Herring Larvae Survey Programme (IHLS) are stored in a database containing data from 1972 onwards. When reviewing the database, it became obvious that calculation procedures for the abundance indices have been changed in some steps since the initiation of this programme. Consequently, a special attempt was made to establish a homogeneous calculation procedure. A detailed description of the reviewed calculation procedure has been made. The ICES Herring Survey Planning Group and the Herring Assessment Working Group have approved this procedure. The revision of the historical database according to the results on sampler calibrations was initiated in March 1999, but not finished yet.

Identification of minimum sampling effort in larvae surveys

Due to a substantial decline in ship time and sampling effort allocated to the Herring Larvae Surveys since the end of the 80's, the Herring Larvae Database has been evaluated recently to identify the minimum sampling effort required for herring larvae surveys and its optimal allocation to the individual spawning areas and time periods.

A reduction in effort results in a loss of information, but as minimum input for MLAI calculations the survey effort should concentrate on Buchan area (1.9.-15.9.), Orkney/Shetland (15.9.-30.9.), and Southern North Sea (15.12.-31.12. and 15A.-31.1.) as the best selection for representing the total variance in the SSB. The surveys in the Central North Sea appear to be of minor importance.

Creation of an international database for acoustic survey data

An international database for the acoustic surveys has been developed. The database shall contain acoustic data for both herring and sprat and will be able to handle acoustic data from mixed layers and observations classified by species. All biological sampling results, trawl hauls will be stored in the database as well.

Development of software tools for echosounder calibration at sea

The calibration of the equipment is a prerequisite in hydroacoustic measurements. This is usually done prior to a hydroacoustic survey by moving a sphere of defined diameter through the beam of the echo transducer. The hardware manufacturer, Simrad, provides a PC-program ("Lobe") for this purpose. A proper calibration requires that the calibration sphere maintains a constant position in the centre of the beam of the transducer while running the program. Each movement of the sphere leads to an error. For this reason very calm sea conditions are necessary for calibration. For many vessels taking part in hydroacoustic surveys it is very time-consuming to reach such a sheltered place, which is also deep enough to have a reasonable distance between transducer and sphere. The application developed within the Study HERSUR aims to solve this problem by allowing to calibrate at the open sea. Still, calm sea conditions are preferable, but the sphere has now only to be positioned inside the beam instead of the centre of the beam.

PROJECT N° 97/048: EVALUATION OF THE SOUTHERN GREEK ANCHOVY STOCKS

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SUMMARY

The magnitude of the by catches and discards of living marine resources may have profound population, ecosystem and socio-economic effects on resources managed and on the communities dependent on those resources. Little is known about the biology and population state of large pelagic sharks because many species are difficult to sample, are of relative large size, are highly mobile, exhibit seasonality and are of minor commercial value in comparison with other large pelagic fishes. However during the last decade, the commercial exploitation of sharks has been rapidly increasing all over the world, making information about their life history essential for understanding and managing their populations.

During the two year period 1998-1999 a shark sampling program has been established in Greece, Italy and Spain to improve the knowledge both on biology and stock structure of the most important pelagic shark species caught in the Mediterranean Sea by the tuna and swordfish fisheries. The incidence of these fisheries on sharks was studied in various vast areas of the Mediterranean Sea such as the Alboran, Balearic, Catalanian, Tyrrhenian, Adriatic, Ionian, Aegean Sea and Levantine basin.

Catch and effort data as well as measurements and biological samples were collected both on board of professional fishing vessels and during the landings at selected pilot fishing ports of the three countries.

Catch composition data indicated that the most common species of sharks caught by drifting longlines was the blue shark, *Prionace glauca*. Other species of sharks caught by longlines were by order of importance the shortfin mako, *Isurus oxyrinchus*, the thresher shark *Alopias vulpinus*, the porbeagle, *Lamna nasus*, the tope shark, *Galeorhinus galeus*.

Fishing data obtained both on board and at landings revealed that the greater incidence of sharks occurred in the swordfish fishery. In particular, their presence in the swordfish fishery landings reached the higher percentages in the Alboran Sea (29 % of the landings in 1998 and 20.1 % in 1999) and Adriatic Sea (23.1 % of the landings in 1999). Besides, considering only the on board data it was showed that shark by catches in the swordfish fishery ranged from 0.44 to 7.6 % in the Spanish areas, from 1.82 to 4.9 % in the Greek areas and from 0.7 to 39.7 % in the Italian areas. The incidence of sharks in the albacore longline fishery was almost negligible.

The observations on shark vitality carried out on board allowed to hypothesise that a high percentage of sharks caught by the longlines have a good chance to survive if discarded at sea. However, because sharks have a commercial value almost no discards were recorded from the on board observations.

The analysis of the shark catches distribution by moon phase did not allow to discriminate if catches were higher during full or new moon phase. Both high and low values of CPUE in number of specimens/1000 hooks were observed during the two moon phases indifferently. Instead it seems that SST has some influence on the presence and therefor on the catches

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of blue shark, *Prionace glauca* as higher catches of the blue shark were observed at SST ranging from 21 to 22°C in the Italian areas and from 24 to 27°C in the Greek areas.

From the study of the size frequency distributions of the main pelagic sharks species sampled it was noted that the swordfish longline fished the larger specimens whereas the albacore longline fished the smaller ones.

Length-weight and other morphometric relationships were calculated presenting high values of correlation coefficients. A total of 555 blue shark, *Prionace glauca*, 14 porbeagle, *Lamna nasus* and 19 common thresher shark, *Alopias vulpinus*, was used for the evaluation of the length-weight relationships using regression analysis.

Moreover, a preliminary study of the age and the biology of reproduction of blue shark, *Prionace glauca* and some other species of pelagic sharks was conducted. Age estimations for blue shark, *Prionace glauca*, ranged from young of the year to seven years.

A total of 694 specimens of sharks were sampled for sex. In general males were more abundant than females for the majority of the species examined.

The reproductive systems of Mediterranean blue shark, which is the most abundant species among the sharks caught in large pelagic fisheries, have been investigated to better understand the life history of this important apex predator.

The study of the sexual maturity of male blue shark showed that all the specimens with TL lower than 125 cm were immature; 50 % of the fish with TL ranging from 185 and 195 cm were mature; 100 % of the fish with TL starting from 215 cm were mature. The study of the sexual maturity of female blue shark showed that: a) all the specimens with TL lower than about 120 cm had immature ovaries without visible eggs; b) all the specimens with TL³ 120 cm had ovaries with visible yolked eggs; c) 20 % of the specimens with TL ranging from 200 and 210 cm were full mature, but only starting from 220 cm 100 % of the specimens were full mature.

The histological analysis demonstrated that the gametogenesis in blue shark occurs according the model already described in other Elasmobranchs. A complete spermatogenesis, with deiscent spermatozoa spermatocysts, was revealed in all the testes examined, included those belonging to specimens macroscopically immature. The presence of "corpora lutea" was revealed in all the ovaries observed, included those macroscopically classified as immature.

PROJECT N° 98/077: RESEARCH VESSEL SURVEYS FOR STOCK ASSESSMENT (ASSUR3)

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SUMMARY

This EU funded study covers six monitoring surveys directed to commercially exploited fish stocks. The major stocks, covered by these surveys are herring, sprat, cod, haddock, whiting, Norway pout, plaice, and sole in the North Sea and in Skagerrak/Kattegat. For these stocks independent indices of stock size and/or the level of expected recruitment are obtained by trawl surveys. In addition, these surveys obtain valuable information on several stocks of non-target species. Also egg surveys are carried out to estimate spawning stock size of North Sea mackerel and Western mackerel. All surveys are carried out on board research vessels by the Netherlands Institute for Fisheries Research (RIVO). The results of the various surveys, internationally co-ordinated within ICES, are used by various ICES working groups and the Advisory Committee on Fisheries Management (ACFM) for annual assessments of the state of the stocks and the provision of management advice to the EU.

PROJECT N° 99/006: HERRING SURVEYS IN THE NORTH SEA AND WEST SCOTLAND

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SUMMARY

Reviews

Reviews have been made on state of the art on design of square mesh escape windows in trawls and the management tools using square mesh escape windows introduced in the legislation.

Danish sea trials

The Danish trials focussed on comparing the selectivity in a conventional 100 mm diamond mesh codend with codends with an inserted escape windows with 90 mm mesh size. Two different placements of the window were tested. One codend had the window inserted in the side. The other codend had the window in the top panel, which covers the top half part of the codend.

A commercial 520 HP vessel was chartered for sea trials in the Skagerak area. A twin trawl rig was used where one trawl fished a test codend and the other trawl with a Small meshed codend which retains all the catch.

The top window had the highest Selection Factor (SF) for haddock and the steepest selection curve. There was no significant difference in L50 between the side and top window codend for cod. The standard codend had a relatively poor selectivity (low SF) for both haddock and cod and a less steep selection curve compared to the codends with escape window.

The estimated selection in relation to the Danish minimum landing size of cod and haddock is relatively low if minimum allowed mesh sizes are used. Consequently a relatively high discard rate could be expected if fish under minimum landing size encounters the codend when the minimum mesh size specified by the legislation is used.

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Scottish sea trials

The Scottish trials concentrated on the effect of inserting a 3 m long panel of square mesh netting in the top sheet of a 100 mm codend. Previous work in the Baltic and the North Sea has shown that such panels can improve conservation by reducing the capture of small fish. The more open square meshes probably give more opportunity for fish to escape than from a normal diamond mesh codend in which the meshes tend to close under tension.

The 960 kW Scottish commercial twin trawler Challenge II was chartered to fish for 15 days (7-21 August 2000) on North Sea fishing grounds, 16 nm NE of Peterhead, Scotland. A 90 mm panel was inserted in three different positions near the aft end of the net where most escapes occur. The results were compared with those from a codend with no panel.

Haddock and whiting were present on the grounds but unfortunately insufficient numbers of cod. The experiment was designed to give an indication of the numbers of fish caught in the experimental trawls and also the numbers of fish in the population present on the grounds during fishing. Thus it was possible to estimate the reduction in the numbers of fish retained when the panels were put in place. The reduction in the numbers of small undersized fish caught represent the benefit to conservation and the numbers of marketable fish lost represent the economic loss to the fisherman. Because there were few marketable fish (both haddock and whiting) on the grounds the estimates of losses of marketable fish are less reliable.

For haddock, the percentage of all the small fish in the population that were retained reduced from 46 % without a panel to about 25 % with the panel at either 9-12 m or 6-9 m from the codline, to 14 % with the panel at 3-6 m. No marketable fish were lost from the codend without a panel whereas losses varied between 2 % of marketable fish for the 3-6 m position, 4 % for the 9-12 m position and 18 % for the 6-9 m position.

For whiting, 18 % of all the small fish in the population were retained without a panel and when the panel was at 9-12 m. This figure was reduced to 8 % with the panel at 6-9 m from the codline and 3 % with the panel at 3-6 m. 34 % marketable fish were lost from the codend without a panel but this is likely to be an anomalous result. Losses increased from 5 % of marketable fish for the 9-12 m position to 38 % for the 6-9 m position and to 50 % for the 3-6 m position.

In summary, these trials have shown that inserting a 90 mm panel into a 100 mm codend does have a significant beneficial effect on release of small fish. If the panel is placed nearer the end of the codend then the benefit is greater but there is likely to be a greater penalty in terms of lost marketable fish. Because of the lower minimum landing size of whiting the losses of marketable fish are likely to be greater for whiting than for haddock but at the same time a smaller percentage of whiting below minimum landing size is retained.

Sub-domain 1.5:

Improvement of Survey design and Standardisation of Methods

**PROJECT N° 97/009: THE USE OF MULTIVARIATE DATA
FOR IMPROVING THE QUALITY OF SURVEY-BASED STOCK
ESTIMATION IN THE NORTH SEA (MIQES)**

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SUMMARY

The project focussed on two internationally co-ordinated research surveys in the North Sea, the International Bottom Trawl Survey (IBTS) and the International Beam Trawl Survey (BTS) for round- and flatfish, respectively, which had both so far not been subject to thorough scientific analysis. The project aimed at enhancing the utility of these surveys by delivering improved indices of abundance based on multivariate analyses. The principal species of interest were herring, haddock, whiting, cod, plaice and sole.

From the IBTS, data from the 1st quarter were available from 1983 to 1997, and data from the 2nd, 3rd and 4th quarter were additionally used from 1991-1997, when quarterly surveys were carried out. From the BTS, which has been conducted annually in the 3rd quarter since 1985, data were analysed up to 1999. Comprehensive data files were compiled by combining trawl data with environmental information received from different ICES databases. Numerous errors in the raw data were corrected in consultation with national IBTS and BTS experts, and trawl and hydrographic stations were linked in space and time. Additional covariates, e.g. sun elevation and sediment grain size, were introduced.

Exploratory and standard statistical analysis revealed restrictions for the further use of the survey data for some species and age groups. Catches for some IBTS target species were extremely variable and were therefore either excluded from further analysis (mackerel and saithe) or used as covariates only (Norway pout and sprat). 2nd and 4th quarter data were not further analysed due to inadequate sampling intensity. Age I cod, whiting and haddock were not well represented in 1st quarter catches. For flatfish, the analysis was limited to BTS catches of plaice and sole, but all ages were included. A significant daylight effect on 1st quarter catches was found for haddock and herring at all ages and for cod age 2 and 3+. The IBTS data of the 3rd quarter data showed a pronounced vessel/gear effect in

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particular for the juveniles. The results of Principal Component Analysis indicated the usefulness of biotic covariates for whiting, cod, plaice and sole.

New survey based abundance estimates of different age groups of herring, haddock, whiting, cod, plaice and sole were derived from multivariate kriging and generalised additive models (GAMs). As a modification of assessment, Bayesian populations models combining Markov Chain Monte Carlo and Time Series analysis were applied to herring and whiting. The IBTS and BTS standard indices for herring, haddock, whiting and cod as well as for plaice and sole, respectively, showed remarkably robust against sampling irregularities in spite of the simple way they are calculated. External Drift kriging with a day/night indicator and especially with time of day proved superior to the IBTS standard indices in those cases where a statistical significant daylight effect existed, i.e. in the case of haddock and herring, and can therefore be regarded as a valuable alternative for the calculation of survey-based abundance indices. The GAMs demonstrated the usefulness of environmental covariates for all species, and proved superior to current practice for herring, plaice and sole. Earlier indications of discrepancies between survey-based estimates and estimates derived from commercial data were supported for whiting and cod. Important progress was achieved with respect to the implementation of Bayesian population models, but full spatial dynamics could not yet be achieved.

The assessment of herring was substantially improved by generalised additive modelling. For the other species, it is unlikely that the new abundance indices obtained by geostatistics and GAMs would change the assessment results substantially. However, the achievement of the project concerning methodological consistency and explicit incorporation of environmental covariates is an important progress in itself.

PROJECT N° 97/097: EVALUATION AND DEVELOPMENT OF SPATIO-TEMPORAL MODELS AND SURVEY DESIGNS FOR EFFICIENT ASSESSMENT OF MACKEREL AND HORSE MACKEREL

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SUMMARY

Egg production methods are used to assess mackerel and horse mackerel stocks. Generalized additive models (GAMs) can be used to model smooth trend in egg distribution and hence estimate egg production more precisely. However, GAM estimates of egg production are not necessarily unbiased and if they are to be used for routine assessment of the stocks, their bias relative to that of the current ("traditional") method must be established.

The principal objectives of this study are as follows:

1. Evaluate by simulation, the bias and precision of a GAM method for estimating the distribution and annual egg production. This included evaluating its performance relative to that of the traditional annual egg production method (AEPM).
2. Investigate improved survey designs for the method.

Software for implementing the methods was also to be developed.

Simulation scenarios: Data from the southern stocks were inadequate for construction of realistic simulation models, and results given here relate to the western stock only. Some results for the southern stock are given in the report. Three features of the spatio-temporal

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distribution of eggs were identified as important for evaluating estimator performance. They are (a) whether or not the egg production curves were bimodal, (b) the time of onset and termination of spawning relative to the survey period, and (c) the westward extent of the egg distribution. The set of simulation scenarios was constructed using flexible model fits to existing survey datasets, and where necessary supplementing these by modified fits, so that the range of simulation scenarios included all the features (a)-(c).

Survey designs: Inadequate spatial coverage, and confounding of spatial and temporal coverage has previously been identified as problematic for the GAM method. Designs with more even, and fuller spatio-temporal coverage were simulated, along with the current design.

Estimator Performance:

1. Bias: The GAM estimator had lower bias than the traditional estimator in 21 of the 26 scenarios. The median bias of the GAM estimator was -4.43 % while that for the traditional estimator was -9.80 %.
2. Root Mean Squared Error: The RMSE of the GAM method was lower than that of the traditional estimator in 22 out of 26 scenarios
3. Variance Estimation: The project was too short for proper evaluation of the bias of variance estimators, but the limited results obtained indicate no serious problems with the estimation procedure in the absence of unmodelled spatial correlation. There is some evidence to suggest that spatial correlation is not fully modelled (Augustin et al 1998).
4. Qualitative Results: The GAM estimator performed well with egg distributions differing in the temporal location of the spawning peak, but less well with westerly shifts in distribution. Fitting the GAM was more problematic with horse-mackerel distributions than mackerel distributions, due to the different spatial and temporal spawning of the two species and the fact that the survey is designed primarily to coincide with the peak mackerel spawning.

Simulation Designs: When the encountered egg distribution varies substantially from that expected, and hence survey coverage is substantially incomplete, the use of temporal structural zeros with the GAM method may be justified. With good coverage they are not necessary. Survey designs that are adaptive in their westerly extent and thus cover nearly the full spatial distribution of spawning, eliminate the need for spatial structural zeros.

Survey designs with stations every 1° latitude and 1/2° longitude generally performed better than designs sampling both longitude and latitude at 1/2° increments (as the current design does) and designs with stations at 1° latitude and 1° longitude.

Conclusion: Substantial improvements to AEPM estimates can be made by adopting the GAM-based method and a modified survey design. The absolute bias of both estimation methods is somewhat sensitive to specification of simulation model, but GAM-based estimator tends to perform better than the traditional estimator independently of simulation model. Software has been developed and is available from the first contractor.

PROJECT N° 98/029: SURVEY-BASED ABUNDANCE INDICES THAT ACCOUNT FOR FINE SPATIAL SCALE INFORMATION FOR NORTH SEA STOCKS (FINE)

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SUMMARY

Estimates of fish abundance derived from surveys are the only source of fisheries independent information available for most stock assessments. Surveys are usually performed at coarse spatial scales and regular coverage. Estimates from this design based approach, where randomness lies in the sampling process, consist on global means with high variability. Model approaches, an alternative for fish abundance estimation, correspond to an inferential framework where randomness lies in the abundance process. Statistical models can consist of a deterministic component for relating observed catch rates and covariates such as environmental factors like temperature or depth, and a probability model. The relationships can be used to predict catch over not sampled areas. Predicted estimates can be obtained using Generalized Linear and Additive models or Geostatistics. Indices are still limited by the scale data are collected. In the North Sea, estimates of fish abundance are estimated from data annually collected during the International Bottom Trawl Surveys (IBTS), performed at coarse scale. Other surveys with higher spatial resolution as the German Small-Scale Bottom Trawl Surveys (GSBTS), are also conducted. This study investigates the value of using these high-resolution data within a model-based approach to derive abundance estimates of fish stock abundance. The application is for cod (*Gadus morhua*), whiting (*Merlangius merlangus*), haddock (*Melanogrammus aeglefinus*), herring (*Clupea harengus*), and Norway pout (*Trisopterus esmarki*). Within this framework, catch and environmental data mostly from IBTS and GSBTS were processed. An inventory was made with these and other national surveys undertaken between May and September 1991-1999. Data were evaluated; many inconsistencies identified and rectified and were transferred to a common database consisting of 136595 records and stored in Bundesforschungsanstalt für Fischerei in Hamburg, Germany. Additionally GSBTS were conducted in 1999 including two extra areas to complement the coverage in the northern North Sea. Data were processed and made available for analysis. Statistical analysis of the properties of these data for species selected was performed and summary statistics were derived. Data sets were assessed by application of multivariate techniques, generalized linear and additive models and geo-statistical techniques. The effect of biological and environmental covariates on distribution of selected species and of groups of species was quantified. Effects of covariates on

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catchability and measures of fishing effort were also analysed. Indices were generated from surveys at different spatial resolution. A statistical framework based on Bayesian approach to integrate sources of information was developed. Further, abundance indices were estimated globally and locally and represented as maps of spatial distribution by integrating data sampled at different scales using generalized linear models, geostatistics and the Bayesian approach. Species distributions were simulated and hypothetical-sampling schemes investigated using computational techniques. The study demonstrated the value of high spatial resolution data to improve abundance indices derived from coarse spatial scale and the feasibility to derive abundance indices using solely data generated from GSBTS surveys. The cost of such surveys represents a third of that of the current surveys. This result alone could have a tremendous impact in future endeavours in the region.

PROJECT N° 98/057: INTERNATIONAL PROGRAM OF STANDARDIZED BOTTOM TRAWL SURVEYS OF NORTH-WESTERN EUROPE

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SUMMARY

The IPROSTS project had two main objective:

- Completion of research vessel surveys in the autumn of 1999 and 2000 in ICES 1 areas VI, VII and VIII in order to provide abundance indices at age for the major commercial species exploited in these areas,
- Standardisation of the methodology used in bottom trawl surveys.

For completion of the first objective, the French Research institute IFREMER conducted surveys in the Celtic Sea and the Bay of Biscay on board the Research Vessel, Thalassa. The Marine Institute of Dublin conducted surveys in the Irish Sea and Celtic Sea on board the Research Vessel Celtic Voyager and in the Western area of Ireland on board two chartered commercial fishing vessels (Marliona and Shauna Ann). The Marine Laboratory of Aberdeen conducted surveys in subareas Via, northern Irish Sea and northern part of subarea V lib on board the research vessel SCOTIA. The SCOTIA and THALASSA used standard GOV bottom trawl, the Celtic Voyager a GOV designed bottom trawl but smaller, adapted to the size of the vessel. The commercial fishing vessel used Rock hopper commercial gear fitted with 1 a 20 mm codend liner.

From the data collected, time series of abundance indices at age were completed to 1., be used as tuning indices in Assessment Working Groups.

Regarding the second objective, two field of study were identified. The first is related to gear performance.

The first question is are research vessels fishing together with similar gear getting similar catches. To answer this question, two intercalibration experiments were, undertaken between the SCOTIA and CEL TIC VOYAGER and between the THALASSA and CELTIC VOYAGER. Initially intercalibration was also planned between the Irish Research and commercial vessels but a national decision was taken after the start of the study to build a new ship to undertake the surveys in the area covered with the commercial vessel. It was therefore decided to abandon this part and to carry the intercalibration with the new vessel when she is on duty. The analysis showed that there was no statistical evidence to support the hypothesis that the catches were different. The second question considered whether, on a single vessel using the same gear, gear performance varies in relation to external factors r and whether or not this affects catchability. Conclusions were that all surveys produced major depth related changes in gear performance and that each net, including those of identical construction, display individual gear geometry; this may have an effect on the catch performance. The second field of study was sampling strategies. A study was undertaken on sampling for age and showed that optimisation can be achieved by choosing the strategy adapted to the biological characteristics of the target species. Finally from the hydrological data collected during the SCOTIA and THALASSA surveys, hydrological maps of surface and bottom temperature were produced.

PROJECT N° 98/062: THONS, ECHANTILLONNAGE SYSTEMES STATISTIQUES (TESS)

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SUMMARY

Cette proposition avait pour motivation principale d'améliorer le système de collecte des statistiques de la pêche thonière européenne, en assurant la continuité des actions entreprises dans le cadre du projet "Étude d'un laboratoire européen de recherches sur les thons: Observatoire de Recherche sur la Dynamique de l'Exploitation des Thonidés" (ORDET, déjà financé par l'Union Européenne et qui s'est terminé début 2000) et le futur projet ORDET lui-même dont la mise en place opérationnelle — initialement prévue en 2000 — est retardée du fait des difficultés survenues au niveau du choix de son site central.

Dans la première phase du projet, les grandes lignes de ce futur laboratoire avaient été définies, les principaux domaines d'intervention dégagés, le contenu et les principales caractéristiques des futures bases de données précisées. Mettant en œuvre les résultats acquis lors du programme ET ("Analyse du schéma d'échantillonnage multispécifique des thonidés tropicaux", 1995-1997 sur financement Européen), une première version d'un nouveau logiciel (AVDTH: "Acquisition Validation des Données Thonières") fiable, ergonomique et moderne avait été conçu.

La proposition TESS ("Thons, Échantillonnages, Systèmes Statistiques") représente la phase intérimaire (prévus à l'origine sur 18 mois) de ce projet de longue haleine, et participe de la finalisation de la mise en place du projet final ORDET; elle a pour objectif

- De mettre en œuvre sur le terrain l'utilisation de AVDTH;
- D'assurer la transition entre l'ancien et le nouveau système, tout en conservant la considérable masse des données acquises depuis les années 50;
- De poursuivre la définition et la mise en place des nouveaux outils nécessaires à la poursuite du projet;
- D'assurer la nécessaire continuité des actions de collecte des données thonières mises en place par l'IRD et l'IEO en coopération avec leurs partenaires du sud dans les océans Atlantique (Côte d'Ivoire et Sénégal) et Indien (Madagascar et Seychelles).

Ces activités ont été menées en liaison étroite avec celles du projet BIOTHON (DG-Pêche 99/19) qui a démarré en mars 2000 sur deux ans avec pour objectif spécifique l'amélioration de la qualité des statistiques biologiques (composition spécifique et structure en taille des captures).

Le projet TESS s'articule autour de trois objectifs principaux, les deux premiers concernant les pêcheries thonières tropicales pour lesquelles la réflexion est la plus avancée, le troisième ayant trait au thon rouge dont la situation au niveau des statistiques est préoccupante. Il va de soi que les autres aspects de la pêche thonière (espèces tempérées,

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rejets et prises accessoires) restent néanmoins des éléments incontournables qui seront ultérieurement abordés dans le cadre soit du projet final ORDET, soit de projets plus spécifiques inclus dans la proposition de Programme National Pluriannuel (2002-2006) de collecte des données de base présenté par la France en application du règlement (CE)1543/2000 du Conseil du 29 juin 2000.

Démarré en juin 1999 pour 18 mois, le projet a en fait duré 26 mois après avoir été prolongé deux fois de quatre mois.

**PROJECT N° 98/090: DEVELOPMENT AND VALIDATION
OF EGG-PRODUCTION BASED BIOMASS ESTIMATES, USING COD
AND PLAICE STOCKS IN THE IRISH SEA**

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SUMMARY

Contract 1998/090 was awarded to carry out further development of the Annual Egg Production Method (AEPM) for estimating spawning stock biomass of determinate spawning fish, using Irish Sea cod and plaice as the target species. In a previous contract (AIR3-CT94-2263) AEPM estimates of SSB of Irish Sea cod, sole and plaice exceeded the corresponding estimates from Virtual Population Analysis (VPA) by factors of 2.3, 2.7 and 4.3 respectively. The present contract focused on the following aspects of AEPM surveys: survey design and analysis; identification of eggs; development rates of eggs in relation to temperature; mortality rates of eggs; estimation of population structure of adult fish; and estimation of fecundity and losses of eggs due to re-absorption (atresia). A series of eight ichthyoplankton surveys from late January to mid May 2000 provided data on abundance of eggs in six embryonic development stages. The surveys were stratified to improve precision, based on analysis survey data from 1995, and the data were analysed using two stratified schemes and General Additive Models. Plaice eggs were identified by size and morphology. Cod eggs, which cannot be distinguished from early-stage haddock eggs by morphology alone, were identified by isoelectric focussing (IEF) calibrated using known standards from the Irish Sea. Less than 20 % of the cod-sized eggs were identified as cod, the remainder being mostly haddock, plaice and whiting. Gene probes were also tried but worked only on alcohol-preserved eggs and not the formaldehyde-preserved eggs collected on the surveys. Mean daily egg production by development stage was calculated at each station using temperature-development relationships from laboratory experiments carried out on Irish Sea cod and plaice in the present contract. These experiments showed the importance of determining stock-specific relationships from multiple crosses of native parents, and the need to consider the range and variation about the relationships as well as the size of eggs through the spawning period. Annual egg production by stage was estimated by integrating survey estimates over time. The decline in plaice egg production with mean age of stage approximately followed a simple exponential mortality model although there was evidence for increased mortality after stage II. The estimated mortality rates of 0.18 d⁻¹ (eastern Irish Sea) and 0.21 d⁻¹ (west) were similar to estimates of 0.19 d⁻¹ and 0.22 d⁻¹ obtained in 1995. Extrapolating the egg mortality curves to age zero to estimate the annual egg production at spawning gave estimates almost identical to the stage IA production in the west and 17 % higher than stage IA production in the east.

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The exponential model poorly described cod egg production. In view of the potential biases involved in identifying the appropriate mortality function for early stage eggs, the SSB estimates for cod and plaice were calculated using stage IA production only and thus are likely to be underestimates. Mean female weight and sex ratio of plaice and cod were estimated from a series of otter trawl surveys and charters of commercial trawlers. Optimum survey design for plaice was determined from analysis of historical survey data. As in 1995, otter trawl surveys gave lower estimates of mean female weight of cod and female proportion of SSB than given by mid-water trawlers. This resulted in 34 % higher SSB estimates than given by mid-water trawlers due to the size-related fecundity per unit weight. Survey estimates of female proportion of SSB were generally poor due to distribution and behaviour effects on catchability, whilst estimates of proportion mature at size and age were less affected by method of capture. Potential fecundity in cod and plaice was estimated gravimetrically and was linearly related to fish weight. Samples were screened by histology to ensure that only pre-spawners were used for estimating potential fecundity. Fecundity per unit weight was higher in cod and western Irish Sea plaice than recorded in 1995. Atresia was negligible in both species, and thus realised fecundity was almost identical to potential fecundity. The AEPM estimates of total SSB for the whole Irish Sea in 2000 were 15,500 t (CV = 23 %) for plaice and 6,510 t (CV=19 %) for cod. The equivalent ICES estimates from VPA were 4,830 t and 4,330 t after re-working to include the maturity ogives estimated for 2000. These discrepancies were similar to those obtained in 1995. A preliminary application of the daily fecundity reduction method (DFRM) for plaice gave an SSB estimate for the western Irish Sea similar to the AEPM estimate, but the figure for the eastern Irish Sea was more than double the AEPM estimate. The precision of the GAM estimate of egg production used by the DFRM has not yet been computed.

PROJECT N° 98/099: IMPROVEMENT OF STOCK ASSESSMENT AND DATA COLLECTION BY CONTINUATION, STANDARDISATION AND DESIGN IMPROVEMENT OF THE BALTIC INTERNATIONAL BOTTOM TRAWL SURVEYS FOR FISHERY RESOURCE ASSESSMENT (ISDBITS)

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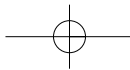
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SUMMARY

The main objective of the project is to strengthen the stock assessment of demersal fishery resources in the Baltic Sea by continuing surveying and improving the quality of data obtained from international trawl surveys. The aims are to:

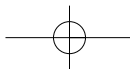
- to continue the standard Baltic International Bottom Trawl Survey (BITS)
- to improve the reproducibility and consistency of the international Baltic resource surveys through standardisation of design and operation of the trawl gear as well as through evaluation and revision of survey design in relation to the specific objectives of the survey
- to enable a shift of the recruitment index used in stock assessments of Baltic cod from an age of 2 years to 1 year by introduction of a trawl with better selectivity for the I-age-group and through modification of survey design to also fully cover this age group in order to get better estimates of year class strength for all age groups

In order to achieve sustainable exploitation of fisheries resources improved data quality and methods of fish stock assessment techniques are required. The currently used assessment methods for the demersal stocks in the Baltic Sea are mainly fishery based, but they also to a very high extent rely on fishery independent data. The data from the fisheries have proven unreliable in periods where the need for reliable assessments was most pertinent. For that reason there is an ever increasingly demand for high quality and reliable long time series of data from fishery independent sources such as resource surveys. The present project intends to meet these basic requirements for the fishery independent Baltic International Trawl Survey (BITS) by introducing a standardisation of design and operation of the trawl gear, as well as by making an evaluation of and a suggested revision of a standardised survey design and haul stratification in this fishery resource survey mainly targeting Baltic



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cod. One of the main problems in the utility of the biological advice for management is that the most recent index for prognoses is 2-year olds, introducing a large uncertainty in the catch forecast due to the contribution of an unknown year class. The present project intends to introduce a survey gear and survey design that will enable a 1-year index to be used for forecast.



PROJECT Nº 99/010: DIRECT ABUNDANCE ESTIMATION AND DISTRIBUTION OF PELAGIC FISH SPECIES IN NORTH EAST ATLANTIC WATERS. IMPROVING ACOUSTIC AND DAILY EGG PRODUCTION METHODS FOR SARDINE AND ANCHOVY (PELASSES)

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SUMMARY

The anchovy and sardine populations distributed of north-east European atlantic coasts are routinely assessed using direct methods, namely, acoustic (echo-integration) and egg production (Daily Egg Production Method). Both methods are carried out in spring at the spawning period of both fish species. PELASSES, aims to improve the methodology of both methods, especially, to achieve an increase in the precision of the biomass estimation, but also to set up the CUFES as an absolute estimator of the egg production. During spring 2000 and 2001, the coastal waters, from the sea shore until 200 and some areas to 1000, of north east Atlantic waters were steamed in a co-ordinated coverage using the same methodology. R/V Noruega covered the Gulf of Cadiz and the Portuguese waters while R/V Thalassa covered the Spanish and the French waters. Daily hours were devoted to implement the acoustic activities, echosounding using 38 and 120 kHz and fishing station, on a regular track with parallel transects equally spaced and normal to the coast line at 8-12 nmi apart. In addition, continuous records of sub-surface (3 m depth) temperature, fluorometry, salinity and eggs (CUFES) from underway pumps were gathered. During night time, over the same area, discrete samples of plankton, including ichthyoplankton, and CTD casts were performed. In addition a specific survey was carried in the inner part of the Bay of Biscay. This survey combined LHPR hauls with PAIROVET tows and CUFES with the main objective of setting up the CUFES as an absolute estimator of the egg abundance. In total eight survey were carried out.

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Once the different data were gathered, a general database constructed in a GIS environment was performed. Analysis of data comprised biological information (i.e. sardine morphometry and genetics, otolith reading and egg staging exchange and workshops), standardisation of oceanographic data and its interpretation, acoustic methodology (i.e. backscattering energy allocation criteria, BEAC), spatial distribution (i.e. geostatistic analysis), relationships among fish distribution and fish abundance with oceanographic and biological variables (i.e. GAM approach), sardine and anchovy abundance estimation and distribution (echo-integration) and modeling the vertical sardine and anchovy egg distribution according to different scenarios of buoyancy in relation with age, oceanographic and turbulence features.

After a first meeting to standardise the different methodologies and to fix the general criteria to construct the databases, the surveys were undertaken without noticeable incidences. A GIS database was constructed with all data. New approach for BEAC was implemented although more investigations are needed. The inclusion of environmental and biological variables such as haline fronts, egg presence among others would result in a improvement of the objective methods based on PCA and CLUSTER analysis which include morphometric, location and energetic variables from schools present in a defined portion of the steamed track. On the other hand, while this method seems to perform well in a multispecies context, with fish occurring in similar size schools, some problems were detected when in a particular area big, isolated schools are present. Since this kind of schools are difficult to catch (due to avoidance and scaping reaction), no representation at the ground truth fishing station is expected and, therefore, in this area the accuracy of the method is unknown. On account of these findings, further studies are needed. Nevertheless, the inclusion of the egg sardine or anchovy presence/absence as explanatory variable, greatly improves the allocation method.

Biomass estimation by age for sardine and anchovy was improved on account the results of the exchange otolith programmes and workshops. For both species, sardine and anchovy, the work developed with PELASSES greatly contributed to increase the precision in the biomass and abundance estimates by age group. From 2000 to 2001, sardine expanded its distribution area, especially off northwestern part of the Iberian Peninsula (i.e. Galician waters). Together with this expansion, it is also noticeable the strength of the 2000 year class. During the surveys performed in spring 2001, this cohort which was one year old, expanded its distribution area from the Portuguese waters towards the Cantabrian Sea. Egg distribution matched quite well with that estimated for the adults from the acoustic records. On the other hand, anchovy was found roughly in the same areas in both years, occurring in two main locations, the Gulf of Cadiz and the inner part of the Bay of Biscay. Some schools were also seen off north Portugal. Nevertheless, in 2000 some anchovies were also observed in early March further north, around the northern part of the French Brittany.

Intensive work was also allocated in investigating the feasibility of using CUFES as absolute estimator of the egg production. Vertical egg distribution derived from the LHPR hauls, revealed that most of the eggs of sardine and anchovy occur in the few top meters of the water column (i.e. between 0 to 5 m), being accesibles for the CUFES pump which is placed at around 3-5 m depth. However, the percentage of damaged eggs is high, being sometimes difficult to stage those eggs. A new key with only 3 stages instead of the standard of 11 stages was suggested. In addition buoyancy experiments were done over different turbulence regimes and density scenarios. The vertical distribution of egg for both species was modelled aiming at to establish CUFES as an absolute estimator of the egg production. In spite the results were promising, more work is needed before to derive from the CUFES counts, firstly the egg abundance in the whole water column and secondly, the Egg Production. Estimated egg abundance in the water column by egg stage is still biased in low density areas, (i.e. river plumes) on account of the results of the true distribution derived from the LHPR hauls, although for other scenarios the model performed better. In this sense, because of the general low salinities observed in 2001, overall, the model performed better for data from 2000 than those of 2001.

PROJECT N° 99/011: CALIBRATION OF ABUNDANCE INDICES ESTIMATED FROM SOUTHWESTERN ATLANTIC AND WESTERN MEDITERRANEAN GROUND FISH SURVEYS

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SUMMARY

Groundfish resources in Spanish waters are regularly assessed by the Instituto Español de Oceanografía (IEO) in annual random-stratified trawl surveys on board the R/V Cornide de Saavedra. The Baka 44/60 and GOC 73 otter-trawls are the standard survey gears in the research cruises conducted in Atlantic and Mediterranean Spanish waters respectively, but their relative fishing power is unknown. Aiming to estimate this fishing relative power, two calibration experiments based on the conduction of paired hauls (CALIMA surveys) were carried out in early November in 2000 (6-20/11/00) and 2001 (2-19/11/01). The sampling area corresponded to the bottoms located between 15 and 500-m depth off the Atlantic Spanish waters of the Gulf of Cadiz (5 974 km²). The selection of this area was based on the Atlantic-Mediterranean transitional character showing its groundfish resources.

The Cornide surveys' annual calendar prevented from conducting CALIMA surveys under a more specific survey plan (i.e., higher number of paired hauls in a small survey area showing high abundance for the whole target species set). Instead, fishing stations were randomly selected, the paired hauls being conducted as in their respective surveys at a mean towing speed of 3 knots. Several vessel-gear's operational constraints not only determined the number of paired hauls per survey (30 in the 2000 survey and 35 in the 2001 one) but also posed some problems in the minimisation of spatio-temporal residual variability included in the "fishing station or haul" effect. The coverage of the sampling area was of 5 and 6 paired hauls/1000 km² in each survey respectively. Gear performance was only possible to be monitored for vertical net opening and groundrope-bottom distance. Nevertheless, both gears performed as expected, although the GOC gear behaved some unstable. Mean vertical net openings for Baka and GOC trawls were estimated at 1.97 and 2.80 m respectively, these values being very close to their standards.

Two catshark, 14 fish, two crustacean, and 9 cephalopod species were analysed. Most species showed declined abundance levels in relation to precedent years that entailed increased proportions of zero tows and a reduction of their effective sample size required for the estimation of their catchability conversion coefficients. The conditions in that paired hauls were conducted were thoroughly explored. Pooling data from both surveys was feasible for the most species but elegant cuttlefish and both Eledone species that required a separate treatment per survey. Differences (non-parametrically tested from raw data) in gear catchabilities were found for small spotted catshark, horse-mackerel recruits, blue whiting, striped red mullet, spotted flounder, European squid, pink and elegant cuttlefish, and octopus species. Their conversion coefficients were estimated by applying a generalised linear model (GLM) to log-transformed catch rates. Paired hauls containing a zero catch were rejected from the model. These estimates indicated a greater relative fishing power of the GOC trawl in capturing catshark, horse-mackerel recruits, blue whiting, striped red mullet, elegant cuttlefish and octopuses. The Baka gear only showed slightly more efficient in capturing spotted flounder and European squid. Nevertheless, conversion coefficients were characterised by wide confidence intervals. Further research will involve the feasibility of applying more robust estimation methods (e.g., Pelletier's quasi-likelihood approach (Pelletier, 1998)) to the available data.

PROJECT N° 99/080: USING ENVIRONMENTAL VARIABLES WITH IMPROVED DEPM METHODS TO CONSOLIDATE THE SERIES OF SARDINE AND ANCHOVY ESTIMATES

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SUMMARY

The primary objectives of the project were:

1. Improve the efficiency and generality of the DEPM Estimates
2. Modernize the analysis tools
3. Improve precision of the biomass time-series for the Ibero-Atlantic Sardine and Anchovy Stocks.
4. Map stock distribution with respect to spatial and environmental variables, and how this has changed.
5. Establish the quantitative relationships between egg distribution and environmental variables.

Method development: The first two objectives involve developing analysis methods to capitalize on recent advances in flexible surface fitting using generalized additive models (GAMs). Two software packages were developed for this purpose, in the free statistical computing language R. Substantial general improvements to existing GAM methodology were developed and implemented in a package *mgcv*, which is of such quality and general utility that it has been adopted by the R developers for distribution with the R core functions. The main methodological innovations are:

1. Multi-dimensional smoothing of an arbitrary number of variables;
2. Improved model selection methods that make otherwise impracticably large multi-dimensional model selection problems feasible;
3. A rigorous method of interval estimation;
4. Extension to include “multiplicative offsets”, which in the context of this project, allow simultaneous estimation of egg production surfaces and egg mortality surfaces;
5. Optimally stable, numerically efficient fitting methods, including negative binomial error models.

The second package, *depmode1*, implements an innovative GAM-based daily egg production method (DEPM) developed in the project, that allows egg production and

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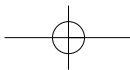
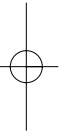
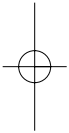
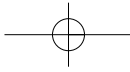
mortality to be estimated as functions of environmental and other variables. This includes a new method developed in the project for analysis of incubation experiments.

Improved inferences about Ibero-Atlantic anchovy and sardine stocks: The last three primary objectives involve use of the new methods and software to improve the series of anchovy and sardine biomass estimates. Point estimates of egg production (Po) from the new estimation methods are consistent with those from traditional methods (they generally differ by less than 10 %). The new methods have also been successful in reducing the uncertainty associated with Po and spawning stock biomass (SSB) by modelling spatial trends in egg production as functions of location and environmental variables (coefficients of variation are 5-15 % lower in the case of sardine), and they do so in a statistically rigorous way. In the case of anchovy, improvements in precision were not achieved, but this is probably due to negative bias in the traditional estimates of precision. Preliminary attempts in modelling adult DEPM parameters showed that the exercise is relatively trivial in comparison to modelling egg production, but for the time being is impractical due to the limited number of available adult samples. Sufficient adult information would most likely permit a model-based estimation of spawning biomass by the DEPM, avoiding subjective decisions on post-stratification.

The new methods have also been successful in mapping the distribution of Po in the spawning region, and in showing how this has changed over the years. The distribution maps of fitted anchovy egg production allow easy isualization of the spatial pattern of spawning, and reveal some stability in the spawning activity over the French shelf in around the Gironde estuary and substantial changes over time in the remaining survey area.

In the case of sardine, fitted distributions correspond well to the observations, showing a radical shift in spawning distribution from the late 80s to the late 90s (from northern Portugal and Galicia to southern Portugal and the Gulf of Cadiz) and a change in 2002. Finally, although the fitted models estimated significant relationships between environmental variables and Po these varied over time and did not support inferences about causal relations between sardine and anchovy spawning physiology/behaviour and environmental conditions.

Scientists from AZTI, IEO and IPIMAR were trained in use of the methods and software; they are in a position to use the methods independently in future. The software is freely available via the project website, as are an example dataset, related publications and example analyses. The methods and results are being disseminated by presentations at fisheries assessment group meetings, peer-reviewed publications, and the web.



Domain 2: Sampling of Commercial Fisheries — Assessment & management



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Sub-domain 2.1:

Biological sampling of commercial fisheries

**PROJECT N° 97/003: BELGIAN FISH SAMPLING PROGRAMME
AND ASSOCIATED ACTIVITIES IN SUPPORT OF THE COMMON
FISHERIES POLICY**

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SUMMARY

The main objective of this project is to provide the EU with information for setting annual TAC's and to assure the continuation of the existing Belgian sampling programmes on several fish stocks, viz. sole and plaice in the North Sea, English Channel, Celtic Sea and Irish Sea, sole in the Gulf of Biscay, and cod, whiting and haddock in the North Sea. Therefore the project comprises data requirements for sampling of the commercial landings and fishery independent data.

Fisheries and biological data for all Belgian gears was obtained from commercial landings in two Belgian fishing ports: Oostende and Zeebrugge. Per market category all necessary formation was collected from the most important management units.

During 1998, respectively 1999 a total of 54,249 respectively 52,035 specimens were sampled for length measurements and 9,095 respectively 12,238 otholiths were taken for subsequent age determination within the laboratory.

The stratified sampling procedure involves a two-step sampling procedure. First a length distribution per vessel is calculated for the landings of Belgian fishing vessels. By application of the age/length key, the total length distribution will be transformed into a total age composition for each quarter per area. By combining the data for the quarters and sexes separately in a database, annual age compositions for each management unit will be calculated.

The results of this extensive market sampling have shall be further combined with the data from other European countries and are and will be presented at the ICES assessment Working Group meetings.

To obtain fisheries independent data on the abundance and distribution of juveniles and adults of the target species, a stratified sampling (beam trawl survey) was carried out on the Belgian Continental Shelf and in the Southern North Sea.

In general the juvenile flatfish stock along the Belgian coast recovered slightly in 1998 from the decline observed in the previous years. The yearclass of plaice in 1998 was even above the geometric mean. However, in 1999, the negative trend of the previous years (before 1998) for juvenile flatfish stock density was again confirmed. The roundfish stocks showed a similar tendency in the abundance of the 0-group fish. The abundance of cod in 1998 was slightly above the geometric mean, but was low in 1999. Densities of 0-group whiting (1998 and 1999) were above the geometric mean for the period '72-'97.

In the Southern North Sea the flatfish densities observed on adults were generally rather low and were also substantially lower compared to previous years. This was obvious for the recorded densities on the sole and the plaice stock.

The decline was also present in the cod and haddock stocks, whereas the whiting stock showed higher densities in all areas.

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PROJECT N° 97/004: SAMPLING OF 8 GERMAN COMMERCIAL FISHERIES

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SUMMARY

The German saithe fishery in the northern North Sea could be covered well with sampling during the course of this study. The most important division was 4a. There was only one quarter (quarter 2 in 1999) not covered with sampling. The fishery is characterized by low discard rates in the directed fishery. One sample of by-catch of saithe in the cod fishery reveals also very low discard rates (<1 %). A lot of by-catch species (up to 35) were observed in the fishery directed on saithe. However, the by-catch rates in terms of weight are low or moderate. The average rate is 9 % and only in the 1st quarter of 2000 it reaches nearly 25 %. Cod and haddock are the main by-catch species in the saithe fishery. Most of the by-catch of these species was landed. The discard rate in the cod by-catch is on average 5.7 % with a maximum in the 4th quarter of 1999 when it reached 17.5 %. for haddock the values are a bit higher. The discard rate in the haddock by-catch on average is 14.7 % with an extreme of 47.6 % in the 1st quarter of 2000.

During the study all quarters except quarter 4 in 1999 and quarter 1 in 2000 could be covered with samples in the cod fishery. The most important division/quarter combination have been sampled. The German cod directed fishery changed during the study to a more mixed fishery with flatfish. Compared to 1998 the effort was significantly reduced in 1999. During the study discarding of cod was in general no problem. Only in two of 7 division/quarter combinations the discarding of the target species cod reached levels of concern. The fishery takes a number by-catch species partly landed and partly discarded due to restriction in quota or size as well as due to low commercial value. Main by-catch species are haddock, Grey gurnard, dab and plaice in the rank of their importance in terms of weight. Haddock was mostly landed and in no case more than 50 % was discarded. Grey gurnard was only in one case landed and otherwise discarded. The calculated discards for this species were in some cases nearly 3 times higher than the official landings. Discards of dab were in general equal or higher than the landings. For plaice only in one case discards were higher than the landings.

In the plaice fishery during the study all quarters except quarters 1 and 4 in 1999 could be covered with samples. The most important division/quarter combination have been sampled. The German plaice directed fishery changed during the study to a more mixed fishery with cod. Compared to 1998 the effort was significantly increased in 1999. During the study discarding of plaice was a general problem. In all sampled division/quarter

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combinations the discarding of the target species plaice reached levels higher than that of the landings. The fishery is characterized by a high number of by-catch species partly landed and partly discarded due to restriction in quota or size as well as due to low commercial value. Main by-catch species are cod, dab, Grey gurnard, Lemon sole and brill in the rank of their importance in terms of weight. Cod was mostly landed and in all cases far less than 50 % was discarded. Grey gurnard was only in one case landed and otherwise discarded. The calculated discards for this species were in some cases much higher than the official landings. Discards of dab were except for one quarter/division combination higher than the landings. Brill and Lemon sole were landed due to their commercial value. For the sole fishery during the study all quarters could be covered with samples in division 4b which was the most important for the sole fishery. The German sole directed fishery is a more mixed fishery with plaice and dab although the target is sole because of its commercial value. Compared to 1998 the effort was significantly increased in 1999 in division 4b with division 4c suffering a simultaneous decrease in effort. During the study discarding of sole was also a problem. In some sampled division/quarter combinations the discarding of the target species sole reached levels of 50 % in terms of numbers and 30 % in terms of weight. The fishery is characterized by a high number of by-catch species partly landed and partly discarded. Main by-catch species are plaice, dab, cod, turbot, Grey gurnard and Lemon sole in the rank of their importance in terms of weight. Cod and the other valuable species like turbot and Lemon sole were landed. Grey gurnard was only in one case landed and otherwise discarded. The target species sole never reached more than 25 % proportion in the catch weight. On an average the weight proportion of sole in the catch was about 10 %.

In the redfish fishery in the Irminger Sea all of the important quarter/division combinations could be covered by samples. The oceanic redfish fishery is almost completely a clean fishery. By-catches appear mostly as individual fish of sometimes rare species. Discarding is done if ever only for damaged fish or as offal's from processing.

All of the important quarter/division combinations in the Greenland halibut fishery could be covered by samples. The Greenland halibut fishery produces only few discards of the target species. By-catches appear mostly as individual fish of sometimes rare species. Only redfish, both grenadier species and some rays are caught in reasonable amounts. Compared to other fisheries the by-catch appears not to be a severe problem.

Most of the important herring catches in the North Sea and adjacent waters could be covered by samples in spite of only one sampled trip in 1998. However, in 1999 the coverage was insufficient mainly because also only one sampled trip could be arranged. Requests for sampling the fishery in division 2a on Atlanto-Skandian herring in the years 1998, 1999 and 2000 were answered negatively due to logistic reasons. Progress was made in estimating herring discards compared to Study 94/019. Though, no progress could be made in estimating discards due to high-grading. In order to get more information sampling intensity must be increased despite of the logistic problems prevailing. Because only one trip could be observed in both years discarding practice cannot be considered representative. Mackerel was the most important by-catch in both years observed with a maximum of about 10 % in terms of weight in division 4a in quarter 3 of 1999. This by-catch of mackerel was mostly landed whereas all by-catch observed in 1998 was discarded.

Most of the important mackerel catches in 1999 and 2000 in the North Sea (Subarea 4), division 6a and Subarea 7 could be covered by samples. Progress was made in estimating mackerel discards compared to Study 94/019. In order to get more information sampling intensity must be increased despite of the logistic problems prevailing. In the directed fishery on mackerel discarding was observed only in 1999. It reaches 3 % in terms of total catch in division 6a whereas in division 7b discarding was negligible. In divisions 4a (35 % of total catch weight) and 6a (58 % of total catch weight) in 1999 herring was taken as by-catch in the mackerel fishery and mostly landed. In 2000 no herring was observed as by-

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catch. Discarding of herring in the mackerel fishery in the first quarter of the year depends on the strategy to exploit the herring quota later in the year. Most important by-catch species in both years was horse mackerel. The by-catch rates are about 1 % of total catch weight. Blue whiting appeared as a minor by-catch species in 1999. However, in 2000 it contributed more than 70 % to the catch weight in a sample from division 7c.

Most of the important horse mackerel catches in 1998, 1999 and 2000 in division 6a and Subarea 7 could be covered by samples. Only the second quarter in 1999 and 2000 could not be sampled although the catch contribution from this quarters was considerable. Progress was made in estimating horse mackerel discards compared to Study 94/019. In order to get more information sampling intensity must be increased despite of the logistic problems prevailing. Mackerel was the most important by-catch species in the horse mackerel fishery. In the directed fishery on horse mackerel, mackerel discarding was negligible. The maximum observed value of 20 % in terms of total catch weight occurred only once. The second ranked by-catch species was sardine the maximum by-catch rate reaching 9 % in sampled total catch weight.

**PROJECT N° 97/026: STRUCTURES DÉMOGRAPHIQUES
DES DÉBARQUEMENTS FRANÇAIS DES PRINCIPAUX STOCKS
EXPLOITÉS EN MER DU NORD ET MANCHE ORIENTALE**

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SUMMARY

Marine research institutes of the European Community regularly assess the status of main exploited fish stocks. One way of this is to study demographic structures and the relation with fishing activity.

The objective of this contract is to provide these structures for sole, plaice and whiting caught in the Eastern English Channel and the North sea in 1998 and 1999.

Size structures are obtained by sampling landings in auctions. Relationship between size and age of fishes is calculated by taking bony pieces (otoliths) off and reading them. Age compositions are built, when possible, for each "métier".

A métier is defined as a fishing activity which is characterised by one catching gear and a group of target species, operating in a given area during a given season, within which the catches taken by any unit of fishing effort account for the same pattern of exploitation by species and size group.

This report presents achieved results for each studied species, and a description of process which have been used. It gives essential data for diagnosis of these species done by ICES.

Results depend on production statistics quality and availability.

PROJECT N° 97/066: MEDITERRANEAN LANDINGS PILOT PROJECT (MEDLAND)

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SUMMARY

The main aim of the MEDLAND project was the carrying out of a "pilot sample survey" in order to collect landing and effort data about demersal resources. At the same time the pilot sample survey represented a first "module" enabling the test of common methodology and procedures.

The MEDLAND project started on February 1998 and has been concluded on February 2000. The program organisation consisted of 8 research groups from 4 countries (Spain, France, Italy, and Greece), covering 10 study areas.

The survey target, in the different ports of each pilot area, was the trawler fleet, as this fishing segment is highly involved in the exploitation of the demersal resources in those landing sites. The general sampling scheme, adopted within the project, was based on the two stage sampling design with pre-selected primary units.

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The main results of the frame survey were the description of:

- The study area, the fishing ground, the fishing habits;
- The fishing fleet (GRT, KW, etc...), the species mostly landed.

The main results of the landing survey were the monthly estimations in each pilot area, for a one-year period, of the following categories:

- commercial catches (landings);
- fishing effort and fishing pattern;
- catch per unit effort (CPUEs).

The fishes were the most part of the landing (57 %), followed by cephalopods (23 %) and crustaceans (20 %). The six most abundant species in the overall landing were: *Merluccius merluccius* (15 %), *Mullus* spp. (8 %), *Octopus* spp. (7 %), *Parapenaeus longirostris* (7 %), *Eledone* spp (6 %), *Nephrops norvegicus* (5 %).

Considering the mean value of the estimated monthly fishing effort, there was only one pilot area (Molfetta) with a very high value (nearly 15,000 hours). The pilot areas of Malaga, Santa Pola, Gallipoli and Kavala were characterised by values ranging between 5,000 and 8,500 hours. All the other pilot areas (S. Margherita, Salerno and Chalkis) presented a level of fishing effort lower than 5,000 hours.

As regard the mean value of the catch per unit effort (CPUE), three pilot areas (Kavala, Chalkis and Santa Pola) showed the higher values, which ranged between 20 and 25 kg/h/boat. In four pilot areas (Malaga, S. Margherita, Salerno and Molfetta) the values were ranging between 10 and 15 kg/h/boat. The lower value (nearly 6 kg/h/boat) was found in Gallipoli.

The coefficients of variation of the CPUEs, estimated on a monthly basis, highlighted that, in the most part of both pilot areas and months, a rather good level of precision was reached. Particularly, in Kavala, Salerno, Gallipoli, S. Margherita, Santa Pola and Molfetta almost all the coefficients of variation were lower than 20 %, with only few values higher than this threshold value.

An analysis of the relationship between the coefficients of variation and the mean daily percentage of interviews, along six days per month over the survey period, showed that, with a fixed level of coefficient of variation equal to 20 %, the needed mean daily percentage of interviews was about 21 %.

Besides this basic information, the study, which is connected with MEDITS project, has also gathered ancillary information on biological aspects, such as size and related maturity, of few target species particularly important in the trawl catches of the different pilot areas.

A preliminary comparison between the CPUEs obtained from the MEDLAND project and those estimated from trawl surveys programs (mainly MEDITS) was also performed, in order to have a first idea of the variations occurring between abundance indices derived by two different approaches. An attempt of exploring the applicability of length-structured prediction model using both trawl survey and effort data, the latter derived from MEDLAND, was also carried out. Moreover, on the basis of the adopted sampling approach, an hypothesis of extending the applied methodology to a larger scale was also analysed, taking into account the level of variation obtained for the main MEDLAND categories.

The main difficulties faced during the carrying out of the program were related to the unlike habits of the fleets in the different Countries. This matter implied the necessity of adapting the common methodology to the various specific situations. In some cases, the data of the landings were collected at markets and the information, on the fishing effort, were integrated by the direct interviews. In other pilot areas, both the data (landings and fishing effort) were gathered during the landing operations by direct interviews with the fisherman. In the latter case, a rather good collaboration of the fisherman allowed the collection of the information required, although with a larger effort than in the market approach.

PROJECT N° 97/068: MONITORING OF THE TRAWL AND GILLNET LANDINGS IN THE CENTRAL AND NORTHERN TYRRHENIAN SEA

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SUMMARY

The aim of this project is to collect detailed data on bottom trawl landing and demographic structure of the most important demersal species in three important ports of the Northern and Central Tyrrhenian Sea. The fishery with gill net targeting hake was considered as well. Castiglione della Pescaia and Porto Santo Stefano in the Northern Tyrrhenian Sea and Terracina in the Central Tyrrhenian Sea were selected to carry out the study; regarding the target species, hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), Norway lobster (*Nephrops norvegicus*), horned octopus (*Eledone cirrhosa*) and deep-water rose shrimp (*Parapeanaeus longirostris*) were chosen.

An exhaustive characterisation of the trawl and gill net fleets of each port has been carried out. Furthermore maps of the fishing grounds of the target species by type of gear and by port were produced.

From August 1998 to November 1999 monthly development of the landing (total and by gear) for the target species and for the by catch was presented. The analysis of the landing was carried out according to the different commercial categories adopted by the local fishermen.

To obtain the size frequency distributions, the sampling was carried out with fishing trips on commercial vessels of Porto Santo Stefano and Terracina. The demography of the target species landing based on the bi-monthly distributions of size frequencies corresponding to each gear was studied.

Finally, monthly Catch per Unit of Effort of the target species by type of gear were analysed. Regarding trawl, the CPUE were analysed considering separately the boats using traditional trawl gear and wide opening trawl gear. In Porto Santo Stefano and Terracina sub-groups of the fleets were considered according to two classes of engine power. The unit of effort was represented by the fishing day for trawl fishery and by meters of net for the gill net fishery.

The information obtained during the study allowed to identify, in the three sampled ports, different groups of trawlers, each one being characterised by an own multispecific composition of the landing. Although each vessel group fished well defined target species, the accessory catch was of great importance in the determination of the economic value of the catch. Moreover, a high percentage of the landing was constituted by small size species and/or by young specimens of larger species.

The presence in the trawl catch of young specimens was particularly evident for Hake, the most important resource in the all considered ports. The landing of this species was characterised by a very high percentage of specimens smaller than the actual Minimum Legal Size (MLS) of 20 cm TL (EC Regulation 1626/94). Their commercialisation and high level of reject at the sea in some period of the year were the most evident consequence of the disagreement between the minimum legal stretched mesh size of the cod-end (40 mm) and the MLS for this species. Although the presence of individuals larger than 20 cm TL in the trawl length was low, in the last years also this important fraction of the population underwent an increasing fishing pressure. The development of the wide opening trawl

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increased the catchability of these specimens. Anyway, a high fishing pressure on the adults was due to the gill net fleet. To protect this resource, it will be necessary to monitor and eventually to assess by regulations this type of activity, that could have serious consequences if indiscriminately exerted. An adequate regulation of the net length, of the boat number and, at same time, the closure of areas during the spawning peaks are important steps for a better assessment of this demographic fraction.

In the case of the trawl exploitation of juveniles, a reduction of the fishing mortality firstly could be obtained performing fishing closures on spatio-temporal basis. Due to the multispecific characteristics of this fishery, the protection of young specimens modifying the gear selectivity seems to be more difficult to apply.

The red mullet landing showed about 10 % of specimens below the minimum legal size of 11 cm TL. These percentages considerably increased during the time of recruitment (September-October). Considering that the nurseries areas of red mullet are localised inside the coastal zones, where trawl fishery is prohibited, it will sufficient a better protection of these bottoms to reduce the fishing mortality on young specimens.

Regarding Norway lobster, the demographic structure of the landing, both in Porto Santo Stefano and Terracina, showed very reduced value of specimens under the minimum legal size (20 mm CL), below 1 % of the landing both in biomass and number of specimens. Also the negligible discard corroborated the hypothesis of an exploitation rate of this species near to the equilibrium.

An estimation of the exploitation state of deep-water rose shrimp and horned octopus through the analysis of the landing and the demographic structure was difficult to realise, because the short life cycle and the great fluctuation in the abundance at sea of these two species. Regarding the deep-water rose shrimp, during the sampling period very high values of landing were observed in respect to the previous years. In the case of horned octopus, during the first year of sampling, the landing of this species was very low, while a notable increase in Porto Santo Stefano and Castiglione della Pescaia during the second year. In these last two ports the small immature specimens constituted an important economic component for many boats during the summer.

In conclusion, the project contributed to extend and improve the data bank on trawl and gill net commercial landing and on the demographic structure of the most important target species of these fleets. Detailed information on the technical characteristics of the boats and the gears and on the spatio-temporal fishing activity gave a satisfactory interpretation of the landing data recorded. These results have largely demonstrated that an adequate and independent network of survey and control is necessary to obtain reliable and useful data for the resources management.

PROJECT N° 97/074: REGULATORY DISCARD OF SWORDFISH (XIPHIAS GLADIUS L.): EFFECTIVENESS OF THE EU REGULATION REGARDING THE CATCH MINIMUM SIZE OF SWORDFISH IN THE MEDITERRANEAN

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SUMMARY

The objective of the project was to verify the effectiveness of the EU Council Regulation N. 1626/94 of June 27, 1994, which, among other things establishes a minimum lower jaw-fork length (LJFL) of 120 cm for swordfish captured in the Mediterranean Sea.

To this end, during the two-year period 1998-1999, an investigation was carried out on the Spanish, Italian and Greek fleets targeting swordfish.

The investigation was carried out using observers both on board and at landing who collected catch and effort data in the Catalanian, Alboran, Tyrrhenian, Strait of Sicily, Ionian, Adriatic, Aegean and Levantine seas. Measurements of caught specimens were taken to assess their size distributions per month and per gear.

In the Mediterranean Sea, swordfish surface long line fishing is characterised by a high heterogeneity as regards both the characteristics of the vessels and the fishing gears used. Furthermore, it is also characterised by changes in the fishing strategies: some fishermen go on very long trips, fishing in large areas of the Mediterranean Sea, whereas some others, because of the size of the boats and the absence of facilities on board, can stay at sea only for a few days, or, more often, they land at the end of the day to deliver their catch.

The average CPUE values in biomass at landing were 101.7, 105.2 and 86.3, for the year 1998, and 97.0, 55.7 and 285.1, for the year 1999, in Spain, Italy and Greece respectively.

In the two-year period 1998-1999, the length of the sampled swordfish ranged from 20 to 215 cm in Spain, from 40 to 229 in Italy, and from 60 to 242 cm in Greece. The percentage of undersize swordfish showed fluctuations within the areas. The higher percentages were observed in Spain followed by Italy and Greece. Anyway, considering all the fishing areas under investigation, the percentage of the swordfish with LJFL lower than 120 cm was 74 % for both 1998 and 1999.

In terms of differences among the countries participating in the project, the percentages in number of undersize swordfish observed at landing, were 83.8 %, 71.4 % and 19.3 %, for the year 1998, and 79.9 %, 67.6 % and 28.1 %, for the year 1999, for Spain, Italy and Greece respectively. Instead the percentages observed on board were 76.0 %, 77.4 % and

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51.3 %, for the first year, and 87.0 %, 81.4 % and 38.9 %, for the second year, for Spain, Italy and Greece respectively.

As to the vitality of swordfish caught, the higher percentage of the specimens showing good health conditions at boarding was recorded in Italy (25.9 %) for the specimens caught by traditional long line, followed by Spain (19.1 %) for the fish caught by the same gear, and by Greece (15.8 %) for the fish caught by American long line.

Analysing vitality by size (LJFL lower and higher than 120 cm), the higher percentage of the specimens in good health conditions was recorded in the youngest animals.

It seems that the major factors affecting the undersize swordfish catches are: the availability of juveniles in the fishing areas, which historically are considered spawning areas, the hook selectivity, and the extraordinary trophic capacity of the species.

But other contributing factors including fishing depth; distance from the coast and from the spawning areas; the good environmental conditions, which permit smaller vessels to operate closer to the coast; the size of the boats, the fishing period (especially the autumnal period during which few-month old fish are in the area), the biological factors, as migration, reproduction and trophic needs; the degree of exploitation of fishing area; the fishing strategy and technology, are also involved in the above problem.

Despite the fact that the Spanish, Italian and Greek fleets usually operate in compliance with national and European regulations, significant catches of undersize fish, which in some cases reached more than 80 % of the total catch in number of fish, were reported by both on board and at landing observers. Therefore it could be asserted that the present national and EU regulations are not enforceable and therefore they might not be sufficient to protect the stock.

Precautionary measures should be taken, considering all the factors, which affect undersize swordfish catches, the biology of the species and the social economic impact of these new regulations would have once enforced.

In the light of the results obtained the following measures are proposed according to two lines, namely avoidance of juvenile captures and reduction of total catches.

Avoidance of juvenile captures may be achieved by means of enforcing the respect of minimum size by absolute prohibition, with no tolerance, to catch specimens smaller than 100 cm LJFL (upper limit of class 0); of acting on hook size and elements associated with the gear; of acting on fishing strategy and technology considering the interesting results coming from semi-pelagic long line (piedrabola) in Spain and overall from American long line in Greece; of acting on fishing season by establishment of a temporary close season for the whole fishing area from 1st October to 31st December for the protection of the juveniles and from 1st June to 15th July for the protection of breeding individuals; of acting on fishing areas of maximum juvenile abundance prohibiting fishing in these areas for the whole year (spatial prohibition).

The measures to reduce total fishing effort are to freeze the effort at the 1995 levels, as recommended by ICCAT, to set limits to fishing times (compulsory maximum fishing times and recovery of the gear before dawn).

Lastly, the characteristics of vessels are to be taken into account. The group of measures proposed would probably affect the sector, included smaller vessels (opportunistic), with lower capacity and autonomy, which have had to adapt the gear to catch young specimens.

PROJECT N° 97/076: MARKET SAMPLING OF DUTCH LANDINGS OF COMMERCIAL SPECIES (MARSAM2)

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SUMMARY

This report gives an overview of the biological sampling activities of the major marine fish species landed in the Netherlands during the period 1998-1999. In the market sampling programme biological samples are taken from the landings of herring, mackerel, horse mackerel, sole, plaice, cod, whiting, blue whiting and greater argentine from the areas where they have been exploited by the Dutch commercial fleet. The sampling procedures for these species from the commercial fishery are described. The sampling targets for age sampling have been reached in 1998 and 1999 for all species, except for some pelagic species in 1998. The targets for length sampling have not been reached for cod and whiting regarding the number of length samples, although the number of length measurements has been above the target. It is recommended that more length samples are taken in 2000 for cod and whiting, but that less fish per sample are measured (especially whiting).

Biological sampling is also carried out during research vessel surveys. This report contains additional information on the biological sampling on board of research vessels, as far as this includes the collection of age/length information of some commercial species for the market sampling programme. In addition the biological sampling of non-commercial species is presented in this report.

**PROJECT N° 97/078: BY-CATCH SPECIES IN THE NORTH SEA
FLATFISH FISHERY (DAB, TURBOT, BRILL): PRELIMINARY
ASSESSMENT (DATUBRAS)**

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SUMMARY

Turbot and brill are flatfish species of considerable economic value for fisheries in the North Sea and surrounding shelf seas. Their market prices is at the same level as that for the better categories of sole. Hence, the catch of these species is of large interest for fishermen. As a result, it is important to monitor their population and to assess their biological sustainability.

This report describes a study that collected biological information on these species in the 1980ies and the 1990ies. Length, weight and age characteristics form the basic information needed to follow the health of a population, in addition to the numbers of specimens in their natural environment. During several years these data were collected by the Dutch and Belgian fisheries research institutes that contributed to this study, from specimens in the landings. Furthermore, from the locations where turbot and brill were caught, the spatial distribution of turbot and brill could be deduced (since 1967). Additionally, genetic codes of specimens from different shelf seas (North Sea, Skagerrak, Channel, Irish Sea, Celtic Sea, and Bay of Biscay) were studied. Different populations might have different biological characteristics (growth, size, numbers), so that when assessing sustainability, these different populations should be discriminated and, if possible, a differential (future) sampling program should be set up.

When the landings of turbot and brill are considered, it is notable that the Dutch demersal fleet has dominated the landings of these species during the last 30 years. Before that period, the English fleet was the dominating one. This is strongly related to the developments in gears among the different countries. The Dutch fleet has developed mainly into a beam trawling fleet, while the English fleet has mainly focused on otter trawling. Turbot and brill are currently mainly caught as a by-catch in beam trawling, while turbot is also caught as a target species in a gill net fishery by Danish fishermen. The development in fishing gears and trawlers has had its impact on important target fish species. Increases in engine power, vessel size and number of vessels resulted in increases in the catch of most targeted species. For turbot, this is not found; the amount of turbot caught has been fairly stable, until the 1990ies, in which a dramatic decrease has been observed in North Sea landings. Brill did show an increase in catches, especially in the 1970ies with the rise of beam trawling. Also landings of this species showed a decline in the 1990ies, albeit not as dramatic as that for turbot.

Size and growth rates of turbot and brill have been studied for the North Sea populations in the 1980ies (Dutch data) and the 1990ies (Belgian data). A normal feature for flatfish is the

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difference in growth between males and females, with the females growing faster from the third year onwards and thus attaining larger sizes. Turbot can grow up to 50 and 75 cm (males and females respectively) and attain an average maximum weight of 2 and 7 kg. For brill, these figures are 40 and 55 cm respectively, and 1.1 and 2.3 kg. These values, however are for specimens of 8 years or older, while the landings mainly consist of 2 to 3 year old fish. This is the age at which they mature. Consequently, a considerable proportion of turbot and brill caught is not yet mature. These specimens have thus not contributed to the sustainability of the population.

The Belgian study on genetic characteristics of turbot and brill showed that there are probably different stocks of turbot and brill. Although the results were not conclusive, there is evidence for different turbot stocks in the Irish Sea, in the North Sea/Celtic Sea and in the Channel/Bay of Biscay. The results for brill suggest a differentiation between separate populations from Bay of Biscay, Channel, Celtic Sea and the North Sea/Skagerrak.

The data from the Dutch study in the 1980ies were used to model the population dynamics, i.e. the development of numbers at age and size groups of turbot and brill throughout the years of the study period. Such models are used for all major commercially important fish species (sole, plaice, herring, mackerel, etc.) to establish the quota for the fisheries in the different European countries. An important outcome is the mortality of that part of the population due to fishing (F). An F-value that is usually considered acceptable for species such as plaice and sole is around 0.3 to 0.4. Values found for turbot in this study vary from 0.5 to 0.74 and for brill from 0.5 to 1.12.

In conclusion, the high fishing mortality of these species, together with the decline in landings, the large proportion of immature specimens in the landings, and the reduced age at which these species are caught, are indicative for the overexploitation of these species.

PROJECT Nº 97/086: CEPHALOPOD RESOURCES DYNAMICS & FISHERIES TRENDS IN THE ALGARVE AND GULF OF CADIZ (ALCACEPH)

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SUMMARY

The present study is a full study of the fisheries biology of the most important commercial cephalopod species in the Algarve (south of Portugal) and Gulf of Cadiz (Portuguese and Spanish waters). The main target species were the common octopus (*Octopus vulgaris*), curled octopus (*Eledone cirrhosa*), musky octopus (*E. moschata*), common cuttlefish (*Sepia officinalis*) and elegant cuttlefish (*S. elegant*). Some fisheries biological data are also presented of all cephalopod species discarded in Algarve in a total of 20 species.

Samples of each species were collected from the market (first sell) and on board commercial boats, during a twelve months period (1998-1999). However, in the case of Cadiz some biological material and raw data already existed from cruises or previous studies. The catches of two types of commercial fishery — the artisanal fishery (traps) and the trawl fishery — were sampled.

In order to understand the cephalopod fisheries and its future perspectives, official landings fishing data from the most important harbours in the study area was compiled and analysed.

In spite of the study area being a continues area with common waters and sometimes with common traditions, the commercial cephalopod species are caught with different fishing gears and sometimes with the same type but with slight modifications. Therefore, all fishing gears and métiers used by both countries in the study area are presented, with special attention on the artisanal fisheries.

Population parameters of the main cephalopod species studied are presented such as length frequency distributions, weight-length relationships, maturity, fecundity and growth. For the species common octopus (*Octopus vulgaris*) it was also studied the gametogenesis of the males and females. For the cephalopod discarded species the population parameters presented depend on the number of specimens caught but it was made an effort to present the weight-length relationship, the length frequency distribution and the maturity stages.

**PROJECT N° 97/101: COLLECTION OF FISHERIES DATA
AND DEVELOPMENT OF A BASIC MANAGEMENT MODEL
FOR THE SHETLAND SANDEEL STOCK**

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SUMMARY

Fisheries data has been collected for the Shetland sandeel (*Ammodytes marinus*) stock during 1998 and 1999 through sampling of commercial landings and research surveys, in continuation of a previous study.

During each year of this study the fishing season was divided by a closed period during the months of June and July, the main seabird breeding season. Similar proportions of the total annual catch were taken before (March, April and May) and after (August and September) the closure. Before the closure catches are dominated by one and two group sandeels, but after the closure newly recruited 0-group sandeels predominate. In both years the fishery failed to take the 7,000 TAC.

Research surveys were carried out in continuation of surveys carried out since 1984, providing annual indexes of sandeel abundance. Other surveys monitored catch-per-unit effort throughout the fishing season and investigated relationships between catch rates and environmental parameters. No such relationships were identified and the planned development of a management model for the fishery provide not be practical given the current state of knowledge of the Shetland sandeel stock.

PROJECT N° 98/024: INTERNATIONAL BALTIC SEA SAMPLING PROGRAM II (IBSSP II)

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SUMMARY

The aim of the project is improve the collection of catch data from commercial fishing vessels operating in Kattegat and the Baltic Sea in order to get a complete description of the fishing pattern in the area. The data are used as input for fish stock assessment in the area.

Further more it is the aim to secure optimal sampling and consistency of the data collected by the countries involved in the project.

Observers collect the data while they are on board the vessels during active normal commercial fishery. The observers are employed at the national research institutes in the countries participating in the project. The following countries participate in the project: Denmark, Estonia, Finland, Germany, Latvia, Poland, Russia and Sweden.

The project covers all commercial important fleets in Kattegat and The Baltic Sea. The observers collect all relevant information concerning the fishery including catch weight per species (separated into landing- and discard part), length distributions, gear and haul information, etc.

The data are stored in a common database, the IBSSP database. Data are available for scientific purposes on aggregated form for all national scientific institutions on written request to the project co-ordinator.

The study includes a comparison of age-length-keys obtained from different countries, gears and areas for herring and sprat.

PROJECT N° 98/026: A NEW SAMPLING REGIME FOR RESOURCE ASSESSMENT OF HERRING IN THE SKAGERRAK, KATTEGAT AND SW BALTIC

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SUMMARY

Samples for biomarker analyses were taken from both commercial catches and scientific cruises. Sampling included herring larval surveys, sampling of juveniles from bottom trawl and acoustic surveys, adults were sampled from commercial catches and cruises for spawning individuals. Lipid samples were stored in liquid nitrogen and analysed using high resolution chromatographic methods. Otoliths from both spawning and immature herring were polished for the microstructure and Particle Induced X-ray Emission (PIXE) analysis of spatial distribution of Sr content.

In routine otolith microstructure analysis for identification of spawning type, no ripe or spawning individuals had a microstructure indication a deviating spawning type. Daily increment pattern was the same for different spawning aggregations in the Western Baltic. In all cases, larvae showed significantly narrower average daily increment width than adults. Annual otolith growth showed no geographical or age related differences in 1-to 3-ringers, different spawning aggregations of 4 and 5 year old herring had significant differences in late otolith growth as well as 1st annual structure.

Strontium increases with the salinity of the aquatic environment. PIXE analysis was performed on otoliths from the brackish SW Baltic and in the marine Skagerrak and Kattegat. The ratio of Sr/Ca was elevated in the otolith centre in all samples from the Skagerrak and the Kattegat compared to the Baltic, where also seasonal values in juvenile otoliths varied considerably. The PIXE analysis discriminates well between otoliths sampled from marine and brackish waters.

Fatty acid profiles showed no small scale geographical variation and only indicated possible differences between 1- and 2-ringers. Signals of halogenated pollutants were different on a large scale geographical level and had age related trends in the most lipophilic substances. Statistical methods for decision of sample strategy, stratified or non-stratified in relation to optimal estimation of one or more variables, were described and protocols for otolith analysis were formulated.

In a series of intercalibration workshops with technicians from the participating institutes the learning and practical application of the otolith microstructure preparation and analysis methods were compared. Performance improved by use of reference collections and expert advisers.

All collected data were entered into national databases ensuring a comparable data structure for later combination. An effort was made to construct a web-linked database, a prototype was produced for linking secondary analyses and images to the individual fish level of a common database structure.

PROJECT N° 98/048: STUDY OF EXPLOITED FISH IN STOCKS ON THE FLEMISH CAP II

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SUMMARY

Flemish Cap has been a traditional fishery for cod, American plaice and redfish. However, species dominance in the ecosystem deeply changed in most recent years: Greenland halibut and shrimp are nowadays dominants and became the target of very active fisheries. Cod and American plaice suffer from a lengthy failure in recruitment in the most recent years, and the NAFO Fisheries Commission maintains fishing moratoria on both stocks. The objective of this Study was to obtain, handle and use the necessary data for the analysis of the fish stocks on Flemish Cap. Although the reasons for those stocks decline or increase in Flemish Cap are still under analysis, a comprehensive description of the changes is now available.

The cod stock collapsed: both stock biomass and spawning stock biomass at the beginning of 2001 remain at the lowest observed level and are mainly composed of fish 7 years old and older. The spawning stock biomass at the low current levels was not able to produce good recruitments in recent years. With the present age structure of the population it is unlikely that there will be a recovery of the stock in a short or medium terms, even with a moratorium for fishing cod.

The American plaice stock also collapsed. The stock is currently at a very low level and there is no sign of recovery, due to the persistent year-to-year recruitment failure since the beginning of the 1990s. Very poor year-classes were recruited to this stock since 1991, and poor recruitments are also foreseen for the next coming years.

Three species of redfish are present in Flemish Cap: *Sebastes marinus*, *S. mentella* and *S. fasciatus*. The last two species are known as beaked redfish and are the main target of the commercial fishery. Results of the analyses indicate that 3M beaked redfish stock experienced a steep decline from the second half of the eighties till 1994-1996. From 1997 onwards fishing mortality dropped to values well below natural mortality allowing the survival and growth of the remainders from all cohorts, namely from the most abundant one (1990), and forcing a discrete growth of the biomass and female spawning biomass. Meanwhile, no new pulse of recruitment has occurred since 1990.

The Greenland halibut in the Flemish Cap is considered to be part of a biological stock complex distributed through Subareas 0 to 3. The EU survey only partially covers its

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distribution range, but Flemish Cap is a nursery area. Total biomass survey estimates index increased from a level of 4,300 to 8,600 tons in the 1988 to 1994 period, to reach a maximum value of 24,000 tons in 1998. The biomass declined to about 21,000 tons in 1999 and 17,000 tons in 2000. The stock on Flemish Cap, basically immature fish, has gradually extended to the shallowest part of the bank.

The occurrence of shrimp in Flemish Cap has been known for many years, but the concentrations observed were so poor that were never attractive for the commercial fleets up to 1993, when an active fishery started. The current period of high abundance started with the very abundant 1988 year-class and is maintained to the present due to new good recruitments. The survey is a good index of the adult biomass.

Roughhead grenadier is mainly taken as by-catch in the Greenland halibut deepwater fisheries. The EU survey series indicates a continuous increase from 1988 to 1993 and a later decreasing trend up to 2000 in both abundance and biomass. Data available show that roughhead grenadier has a prolonged life cycle, multi-age population structure with differences in growth and mortality between males and females, slow maturation and a low fecundity. It must be noted that commercial catches are mainly composed of immature fishes.

PROJECT Nº 98/082: FISHERIES BIOLOGY AND ASSESSMENT OF DEMERSAL SPECIES (SPARIDAE) FROM THE SOUTH OF PORTUGAL

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SUMMARY

Sea breams (family Sparidae) are hermaphroditic species that are found in coastal waters world-wide. Maximum sizes range from less than 30 cm to more than 100 cm. Many species are commercially valuable and the larger sea breams are highly prized by sport fishermen (rod and line, spear fishing) and are among the most expensive fish in the market.

In the Algarve, sea breams are a dominant group on the continental shelf and in lagoons and estuaries, with more than 20 species regularly caught. The Algarve fisheries are characterised by an important artisanal component, with a large number of small boats licensed to fish with a variety of gears, including gill nets, trammel nets, longlines, hand lines, jigs, traps, pots, dredges and purse seine nets. The fisheries are multi-species and multi-gear in nature and sea breams account for a significant part of the landings of many of these gears.

Landings of sea breams in general and for most Sparidae species have shown a steady decline over the past ten years or more. Together with the increasing rarity of some of the larger sea breams and a decrease in mean size over time, this could be indicative of over exploitation. The only conservation and management measures in effect that are of relevance for sea breams in Algarve waters are minimum landing sizes (MLS) and technical measures such as minimum mesh sizes, amount of netting per boat and regulations delimiting fishing grounds on the basis of vessel size and gear type.

Since 1994, we have been studying the artisanal fisheries of the Algarve, with a special emphasis on sea breams and the impacts of different gears on these species. Thus, a series of projects were carried out to evaluate size selectivity of longlines, gill nets and trammel nets and the recruitment of sea breams is currently being studied. During the course of these projects, biological material was collected and some preliminary fisheries biology studies carried out.

The objective of the current project was to make full use of this biological material by supplementing the samples with individuals obtained from the fish market and with juveniles obtained by beach seining in the Ria Formosa lagoon. The population dynamics parameters of seven sea breams (Sparidae) from the south and south-west coast of Portugal were studied: *Boops boops* (bogue), *Diplodus vulgaris* (two-banded sea bream), *Diplodus sargus* (common or white sea bream), *Lithognathus mormyrus* (marbled sea bream), *Pagellus acame* (axillary sea bream), *Pagellus erythrinus* (common pandora) and *Spondyliosoma cantharus* (black sea bream). Our objectives included obtaining monthly samples for all twelve months of the year, with at least 30 individuals per 1 cm size class for size range that would be representative of the population size structure.

The ages were determined by reading and interpreting growth rings in otoliths (ear bones) and scales. A growth model (von Bertalanffy) was fitted to these data for males, females and all individuals combined in order to estimate growth parameters and comparisons were made to see if there were differences between scales and otoliths and between males and females. Validation of the age and growth methodology was carried out by marginal

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increment analysis for both scales and otoliths and showed that there was indeed an annual periodicity in the deposition of the growth bands in both structures in all seven species. The results of the age and growth study showed that in most cases the sea breams were rather slow growing, with several species reaching maximum ages of at least 20 years. In general, otoliths were judged to be more reliable.

Using only fish that were caught in the longline fishery and thus with known size selectivity parameters (logistic curve), the catch curve method was used to estimate total mortality. This method is based on the plot of the logarithms of the catches-at-age against age. The plot typically has an ascending limb corresponding to fish that are not fully recruited and a descending limb representing the decline in numbers due to fishing and natural mortality. The absolute value of the slope of this part of the curve is the instantaneous total mortality (Z). The natural mortality (M) was estimated using empirical formulae and the fishing mortality calculated as the difference between Z and M . The current exploitation rate was calculated as $E = F/Z$.

The gonads of the sampled fish were analysed visually to determine sex (undetermined, hermaphrodite with the male part dominant, hermaphrodite with the female part dominant, male or female) and the maturity state. The data on the proportion mature in each size class were used to fit logistic curves and to estimate the size at maturity (L_{50}).

The seven sea breams were characterised by fairly long spawning seasons with two main groups. The first group is that of largely winter and spring spawners and consists of Boops boops, Diplodus sargus, Diplodus vulgaris and Spondyliosoma cantharus. The second group spawns from the spring to the autumn and includes Lithognathus mormyrus, Pagellus acarne and Pagellus erythrinus. The estimated sizes at first maturity (L_{50}) were similar (17.1:1.0 cm) and correspond to fish of age classes I and II.

The population dynamics parameters and the longline selectivity parameters were used in yield per recruit analyses. Yield per recruit analysis is based on the consideration that yield depends on growth, age (size) at first capture and fishing mortality. It is useful for evaluating different exploitation strategies, in particular the trade-offs between small size at first capture and large size at first capture. In our analyses we evaluated a range of scenarios, varying size at first capture and exploitation rate. The results of this analysis showed that fishing and exploitation rates for these sea breams caught by longline were generally low and that they were moderately or even under exploited. It is important to note that this analysis was for longline caught fish only. The results are not surprising given the size selective properties of longlines, where the size at first capture is generally large and very few or no fish below the MLS are caught. Results of such an analysis for gears with different size selectivity characteristics would probably be quite different. In our comparative studies we have found very significant differences in the size structures of the catches of different static gears, implying very different impacts in terms of for example fish mortality rates. Thus, since this is a multispecies, multigear fishery, the impacts of other gears must also be evaluated. For all of these gears, size selectivity should be studied and mortality rates estimated. Relative selectivity studies are necessary in order to fully evaluate the state of these valuable resources. The necessary data are not available for most of the demersal species caught in the Algarve artisanal fisheries.

**PROJECT N° 98/093: UTILISING FISHERMEN'S KNOWLEDGE —
PILOT-SCALE TRIALS AND EVALUATION OF A SYSTEM
FOR COLLECTING BIOLOGICAL AND MANAGEMENT INFORMATION
FROM COMMERCIAL FISHERMEN.**

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SUMMARY

Current systems of fish stock assessment within the EU make virtually no use of information supplied by commercial fishermen and in general there are no mechanisms by which their knowledge can be usefully integrated into the fisheries management process. There is a growing body of literature questioning whether traditional fisheries data alone provides an adequate basis upon which to make fisheries management decisions and calling for the integration of fishermen's knowledge within this field. Bearing in mind the long tradition and heavy dependency upon fishing within Shetland, this area was a highly suitable location for the present study that assessed pilot-scale trials and evaluated a system for collecting biological and management information from commercial shellfish fishermen. The Shetland shellfish study incorporated three broad methods for assembling information from fishermen: personal interviews, questionnaires and inspection of log-books.

The first part of this report describes and evaluates investigations utilizing knowledge from Norwegian coastal cod (*Gadus morhua*) fishermen carried out by the Norwegian Institute of Fisheries Science/Norwegian College of Fishery Science (Maurstad & Sundet, 1998a), and a study with cod and lumpfish (*Cyclopterus lumpus*) fishermen undertaken by the Memorial University of Newfoundland and Dalhousie University, Canada (Neis et al., 1999b). The second part of the report concentrates on the studies carried out in Shetland, outlining the background knowledge of Shetland's shellfish fisheries at the outset of this study, describing the methodologies used and discussing the basic results obtained. The final part of the report considers lessons learned whilst undertaking this study and seeks to draw conclusions about efficient methodology and "best practice" when carrying out investigations of this nature in future.

Judging from the forty fishermen who participated in the personal interview programme, there is no doubt that Shetland fishermen have knowledge that could be used to assist the successful management of the shellfish stocks. These interviews plus the views expressed by respondents to the questionnaires showed that fishermen have a keen desire to conserve the shellfish resource in this area and are willing to suggest and comply with conservation regulations and restrictions. However, confidentiality remained a problem throughout the study. Although it is informative and beneficial for the local economy and fisheries management to include fishermen in the management of the fishery, it is crucial that clear objectives are set when undertaking studies of this nature. Although a fisheries scientist was present at some of the personal interviews within this programme, we highly recommend that a qualified fisheries scientist should be present for all interviews in future programmes because they have the necessary training to clarify and pursue relevant

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information. We also suggest that future programmes might incorporate follow-up telephone interviews to particular “experts” identified during the main interview programme, as in the Newfoundland study (Neis et al., 1999b).

Holistic management will encourage equality of opportunity in terms of access to the resource whilst also providing equality of access with respect to individuals, sectors and regions. It will devolve responsibility to local or regional organizations, where appropriate, and protect the interests of fisheries dependent communities such as Shetland, and preserve the rights of minorities with distinctive cultural values.

PROJECT N° 98/098: COLLECTION OF BIOLOGICAL DATA FOR STOCK ASSESSMENT IN SUPPORT OF THE COMMON FISHERIES POLICY

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SUMMARY

The aim of the project is to provide biological data for fish stocks exploited by UK vessels required by international working groups and other ad hoc meetings in support of the CFP. One of the main objectives of the EU's Common Fisheries Policy remains the conservation of exploitable marine resources, so that they continue to provide a sustainable yield to Member States' fisheries. In order to achieve this, it is necessary to be able to monitor the state of the various stocks of commercially important species and to provide advice on their management. This study describes the work carried out by CEFAS to collect biological information on some 20 commercially exploited finfish species using port-based sampling together with commercial and research vessel catches at sea.

Objectives of the study

- To collect length and age based biological data for annual assessments;
- To carry out age determination of TAC species using appropriate methods;
- To provide fishery-independent estimates on the abundance of prerecruit and recruited commercially important finfish.

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**PROJECT N° 99/003: BELGIAN FISH SAMPLING PROGRAMME
AND ASSOCIATED ACTIVITIES IN SUPPORT OF THE COMMON
FISHERIES POLICY**

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SUMMARY

The main objective of this project is to provide ICES and the EU with scientific information for setting annual TAC's. This project also assures the continuation of the existing Belgian sampling programmes on several fish stocks. Viz. Sole, plaice, turbot and brill in the North Sea, Eastern Channel, Celtic Sea, Irish Sea and Gulf of Biscay, and cod, whiting and haddock in the North Sea. Fishery dependent and independent data on length, number and weight at age of the several species are gathered for the period 2000-2001.

PROJECT N° 99/032: THE SWORDFISH FISHERY IN THE MEDITERRANEAN

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SUMMARY

Fisheries data for swordfish were collected from the main Greek, Italian and Spanish fleets exploiting mostly the northern part of the Mediterranean Sea. Data were collected from the main landing ports of the area and included catch and effort statistics and size measurements of a representative number of landed fish. The main objective of the project was to estimate production, abundance indices and the size distribution of the catches. The data collection scheme covered the period April 2000 — December 2001. Taking into account that very few fishing activities for swordfish are carried out in winter it was considered that the collected data allow comparisons among years.

Results indicated that swordfish is mainly exploited by surface long-lines and driftnets. Long-lines were used all over the studied area while the driftnet fishery was mainly exploiting the Tyrrhenian Sea and, to a less extent, the western Ionian. The total production of the studied area was 6210 mt in the year 2000 and 4625 mt in 2001 (production estimates from the western Mediterranean are not included for 2001). Long-line landings represent about 70 % of the total production.

The mean nominal CPUE indices for the long-line fishery ranged from 64.39 kg/1000 hooks (Adriatic), to 201.1kg/1000 hooks (E. Ionian) in 2000, and from 41.54 kg/1000 hooks (W. Ionian) to 186.89 kg/1000hooks (E. Mediterranean) in 2001. For the driftnet fishery the CPUE index ranged from 4.41 to 11.2 kg/km and the higher indices were estimated for the Tyrrhenian Sea fishery.

Catch Per Unit Effort (CPUE) indices were standardised by means of Generalised Linear Modelling (GLM) techniques to examine spatio-temporal effects. In the case of the eastern Mediterranean and Tyrrhenian Sea fisheries data that were compiled within the frames of the 98/034 Study project entitled "Analysis swordfish fisheries data in the Central and Eastern Mediterranean" were also included in the standardisation.

Annual standardised CPUE rates did not show any consistent global trend. However, a locally smoothed line fitted to the scaled standardized indices, suggests that a decreasing trend may exist in the last 3-4 years. Generally, the situation seems to be better in the eastern Mediterranean.

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Mean lengths of fished animals ranged from 98.6 to 138.2 cm for the long-line and 133.9 to 152 cm for the driftnet fisheries. Regarding the long-line fishery, in 2000 the majority of the landed animals had a lower jaw fork length less (LJFL) less than 120 cm in the W. Ionian, Adriatic and W. Mediterranean regions (69 %, 47 % and 94 % respectively). Such percentage was much lower in the Eastern Mediterranean, E. Ionian and Tyrrhenian seas (19 %, 32 % and 27 %, respectively). In 2001, fish with LJFL less than 120 cm were much more common in all areas (W. Ionian 73 %, Adriatic 61 %, Tyrrhenian 78 % and W. Mediterranean 94 %) except of Eastern Mediterranean (19 %) and E. Ionian (39 %) W. Ionian, Adriatic and W. Mediterranean regions (69 %, 47 % and 94 % respectively). Such percentage was much lower in the Eastern Mediterranean, E. Ionian and Tyrrhenian seas (19 %, 32 % and 27 %, respectively). In 2001, fish with LJFL less than 120 cm were much more common in all areas (W. Ionian 73 %, Adriatic 61 %, Tyrrhenian 78 % and W. Mediterranean 94 %) except of Eastern Mediterranean (19 %) and E. Ionian (39 %). The driftnet landings were composed of generally bigger animals and fish less than 120 cm ranged from 10-27 % and 50-72 % in the Tyrrhenian and W. Ionian seas respectively.

PROJECT N° 99/052: MARKET SAMPLING OF DUTCH LANDINGS OF COMMERCIAL SPECIES

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SUMMARY

The biological market-sampling programme provides, together with the information from the assessment surveys by research vessels, the information, which is essential for relating changes in the fish stocks to changes in the fishery. The market sampling programme comprises the collection of fish samples from commercial catches, the analysis of these samples (estimation of length, weight, sex, sexual maturity and age), and the conversion of the national catches in tonnes to age compositions in numbers together with the additional information on mean weight at age, mean length at age, etc. In a later stage, this information by country is combined to figures representative for the whole fish stock. These combined international data, collected over many years, form the basis for population dynamic analyses and for providing biological advice on fishery management.

The age of a fish is determined from the otoliths (ear bones) taken out of the head. Because of seasonal changes in growth (food availability, spawning) ring structures are formed in the otolith similar to the ring structures that can be seen on transverse sections of a tree. Age determination is important because from the annual age compositions, the annual increase in length and weight can be traced. This allows a quantification of important processes such as growth, recruitment of new age groups, mortality etc.

This study contains information on the biological sampling for the market sampling programme: which species are sampled, what gear is used, when and where the samples are taken (date and position), how many fish have been measured, how many fish have been aged, etc. The study gives an overview of all the biological sampling activities during the period 2000-2001 by RIVO on the landings of the commercial important species of herring, mackerel, horse mackerel, sole, plaice, cod, whiting, blue whiting, greater argentine and different species of rays from all the areas where they have been exploited by the Dutch fleet.

The sampling targets for age sampling have been reached in 2000 and 2001 for all species, except for the pelagic species mackerel/herring/horse mackerel in 2000. The targets for length sampling have been reached for cod and whiting in 2000 and 2001.

In addition this study contains information on the biological samples collected during research vessel surveys both from commercial and non-commercial species.

PROJECT N° 00/037: SAMPLING OF GERMAN COMMERCIAL FISHERIES

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SUMMARY

The study enhances sampling of assessment relevant data from three groups of German fisheries in the North Atlantic. It provides age- and length compositions of commercial catches and estimations of discards and by-catch of round- and flatfish fisheries in the North Sea, redfish fisheries in the Irminger Sea respective off Greenland as well as pelagic fisheries in the North Sea and waters west of Great Britain. The pelagic fisheries on mackerel and Blue whiting are observed as clean fisheries during the course of this study. The fishery on oceanic redfish in the Irminger Sea is almost completely clean. There is practically no discarding of redfish. In the North Sea beam trawl fisheries on flatfish and cod produce discard and by-catch levels of concern. The plaice fishery during this study produced less discards than in previous years. Investigations on the precision of the used sampling method on board of beam trawlers are urgently needed. In the sole fishery the target species never reached more than 19 % in terms of weight in the catches. The trawl fishery on saithe is characterized by many by-catch species but with low proportions in catch weight. In the trawl fishery on cod during this study cod discards reached 32 % in terms of numbers and was compared to recent years moderate.

Sub-domain 2.2:

Discard Sampling and analysis

PROJECT N° 97/024: RÉDACTION D'UNE PUBLICATION SUR LES REJETS ET LES PRISES ACCESSOIRES DES NAVIRES DE PÊCHE COMMUNAUTAIRES OPÉRANT DANS LE NE ATLANTIQUE

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SUMMARY

1. The objective of this report is to present a literature review of the scientific publications on discards of Community fishing vessels operating in the North East Atlantic.
2. The problem of bycatch and discards is of paramount importance for the European fisheries, as it is for a number of other fisheries throughout the world. Fishing vessels develop a fishing pressure on target species, but also catch significant amounts of other marine species either marketable (species having a market and legally caught), or non marketable (no market, illegal fishing or undersized). In the first case, there is no waste of resource, while in the second case, species discarded — virtually all dead or injured — are a net loss for the ecosystem. Knowledge of the magnitude of the amount discarded is also important from a fisheries assessment perspective since the relevant information must be entered into the forecasting models on the evolution of the exploited stocks.
3. The European Commission acknowledges the problem and foster research on bycatch and discards in the various fisheries (Atlantic and Mediterranean). About 40 specific research projects on bycatch and discards have been selected for co-funding since 1978. A literature search reveals that there are nearly 140 scientific references on this topic in the waters of the North East Atlantic. A number of international workshops have been organised to try to check the status of the situation and discuss on schemes that would lower the amount of fish discarded. A large number of references are therefore available.
4. A review of the available literature allow to gather relevant information on some fisheries of the Norwegian Sea (shrimps), the North Sea (Nephrops, shrimps, whitefish, pelagic fish), of the English Channel (various artisanal fisheries), of the Bay of Biscay and the North of the Iberian Peninsula (Whitefish, pelagic species). The review of the literature available for each fishery is detailed in this study report, and provides interesting information on the discard rates estimated after research surveys, as well as on species discarded. In most cases, the studies show that discards include very often the target species of the fishing vessels (fish undersized, damaged) but also commercial species not targeted by the said vessels, but also commercial species which are targeted by other fleet segments at later stages.
5. As regards the technical and regulatory tools available to diminish the volumes discarded, the study shows that there are solutions but that it can be difficult to apply them to the Community fisheries which are often multispecific. The technical measures such as square mesh panels escape grids, mesh size increases are already enforced, or are about to be. Some measures have demonstrated some immediate results on discards with limited impact on fishermen revenue. However, there are still some controversies on the actual efficiency of some devices. As regards management, some measures appears to be efficient (seasonal closures of some

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fishing areas for example) but they are more linked to a general framework of reduction of fishing effort on certain stocks.

6. One of the findings of the study is that the various scientific works are not readily comparable, which renders a comparison between fleet segments and fisheries difficult. There are significant variations in the methodology and in the analysis which lead to different concepts of discard rates. In addition, a large number of studies focus on a specific segment of a given Member States when the fisheries are international and involve a variety of gears.

PROJECT N° 97/044: ANALYSIS OF TRAWL'S DISCARD OPERATION IN THE CENTRAL AND EASTERN MEDITERRANEAN SEA

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SUMMARY

The present study is the third of a series of three projects in which data were collected on a regular basis to estimate discard rates in the Central and Eastern Mediterranean trawl fisheries. The sampling procedure of the present project covered two years of sampling (Autumn 1998 to Winter 2000), three seasons in each year (Autumn, Winter and late Spring- early Summer) and six areas (Porto Palo area, Strait of Sicily, Western Ionian sea, Eastern Ionian sea, Cyclades Isles and Thracian sea). The hauls were performed routinely in the above-mentioned areas and covered three strata (stratum A: 0-150 m, stratum B: 150-300 m and stratum C: >300 m). Furthermore, five years of data collected from the present as well as in two previous projects, using the same schedule of sampling, are also presented and analyzed, in the present report. The commercial vessels used were selected are representative of the fleet of each area.

In the trawl fishery, the discard rate varied between hauls, days, areas and seasons, reflecting the differences in local market demand and species composition. The yield of totally discarded species as well as the discarded fraction of the marketable yield were estimated for each haul. The seven most important marketable species were monitored separately (target species: *Merluccius merluccius*, *Mullus barbatus*, *Mullus surmuletus*, *Pagellus erythrinus*, *Parapenaeus longirostris*, *Aristeus antennatus* and *Aristaeomorpha foliacea*). These species constitute the main targets of commercial trawling, presenting a high commercial value and exhibiting a relatively high abundance in the catches of trawlers. The percentage of discard yield varied between 4 % and 90 % of the total yield, while the target species usually contributed about 35-40 % to the marketable yield.

The sizes where 50 % of specimens were discarded (L50) were estimated for the target species. The L50 seems to be a valuable tool to use in the estimation of the discarded fraction of each species from the landings (marketable fraction).

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The main difficulty in monitoring commercial trawls is that each haul covers a great range of depth, corresponding usually to more than one depth strata that consequently reflect changes in the fauna and in the size of fish. A system of classifying functions was estimated for use in the classification of any new observations in the aforementioned clusters. This post-classification was more reasonable for the estimated discard yield. The discarded yields as well as the species composition varied with depth thus the hauls were grouped in two clusters according to their minimum depth. The discard yields of the target species, as well as the discard yields of the taxonomic categories, were correlated with the corresponding marketable yield. The correlations were high in each cluster due to the different bathymetric distribution of each species, as well as due to the trend of smaller fish to be found in shallower waters. The cluster of shallower hauls is characterized by a high number of crustacean species, while the deeper ones is characterized by a low target discard yield. The high variability of the results underlines the importance of monitoring discarding for stock assessment purposes.

PROJECT N° 97/065: DISCARDS FROM THE ADRIATIC SMALL PELAGIC FISHERY

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SUMMARY

Within the northern and central Adriatic Sea, the major fishery by far is for "bluefish", i.e. anchovies (*Engraulis encrasicolus* L.) and sardines (*Sardina pilchardus* Walb.). The fishing gear used are two: midwater pelagic pair trawls (volante) and purse seines, which use light as attraction (lampara). Because the two species are often mixed in shoals, the fishermen usually are not able to distinguish the species composition of these shoals. Due to the very different market price of the two species, sardines are often discarded directly at sea. Sardine catches were at their highest between 1981 and 1985, at around 80,000 tons, after which they have fallen steadily and in 1999 the sardine catches were about 19,000 tons. Information collected by IRPEM on pelagic stocks of anchovies and sardines in the Adriatic Sea include fisheries and biological data, generally from 1975 to date.

An observation programme was set up in the four investigated ports (Chioggia, Porto Garibaldi, Ancona and San Benedetto), due to the variability of the sardine discarding at sea. In addition to that, logbooks were distributed to fishing vessels. Data collection was supplemented with historical data concerning market quantities and prices.

The exploratory data analysis tools of Microsoft Excel and especially S-Plus software packages were used extensively. When attempting to quantitatively assess the influence of the various factors and interactions amongst them, tree models in S-Plus were found particularly useful. Finally, the Bayesian statistical analysis package WinBUGS proved invaluable.

Substantial discarding was identified for vessels operating from Ancona (30-80 %), moderate discarding for vessels operating from Porto Garibaldi (around 50 % of sardines caught with lengths less than 16 cm), and very little if any from the other major Italian Adriatic ports. The reported evidence suggests that there is at most negligible discarding at Chioggia. One can conclude that no significant discarding of sardines occurs at San Benedetto because the sardines from lampara gear tend to be large and thus highly marketable.

The primary method used here for estimating sardine stock abundance is Virtual Population Analysis (VPA). Another approach, IRPEM and MRAG have used since 1992 for sardine stock assessments, is to fit an "ad hoc" DeLury depletion model to catch and CPUE data.

The assessments corrected with estimates of historical discards indicate that the mid-year sardine stock biomass rose steadily from around 400,000 tons in 1975 to a peak of around 950,000 tons in 1984. After that, the biomass declined steadily, with current levels being around 300,000 tons. Current catches are around 20,000 tons, down from the peak levels of 80,000 tons in the first half of the 1980s. The mean ratio between catch and spawning biomass estimated by VPA is around 0.20, and the current ratio is around this value.

PROJECT Nº 97/087: ANALYSIS OF FISHERIES DISCARDS FROM THE SOUTH COAST OF PORTUGAL (DISCARDS — PORTUGAL II)

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SUMMARY

Knowledge of discarding practices and discard rates is of considerable importance for stock assessment and management of fisheries. Estimation of fishing mortality rates is fundamental for stock assessment and the formulation of sound scientific advice. Ideally, estimation of fishing mortality should take into consideration discards. Lack of discard data, or errors in data can cause mortality estimates to be inaccurate.

Discarding rates are known to be high and variable in many fisheries, and stock assessment for such fisheries are likely to be significantly in error if data on discards are not taken into account. Since many highly variable factors can affect discarding, the routine monitoring of discarding is recommended for stock assessment purposes. The monitoring of discards also helps in the assessment of technical measures under the Common Fisheries Policy, and of the ecological effects of discarding.

This study presents the results of a two-year study (February 1998 to January 2000) in which the discards were not only quantified, but the discarded species were also identified and some of their biological parameters were studied.

The data collection methodology has been the direct method: observers on board of commercial boats. Observers went out on the fishing boats and recorded all the information concerning the fishing boat (characteristics, crew and gear, catch storage capacity, etc.), target species, trip duration, and location (longitude, latitude and depth) of the fishing area. Reasons/causes for discarding were recorded for each fishing operation. All data collection was carried out by fishing operation.

The sampling effort in this study involved 25 fishing boats, (5 crustacean trawlers, 3 fish trawlers, 7 demersal purse seiners and 10 pelagic purse seiners), 74 fishing trips and 166 fishing operations (hauls/sets)

Of a total of 240 species identified from all taxa 67 % were always discarded, 29 % frequently discarded and only 4 % were occasionally discarded. However, less than half are commercialised (33 %).

Concerning discards, fish trawl and crustacean trawl were the métiers with the highest discard rates (59 % and 43 %, respectively), while purse seines showed the lowest — 3 % for pelagic purse seine and 7 % for demersal purse seine.

The commercial species that was discarded in greatest quantity for all métiers was the chub mackerel (*Scomber japonicus*) followed by the bogue (*Boops boops*). However, differences were found for the different métiers: for crustacean trawl, blue whiting (*Micromesistius poutassou*); for fish trawl, chub mackerel; for pelagic and demersal purse seine, bogue.

Results of the application of the different multivariate analysis techniques suggest that despite some overlap in species, these métiers differ significantly in terms of species composition, diversity and catch per tow/set. Depth is probably one of the most important factors contributing to the observed differentiation and groupings.

The main reasons for discarding in Algarve are economic (low or non-commercial value, for which there is no readily available market) and legal/administrative (minimum sizes, catch percentages). Less often, technical restrictions are also applied (storage capacities limitations; lifting weight limitations of the crane).

PROJECT N° 97/098: MONITORING OF SCOTTISH LANDINGS AND DISCARDS FROM THE NORTH SEA

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SUMMARY

During the course of the contract at least 719,320 demersal and pelagic fish were measured from Scottish vessels operating in the North Sea. For the majority of species the sampling level is fairly consistent from one time period to the next. Fluctuations in sampling do occur for the pelagic fisheries but these are merely a reflection of the seasonal nature of these fisheries. For example, the herring fishery runs primarily from June to September whilst the main mackerel fishery is from October to January or February.

Whilst the information on length frequencies is useful, of more importance is the transformation of these data into numbers at age. To achieve this objective 71,763 otoliths were read in the first 21 months of the contract with the subsequent construction of the necessary age/length keys. The latter were applied to the appropriate length keys using in-house Scottish protocols and outputs obtained for the numbers of fish at age, mean length at age etc. Scottish procedures allow these outputs to be produced for any combination of time/gear/area. However, for the sake of expedience the outputs included in Appendices 1-16 are limited to a summary by Total North Sea/all Gears for either 1998 or 1999. Data for January-March 2000 have not yet been processed.

Assessments of Nephrops are length based and during the period April 1998 — December 1999 2.9 tonnes were measured at the markets and 94,418 animals measured and sexed. All these data were processed and loaded into the institute's data base. Appendices 17-22 illustrate specimen outputs of quarterly length frequencies for some of the North Sea functional units in either 1998 or 1999.

The data gathered has been provided to a number of ICES Working Groups which include:
North Sea Demersal Working Group
Herring Assessment Working Group
Nephrops and Pandulus Assessment Working Group
Mackerel Assessment Working Group

The Working Groups have combined the Scottish data with similar data from other European institutes and used the combined data to undertake stock assessments on the relevant species. The results from the Working Groups have been presented to the Advisory Committee on Fishery Management (ACFM) and to the European Commission's own advisory body, the Scientific, Technical and Economic Committee on Fisheries (STECF).

**PROJECT N° 97/103: CREATION OF A SCOTTISH MULTISPECIES
DISCARD DATA BASE**

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SUMMARY

In any assessment of the multi-species data it must be remembered that the information is sparse as it is based on an average of 80 trips per year. Restrictions of staff and finances mean that this number is unlikely to be exceeded in the near future. Thus any data produced may be skewed by observations from an atypical observed trip. Nevertheless, this information is almost unique in northern Europe and offers fishery scientists the most complete view yet of the discard practices of the fishing fleets. It is expected that the data will make a significant contribution to a variety of questions posed in relation to fisheries and the environment.

PROJECT N° 98/081: THE EFFICACY OF RELEASING CAUGHT NEPHROPS AS MANAGEMENT MEASURE

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SUMMARY

Nephrops norvegicus, the Norway lobster, is one of the most important species for the trawling fleet catching crustaceans on the South and Southwest coasts of Portugal. In recent years the catches have decreased dramatically reaching levels one order of magnitude lower than catches in the mid 1980's. This same fleet also targets two other species, one in shallower grounds than *Nephrops*, the shrimp *Penaeus longirostris*, and another in deeper grounds, the red shrimp *Aristeus antennatus*.

Previous approaches to defining measures to protect *Nephrops* have emphasized the complete halting of the fishing activity during part of the year. This would bring enormous losses to the industry that would be stopped from fishing, not only *Nephrops*, but the other target species as well.

The objective of this work was to investigate the potential effect on the *Nephrops* population of a management measure that allowed fishing the shrimp species but that forced caught *Nephrops* to be returned to the water. Such a measure would only make sense if the *Nephrops* that were released survived.

To start with, there was information on survival rates of approximately 40 % for areas in the North Sea and Bay of Biscay. There were doubts if survival rates would be significant off the Portuguese coast, since *Nephrops* are found between 200 and 600 meters, at much greater depths than the ones of the populations where the other survival studies were undertaken. A previous mark-recapture study, with a recovery of 1.3 % of marked lobsters indicated that some individuals survived, but no estimates on survival rates were available.

It was the objective of this project to estimate the survival rates of released lobsters and to understand the potential effect such a measure would have on the recovery of the *Nephrops* stock.

Experiments were carried out by placing lobsters caught in commercial trawls in cages and putting them back on the bottom. After around 5 days the cages were lifted and the survival evaluated. The findings suggest that survival is independent of sex, size, or ovigerous condition. The time of the year strongly affected survival with survival rates higher in cold months (48 %) than in warm months (31 %). Considering that catches are much higher in warm months due to behavioural cycles of the species, an overall survival rate was estimated considering season and catch distribution. The value found was 35 % survival.

A simulation of the population indicated that a release policy would be important in the recovery of the resource. As an example let us consider a situation where fishing removes 72 % of the population (in numbers), and with 10 % natural mortality, resulting in survival of only 18 % of the individuals. This corresponds to an instantaneous fishing mortality rate of 1.5 and a natural mortality rate of 0.2, values likely to be close to the present situation of the stock studied. A release policy would increase survival from 18 % to 44 %. This increase in survival is higher at high fishing effort and more moderate with lower fishing efforts, but this is a measure that only makes sense in situations where the stock is overexploited, and is therefore at high levels of fishing effort. In conclusion, a management policy not limiting the fishing activity but forcing the release of caught lobsters would allow the operation of the fleet and the recovery of the resource.

PROJECT N° 98/095: MONITORING OF DISCARDING AND RETENTION BY TRAWL FISHERIES IN WESTERN WATERS AND THE IRISH SEA IN RELATION TO STOCK ASSESSMENT AND TECHNICAL MEASURES

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SUMMARY

Western Waters fisheries face major challenges in relation to the depleted state of the fishery resources and in implementing the adjustments required to bring exploitation of these resources on to a more sustainable basis. Fisheries assessments, as carried out by ICES working groups, use data from market sampling of the landed catch, reported landings and effort figures and also research vessel data to assess the state of fish stocks and to produce short term forecasts for setting Total Allowable Catches. Since the discards may constitute a significant source of extra mortality in some fisheries there is clearly a requirement to adequately describe the levels of discarded fish in order to improve stock assessment and the likelihood of sustainability. In deciding a strategy for improved sustainability there is also a requirement to understand the factors motivating the fishers to target and retain, or discard, fish of a given species and to relate this to the current management and market situation. This, and stock assessment information, could be used to guide research into the most appropriate technology and measures to reduce discarding and hence place the harvesting of these stocks on a more sustainable basis.

The project studied the pattern of discarding and retention, using an onboard observer programme, in the main demersal trawl fisheries of the participating nations' in Western Waters (ICES Divisions V1a,b VIIa,b,c,e(western part), f,g,h and k and from VIIIa,b,c,d and IXa) and describes the use of these data in ICES stock assessments. It assessed the feasibility of using these data to understand the economic aspects of discarding and retention, to assess the impact of technical measures and investigated the effects of trawling on ecosystems.

Data on discarded megrim from Spanish Baka trawlers were used in the assessment of the Northern Stock of this species at the ICES Southern Shelf Demersal Working Group. These results show that including discard data in the assessment improved the description of the strength of incoming year classes, growth and spawning stock biomass. The impact of technical measures designed to reduce discarding was assessed by examining the effect of

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the implementation of EC regulation 850/98 on Jan 1st 2000. In the midwater demersal trawl fishery in the Irish Sea there was a reduction in the catch per effort of discarded. For the baka trawlers exploiting megrim in Sub areas VI and VII there was a change in the discarding practices. Discarding and retention is discussed in relation to economic factors and the exploitation pattern. Possible changes in some métiers were suggested but the very Mixed nature some of the fisheries means that what is selective for one species could result in the loss of economically important catch of other species. It was found that discarding practices were most closely related to economic values, which were a stronger influence than fishery management measures. Measures which are designed to reduce discarding without taking into account market forces, are unlikely to succeed. Limited studies of the impact of technical measures were carried out by developing a model designed to predict the returns which could be obtained by improving selectivity, but these were intended only to develop the model not to use it on Western Waters fisheries during this project.

PROJECT N° 98/097: MONITORING DISCARDING AND RETENTION ON FISHING VESSELS TOWING DEMERSAL GEARS IN THE NORTH SEA AND SKAGERRAK

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SUMMARY

The objectives of this project were to estimate discarding and retention of the commercial fish species caught by towed, demersal gears, primarily otter and beam trawlers, in the North Sea and Skagerrak. A sample survey of fishing vessels using sea-going observers was carried out within Sweden, Denmark, Germany, the Netherlands, Belgium, and England. Norway's participation was severely reduced by restrictive quota for saithe which prevented many Norwegian vessels from fishing in the North Sea.

Random selection of vessels was difficult to implement in some countries for practical and political reasons. Nevertheless, 154 trips were made in the North Sea and 65 in the Skagerrak, amounting to sampling of approximately 0.25 % of all towed-gear effort.

Estimates of discarding were made by raising quantities discarded on each trip in relation to fishing hours. The report includes a CD with estimated total weights, numbers-at-length, and numbers-at-age discarded and retained for the principal commercial species, namely

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cod, haddock, whiting, saithe, plaice, and sole. The data files are available for use by the stock assessment working group, or others, and from the ICES public access web site. Discarding data for other species were also collected during the sampled trips. They are archived nationally and may be of use for ecological studies, e.g. by the ICES working group on ecological effects of fisheries.

A second part of the project was a review of stock assessment data and methods in relation to discarding data. Among many conclusions, the XSA method was found to be vulnerable to errors caused by inclusion of discarding data because the method assumes that the VPA component is exact. Cohort curves were recommended as a better method for estimating stock parameters because they are founded in well-established statistical theory and offer a readily understood picture of the state of the stock.

**PROJECT N° 99/068: MONITORING DISCARDING AND RETENTION
OF THE DANISH GILLNET IN THE NORTH SEA AND SKAGERRAK**

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SUMMARY

The aim of the project is to improve the collection of catch data from commercial fishing vessels operating gillnet in the North Sea and Skagerrak in order to get a more complete description of the fishing pattern in the area. The data are used as input for fish stock assessment in the area.

Further more it is the aim to try to indicate a model, which is able to describe the discard pattern in the gillnet fishery.

Observers collect the data while they are on board the Danish vessels during normal commercial fishery. The observers are employed at the Danish Institute for Fisheries Research (DIFRES).

The observers collect all relevant information concerning the fishery including catch weight per species (separated into landing- and discard part), length distributions, gear and haul information, etc.

An description of the results shows a great variability between trips and between fisheries, which makes it difficult to outcome reliable estimates of total discards. It appears that the minimum landing size (MLS) is by far the main reason to discard for target species and valuable by-catch. The pattern for other by-catch is less clear.

PROJECT N° 99/071: IPDEN — INVESTIGATION OF PELAGIC DISCARDING — EXTENT AND NATURE

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SUMMARY

The aim of the project is to improve the collection of catch data from commercial fishing vessels operating gillnet in the North Sea and Skagerrak in order to get a more complete description of the fishing pattern in the area. The data are used as input for fish stock assessment in the area.

Furthermore it is the aim to try to indicate a model, which is able to describe the discard pattern in the gillnet fishery.

Observers collect the data while they are on board the Danish vessels during normal commercial fishery. The observers are employed at the Danish Institute for Fisheries Research (DIFRES).

The observers collect all relevant information concerning the fishery including catch weight per species (separated into landing- and discard part), length distributions, gear and haul information, etc.

An description of the results shows a great variability between trips and between fisheries, which makes it difficult to outcome reliable estimates of total discards. It appears that the minimum landing size (MLS) is by far the main reason to discard for target species and valuable by-catch. The pattern for other by-catch is less clear.

Key words: Scientific observers were placed onboard Scottish and Norwegian pelagic fishing vessels during the herring and mackerel fisheries between June 2000 and May 2002 to collect information on the extent and nature of discarding in these fisheries. These fishing vessels were of two types, purse-seine netters and pelagic trawlers, and were operating in ICES sub-areas IVa and VIa. The observers recorded information on the size and distribution of catches, and on the frequency, magnitude and causes of discarding. Basic fisheries data on the length, sex, maturity and age of the retained and discarded fish was also recorded.

Some discarding was observed to occur in most hauls due to wastage, i.e. fish remaining meshed in the net or being spilled on the deck while the catch was being pumped onboard, although amounts were generally small. Larger quantities of fish were discarded less frequently, usually because the quantity caught was too small or because the quality of the fish (i.e. their average length) was not suitable for the processors.

In the herring fishery observations were made on a total of 222 hauls during 223 days at sea. Although the fishery occurred in ICES sub-areas IVa and VIa the majority of the fishing activity and therefore the sampling was carried out in sub-area IVa. Discard rates were found to vary over time, between different areas, and in some instances between different types of fishing gear. The overall discard rate averaged 4.2 % by weight. The composition of the discards was influenced by the numbers of smaller, one year old fish. Observations were made on approximately 8 % of the total catch.

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For the mackerel fisheries observations were made on a total of 213 hauls during 338 days at sea. Discard rates again varied over time, between different areas, and between different types of fishing gear, with an overall average rate of 7.3 % by weight. Younger age classes were a significant component of the discarded fish. Overall observations were made on approximately 8 % of the total catch but this varied with area.

Although observations were made on only a proportion of the total catches there was nothing to suggest that the practices of the sampled vessels were not representative of the rest of the fleet.

**PROJECT N° 00/009: ESTIMATION OF TRAWL DISCARDS
IN THE WESTERN MEDITERRANEAN. EUROPEAN HAKE
(MERLUCCIIUS MERLUCCIIUS) AS CASE STUDY**

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SUMMARY

The aim of the project has been the assessment of the discards by the trawl fleets in the western Mediterranean. Discard refers to that part of the gross catch thrown back into the water by fishermen. The study has focused on the European hake *Merluccius merluccius* because it is one of the main target species for trawling and the fact that it was known to be partially discarded.

Field work has been conducted in five fishing ports located in the western Mediterranean, from the northern Tyrrhenian sea to the Gulf of Lions, coasts of Catalonia and Valence, and Balearic Islands. The duration of the sampling has been six months, from February to July 2001. Data collection included sampling on board commercial trawlers, examination of the discard samples in the laboratory, and data on the trawl fleets and landings in the study ports.

The more relevant result to the management of the European hake is that discards can represent a significant part of the total European hake catch both in weight and in number. It is thus necessary considering them in the evaluations to assess the state of exploitation of *M. merluccius* by trawling.

The monthly length frequency distributions in all five study ports show that most part of the European hake catch consists of immature individuals. Nevertheless, the proportion of the catch and sizes that are discarded can be very different, as observed when comparing the different study ports. The percentage of discarded European hake during the six-months sampling ranged between less than 1 % and more than 70 % of the total individuals caught, depending on the month and port; as for the European hake discards expressed as percentage of the total hake catch, it ranged between less than 1 % and 30 % of the total *M. merluccius* catch.

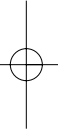
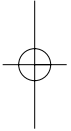
Hake trawl fisheries impact over the benthic and epibenthic communities of the continental shelf and upper slope, as highlighted by the number of species identified during six-months sampling on board commercial trawlers (for example, 319 only in one of the study ports). The vessels targeted to *Merluccius merluccius* include other species in their objectives. The number of species caught by trawl that are commercialised is also high, around 90 in three of the study ports. Within the study ports, on average during the six-months sampling, the amount of discarded catch ranged between 17 % of the total catch and 34 %. The main

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reason for discarding part of the catch is the low or nil commercial interest of the discarded species. In general, the incidence of discards in species with commercial interest is low.

Significant changes in *M. merluccius* abundance have been observed from month to month. Therefore, sampling frequency of this study, monthly, 3 days at sea so as to minimize the effect of autocorrelation of the hauls performed during the same day, seems to have been adequate to detect the changes in hake abundance.

When there is an active European hake discard as observed in one of the study ports, both the total European hake catch and time of the year have a significant effect on the amount of discarded hake. The highest hake catches and discards corresponded to the time of the year with more intense recruitment of European hake to trawling. This result is important when considering the possibility of closed seasons for trawling.



Sub-domain 2.3:

Catch and effort

**PROJECT N° 97/018: ANALYSIS OF THE MEDITERRANEAN
(INCLUDING NORTH AFRICA) DEEP-SEA SHRIMPS FISHERY:
EVOLUTION, CATCHES, EFFORTS AND ECONOMICS.**

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SUMMARY

The project assesses the true status of basic data on catches, effort, and economic significance of the deep-water shrimps (*Aristeus antennatus* — rose shrimp —) and *Aristaeomorpha foliacea* — red shrimp —) fisheries over the entire area of exploitation. The study area encompasses the Mediterranean (coasts of Spain, and Italy) and adjacent areas of the Atlantic (Algarve, Portugal), including North Africa (Tunisia, Algeria, Morocco). It represents a first opportunity for simultaneous and comparative co-operation with the countries of North Africa. COPEMED (FAO) agreed to fund the corresponding part of the study in North Africa. A total of 31 ports around the Western and Central Mediterranean were sampled. The collected data are: catch (biomass) and fishing effort data for the target species (*Aristeus antennatus*, *Aristaeomorpha foliacea*), the species composition and abundance (biomass) catch data for the major by-catch species, the seasonal size-frequency distributions of the target species, the location of the main fishing grounds in each subsector of the study area throughout the year, and the economic aspects of the fishery, costs and benefits. The primary purpose of the methodology employed was more to collect qualitatively accurate data than quantitative data per se, with a view to being able to put forward advisory and management strategies based on reliable information. Visits by observers to the fishing ports for purposes of sampling were conceived as a method of validating/calibrating the quality of the data supplied by the skippers through the logbooks and also as a method of collecting first-hand information where logbooks could not be accepted by fishermen. To that end, once or twice a week sampling was performed in the ports considered when the fishing vessels returned to port, to record the size of landings

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together with supplementary information from skippers on the number of hauls, towing duration, fishing locations, etc. in the period just previous to the sampling date. Results indicate that the deep-water shrimps fishing fleet consists of trawlers and multi-purpose vessels equipped with trawl nets. Catch per unit effort data on *A. antennatus* are most abundant for the Western Mediterranean, off mainland Spain and North Africa. High catches of this species in these areas coincide with low catches of *A. foliacea*. Generally the location of rose shrimp (*A. antennatus*) fishing grounds varied seasonally and were located between 400 and 950 m. Spatio-temporal movements are well described in the literature and submarine canyons play an important role as fishing grounds. For each area the fishing ground locations have been described and its concrete location can be found in the data bank. The profit margin after cost coverage is quite low in most ports. The residual amount has to be used to cover financial costs (depreciation and opportunity cost-interests) and, above all, to remunerate the managerial factor. In fact the highest profit margins are recorded in the ports of Almeria, Mazara del Vallo and Villa Real di San Antonio, i.e. where the rose shrimp fishing fleet is managed at industrial level. All collected data are given in a GIS presentation in the attached CD and in a data bank. Along the development of this project on the Mediterranean deep-sea shrimp fishery we faced a general major problem: the difficulty to collect reliable data to characterise the targeted parameters. These referred to a vast array of concepts necessary to deal with the main features of the fishery, and ranged from the amount of catches to the power of the engines or the actual value of landings.

PROJECT N° 97/046: THE SWORDFISH FISHERY IN THE CENTRAL AND EASTERN MEDITERANEAN

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SUMMARY

Fisheries data for swordfish were collected from the main Greek and Italian fleets exploiting the central and eastern Mediterranean Sea. Data were collected from the main landing ports of the area and included catch and effort statistics and size measurements of a representative number of landed fish. The main objective of the project was to estimate production, abundance indices and the size distribution of the catches. The data collection scheme covered the 1998 fishing season and the first semester of 1999.

Results indicated that the swordfish stock is mainly exploited by surface longlines and driftnets. Longlines are used all over the studied area while the driftnet fishery is mainly exploiting the Tyrrhenian Sea and, to a less extent, the western Ionian. The total production of the studied area was 4312 in 1998 and 2058 mt in the first semester of 1999. Longline landings represent about 55 % of the total production.

Catch Per Unit Effort indices were standardised by means of General Linear Modelling (GLM) techniques to examine area, gear, and temporal effects. For the longline fishery the highest standardised indices were computed: (a) for the spring and summer months in the eastern Mediterranean and (b) for the late summer and autumn months for the central Mediterranean. For the driftnet fishery the highest indices were computed for the summer months. Mean lengths of fished animals ranged from 95-143 cm for the longline and 125-127 cm for the driftnet fisheries.

The catch at age analysis demonstrated that in 1998 the main bulk of landings in terms of numbers (about 80 %) was composed of 1-4 year old fish. About 64 % of the animals caught in driftnets and 55 % of those caught in longlines were estimated to be under age 3, which is considered to be the age at first maturity for female animals. These rates generally agree with those reported in the past. Stock estimates made assuming a "steady state" situation, revealed that the present exploitation rate is higher than the optimum but a large degree of uncertainty remains due to the assumptions made.

PROJECT N° 98/027: ON THE APPLICABILITY OF ECONOMIC INDICATORS TO IMPROVE THE UNDERSTANDING OF THE RELATIONSHIP BETWEEN FISHING EFFORT AND MORTALITY. EXAMPLES FROM THE FLAT AND ROUND FISH FISHERIES OF THE NORTH SEA.

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SUMMARY

This project shall develop relationships between fishing effort and fishing mortality for many of the main demersal fishing fleets operating in the North Sea. The keystone of the fishing effort and fishing mortality relationship is the coefficient of proportionality, which is often referred to as the catchability coefficient. Results should provide valuable advice to fishery managers ahead of the next generation of MAGP and necessary background information for discussion of a possible application of effort regulations in the area. Furthermore, the project will give insight into the performance of abundance indicators, derived from commercial catch rates and economic data, for better use in fish stock assessment. The CPUE (Catch per Unit of Effort) is frequently employed as an indicator of stock abundance. Thus, CPUE is often represented as the product between catchability (defined above) and stock abundance. The utilisation of CPUE as an abundance indicator is therefore based on the underlying assumption that the catchability coefficient remains constant over time. However, evidence is accumulating that the catchability of commercial fleets is subjected to increasing trends. Hence, variability in CPUE should be attributed to both biomass and catchability fluctuations. From a management point of view, failing to incorporate catchability fluctuations may result in large bias in the estimation of fishing mortality and stock size. The scope of this project is threefold: To identify temporal variations in catchability, on a fleet level, based on both biological and economic approaches. To incorporate catchability variations into fisheries assessment tools. To evaluate the benefits of applying the new assessment tools to fisheries advice and management.

The first objective of this project will be to distinguish variations in catchability from stock fluctuations. Both biological and economic analyses will be carried out. On the one hand, the biological approach will aim to extract a time signal from catch-and-effort data, which will be associated to catchability variations. Standard statistical and mathematical methods will be applied to identify and model non-stochastic variations in catchability. On the other hand, the economic analysis will model temporal variability in catchability as a function of parameters related to the total amount of labour, capital and energy, which is developed by fishing activities. The economic analysis will more particularly pay attention to the variations in technical efficiency which, in the context of fishery production, may be defined as the ratio between the catchability of a fishery and some ideal or potential production unit.

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The second objective of the project will be to combine the outcomes of both biological and economic investigations and to develop two models describing, (i) the relationship between fishing mortality and nominal effort and, (ii) variations of CPUE in relation to economic inputs, stock abundance and also TACs (Total Allowable Catches).

The third objective of the project will be to apply the CPUE model to, (i) re-assess the stocks and the biological reference points and, (ii) illustrate how this re-assessment affects short- and long-term projections of future stock assessments, management strategies and fisheries investments. The benefits expected from the application of the re- assessment tools, as an alternative to the current assessment procedure, will then be appraised by means of a few performance indices.

The main fisheries that are to be considered are the round- and flatfish fisheries of the North Sea, which mainly exploit cod, haddock, whiting, plaice and sole. The access to the national databases whether through direct participation (DIFRES, RIVO, IMR) or as external assistance (CEFAS, DIAFE (Danish Institute for Agriculture and Fisheries Economics)) is the keystone of this project, and should be seen as a single integrated element.

PROJECT N° 98/045: THE BLUEFIN TUNA FISHERY IN THE EASTERN MEDITERRANEAN

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SUMMARY

Bluefin tuna (*Thunnus thunnus*) is one of the most commercially important large pelagic species and is heavily exploited in the Atlantic ocean and the Mediterranean sea. For the Mediterranean and the eastern Atlantic populations which are considered to form a common stock the scientists of ICCAT have estimated that the fishing mortality rates have increased considerably the last decade. They have also pointed out that a catch reduction is needed to avoid a radical reduction of the spawning stock after some years.

The available data for the tuna fishery in the Mediterranean are very poor mainly due to the large number and various types of vessels involved in the fishery. The situation is even worse in the eastern part of the basin where the tuna fishery is mostly artisanal and there are numerous landing sites. During the latest bluefin tuna stock assessment session the Scientific Committee of ICCAT expressed great concern about the lack of data from the Mediterranean. They pointed out that this makes doubtful any stock assessment and strongly recommended the collection of basic catch and effort statistics. In the past, within the frames of certain research projects financed by the EU, fisheries and biological data for bluefin tuna have been collected from certain Mediterranean areas exploited by the Greek, Italian and Spanish fishing fleets. Through these projects some demographic parameters of the Mediterranean stock have been estimated and the collected data have been utilised for the ICCAT assessments.

The situation in the eastern Mediterranean which is mainly exploited by the Greek fleets has changed the recent years. Typically, the Greek bluefin tuna fishery was carried out on an opportunistic basis but since 1994 has developed rapidly mainly due to the increased market interest. There is no detailed information about the current state of the fishery in which are involved numerous vessels of different type and size using various fishing gears. The fleet is scattered in several ports and there are many landing sites located on the mainland and the islands. There is also information that recent gear modifications in the swordfish fishery have resulted in high by-catches of bluefin tuna which are often discarded at sea, especially in summer, when the market demand is very low.

The main objective of the present project is to collect and analyse fisheries and biological data for bluefin tuna from the eastern Mediterranean sea. Specifically it is suggested the realisation of a sampling program at the major landing ports of the Aegean sea. Data on the bluefin tuna by-catches in the swordfish fishery will be also collected. This task will be assisted by a running project for the swordfish fishery in the control and eastern Mediterranean.

The collected data will serve future stock assessment studies and will help to identify trends regarding the bluefin tuna fishery in the area and the distribution of the resource. The project will also allow: (a) to assess the impact on the bluefin-tuna catches of the already mentioned modifications in the swordfish gear and (b) to investigate the selection pattern of the different gears used.

PROJECT N° 98/053: FACTORS AFFECTING CATCH RATES OF NORTHWEST MEDITERRANEAN TRAWL FLEETS AND DERIVATION OF STANDARDIZED ABUNDANCE INDICES

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SUMMARY

In the Mediterranean groundfish trawl fisheries have traditionally played an important socio-economic role. These fisheries are multispecific, with up to 104 fish species recorded in commercial tows in some areas. Due to their multispecific nature and the large number of landing harbours involved, it has been traditionally difficult to gather long and reliable series of catch and effort data of trawl fisheries for stock assessment purposes.

Based on now available catch and effort data series from a number of western Mediterranean bottom trawl fleets, this study aimed to analyse factors that affect catch rates of hake *Merluccius merluccius*, one of the main target species of these fisheries, and to estimate standardised indices of abundance. Factors affecting catch rates studied were: time (months and years), vessel characteristics as they relate to fishing power (vessel size, GRT, HP and GT), fishing regulations, e.g., closures and geographic area (harbour). Data records contained monthly landings of main commercial species by vessel and number of days fished. The data come from three groundfish fisheries along the Spanish Mediterranean coast (harbours of Santa Pola, Castellón and Barcelona one from south-eastern France (harbour of Sète) and one from northwest Italy (harbour of Santo Stefano). Data from the following periods were used: Santa Pola 1992-1998, Castellón 1991-1998, Barcelona 1992-1998, Sète 1994-1999 and Santo Stefano 1991-1999. Hake catch rates were analysed by generalised linear and additive models applying routines contained in the S-Plus programming environment.

Hake catches consist mainly of recruits, although older age groups are also present and their relative importance varies spatially and temporally. Since hake landings from the fisheries of Castellón and Barcelona lump together recruits and older ages, in order to model hake recruitment indices it was necessary to identify the components of the fishing activity (vessel-months) targeting the O-age group. Multivariate analyses (Principal Components, Cluster, and Multiple Correspondence) were used to identify métiers/fishing

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tactics targeting hake recruits. Models were run with catch rates of the metiers selected to generate standardised recruitment indices.

Results of modelling showed that vessel identity was the main factor affecting hake catch rates. Among the vessel characteristics, size was the best descriptor of fishing power in the selected trawl fleets. Abundance indices exhibited significant inter-annual and seasonal variations and significant but smaller geographic differences. Main effect models were run to compare abundance indices between: a) the 20 metiers identified within the study fleets, and b) the 5 study areas. Models of recruit catch rates were run to compare recruitment indices between a) the 7 metiers identified as representing recruitment within the study fleets, and b) the 4 study areas where recruitment indices could be estimated. Interactions among factors were also analysed. Trends of standardised recruitment indices obtained in this study were consistent with those derived from surveys (MEDITS serie). This result strongly supports the applicability of catch and effort data to assess hake abundance trends.

PROJECT N° 98/061: EFFICACITÉ DES SENNEURS THONIERS ET DES EFFORTS RÉELS

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SUMMARY

Les flottes de senneurs français et espagnols, qui pêchent les thonidés tropicaux dans l'océan Atlantique et dans l'océan Indien, représentent une activité économique d'une valeur proche de 340 millions d'euros. Cette activité industrielle comporte de forts enjeux économiques pour les armements (durabilité de l'exploitation), ou d'ordre social et politique (maintien des emplois directs et indirects, contexte international du code de pêche responsable) pour les administrations nationales et pour l'Union Européenne. Afin de maîtriser une éventuelle sur-capacité de ce secteur par rapport aux ressources thonières disponibles, tout en maintenant une flotte moderne susceptible de subvenir au marché communautaire, il est essentiel de connaître les facteurs qui modifient l'efficacité de pêche de ces navires. En effet, la qualité des diagnostics effectués lors des évaluations des stocks de thons dépend étroitement de la qualité des informations commerciales utilisées. Ces risques d'erreurs sont importants dans le cas de la pêche thonière à la senne, car cette pêcherie se caractérise par une amélioration continue des équipements technologiques servant à la détection des bancs de thons et à leur capture.

Ce projet mené par l'Institut de Recherche pour le Développement (IRD, France) et par l'Instituto Español de Oceanografía (IEO, Espagne) avait donc pour objectif d'analyser l'impact des innovations technologiques sur l'efficacité de pêche des senneurs communautaires afin d'être en mesure d'estimer l'effort de pêche réellement exercé. En dépit des difficultés rencontrées auprès des professionnels lors l'acquisition des données sur la modernisation des navires nous avons essayé de mieux cerner le rôle de chaque appareil au cours des différentes étapes qui caractérisent le processus de pêche (localisation des bancs, coup de senne, etc.).

En raison de la variabilité entre les navires au niveau de l'acquisition de chaque équipement, du chevauchement entre les périodes d'installation des divers appareils ainsi qu'en raison des interactions entre les effets de ces appareils sur les rendements de pêche, il est souvent difficile de savoir ce qui est dû à l'acquisition de telle ou telle technologie. On peut cependant mettre en avant quelques faits majeurs dans cette évolution. Ainsi la puissance de pêche des senneurs a nettement progressé au cours de la deuxième moitié des années 80, lors du passage au système à anneaux ouvrants chez les Français. De manière plus générale, l'intensification des pêches sous DCP depuis la fin des années 80 est un phénomène majeur qui est admis aussi bien par les professionnels que par les scientifiques. Cependant les progrès sensibles n'ont été enregistrés que lorsque les pêcheurs ont été capables d'instrumenter leurs DCP de façon à pouvoir les retrouver facilement à longue distance. Allant de pair avec l'utilisation des DCP, l'appui fourni par les bateaux d'aide à la pêche est aussi une illustration de l'augmentation de l'efficacité des senneurs qui bénéficient de cette aide. Le projet Esther a permis d'acquérir pour la première fois de précieuses informations sur les modalités d'intervention de ce type de navire et d'évaluer l'impact de cette aide sur les rendements des senneurs espagnols.

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L'importance des radars à oiseaux lors de la pêche est reconnue unanimement par les pêcheurs interrogés sur ce sujet. Cet appareil semble agir essentiellement dans la détection des concentrations, puis lors de la sélection des indices potentiellement intéressants. Il évite ainsi au senneur de se déplacer systématiquement sur le lieu de la détection pour vérifier de visu si l'indice est intéressant. Le sonar existe à bord des thoniers depuis de longues années mais son utilisation fine pour décider du lancer puis pour guider le capitaine lors de l'encerclement du banc (en particulier lors de la pêche sur banc libre) semble correspondre à un apprentissage progressif survenu au cours de la période analysée. L'approfondissement des sennes au cours du temps a permis de capturer des bancs plus profonds et a vraisemblablement contribué à la redistribution de l'effort de pêche dans des secteurs du large, peu favorables par le passé en raison de la profondeur de la thermocline. De nombreux autres facteurs tels que la vitesse de pointe (compétition entre les senneurs sur une concentration), la modernisation des treuils et du power-block (diminution du temps d'immobilisation lors de la calée), etc. ont également contribué à l'accroissement des puissances de pêche individuelles des senneurs communautaires. Il faut toutefois garder à l'esprit que le maintien à bord d'une innovation technologique peut se justifier tout aussi bien par la réduction des coûts d'exploitation du senneur que par un effet directement observable sur l'évolution des cpue.

PROJECT Nº 99/059: USE OF SATELLITE GPS DATA TO MAP EFFORT AND LANDINGS OF THE PORTUGUESE CRUSTACEAN FLEET

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SUMMARY

GPS and speed data provided by the Portuguese Vessel Monitoring System (VMS) were used, for the first time, to estimate and map fishing effort of the South Portuguese Crustacean trawlers. The estimation and mapping of Landings per Unit Effort (LPUE) was also possible by combining VMS with landing figures. A database (DB) was created in MsAccess 2000 to accommodate and relate the VMS and landing data. A specific Geographical Information System (GIS) was developed in Visual Basic 6.0. ADODB and MapObjects 2.0 Pro were used to communicate with the DB and the maps, respectively. The quality of the data provided by VMS was assessed by cross-checking it with other data. This fishery targets three important crustacean species, the Norway lobster *Nephrops norvegicus* (NEP) the Blue and red shrimp, *Aristeus antennatus* (ARA) and the Deepwater rose shrimp, *Parapenaeus longirostris* (DPS). During the study period (1998 and 1999), only 25 out of the 34 licensed trawlers operated monthly, including the four freezer trawlers. With VMS data it was possible to deduce, to some extent, the activity of the vessels, including the definition of fishing trip (FT) performed by vessel. This was possible by analysing the variation of the vessel speed through time combined with landings records. However, this was only possible for 3044 FT, about 41 % of the FT performed during the study period. The position course of each FT, the duration and the corresponding landing were recorded in the DB. The analysis of the vessel speed also helped identifying the different trawl hauls (TH) within each FT. A total of 15673 TH were identified. The towing positions, distance, duration and depth strata limits were calculated for each TH and recorded in the DB. On average, each TH lasted for 4.6 h covering a distance of 13.8 nautical miles at an average speed of 3 knots. TH duration varied, consistently, between Fishing grounds (FG). The number of days spent at sea differed between freezer and non-freezer vessels. In general, freezer-trawlers spent 2.6 days at sea (10 TH/FT), whereas non-freezer trawlers only spent 1.5 days (4.6 TH/FT). Maps were produced to display trawl hauls by vessel or group of vessels, for different periods of time. A grid of 1x1 nautical mile (nm) was used to map different densities corresponding to the number of hours of fishing. The spatial analysis of all TH shaped nine discrete FG: one in Lisbon Region (Lisbon), two in Alentejo (Sines and Arrifana) and six in the Algarve (Sagres, Portimão-Sagres, Olhão-Portimão, Olhão-Tavira, Beirinha and ZEE), covering an area of about 1412 nm², within the depth range 50 to 1000 m. Although Olhão-Portimão and Portimão-Sagres only represent 29 % of the total fishing area, the crustacean fleet spent most time, 65 % of the total number of fishing hours, operating in these two FG. Quarterly and annual density maps were presented for the whole fleet for 1998 and 1999. Important differences in the species composition were observed between FG. A hierarchical cluster analysis was performed on the composition of the landings in order to investigate the possibility to separate exclusive fishing trips (landings) by target species. Results showed that the landings could be divided in six groups (FT types), three of them dominated by DPS (~85 % of the total weight landed in 1999). Only 1.1 and 8.5 % of the FT were classified as targeting NEP and ARA, respectively. The sixth FT type was a mix and less

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representative group (5 %), where the shrimp *Palaemon serratus* was the most important species. The poor discrimination observed can be largely explained by the higher predominance of DPS in the landings. LPUE estimated by species, from exclusive fishing trips showed consistent temporal patterns and differences in magnitude between FG or Regions. LPUE values were, in general higher in 1999 than in 1998, particularly for DPS. Annual mean values of 25 kg/h (DPS), 4 kg/h (ARA) and 3 kg/h (NEP) were observed in 1999, for the total fishing area.

PROJECT N° 99/065: THE RELATIONSHIP BETWEEN FLEET CAPACITY, LANDINGS, AND THE COMPONENT PARTS OF FISHING EFFORT

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SUMMARY

This report contains the results of a two-year study into the relationship between fleet capacity, landings, and the component parts of fishing effort.

Capacity in the fishing industry is difficult to define since the output of a vessel is dependent on the stock available to be fished.

It is perfectly normal in most industries for there to be excess capacity since few companies work in an environment so stable that demand for their product is constant. It is usually economically viable for some spare capacity to be held in reserve to meet periods of peak demand.

In fisheries, because of the logistic growth of the fish stock and the constraint imposed by the environmental carrying capacity, excess capacity develops whereby the output of the fishery could have been produced by a much smaller fleet.

Excess capacity may threaten the viability of the stock but results from the stock being a self-renewing common property resource which is available free to the user.

In open access fisheries and those that are inadequately managed, existing overcapacity can be used profitably in the short-run but this uses stock required to maintain the growth level of the stock in the long-run.

The function which links output and the inputs in fishing is the production function. Output is determined by the level of the stock and the use made of non-stock inputs such as capacity and labour. In the short-run the level of the stock is independent of the amounts of the non-stock inputs used previously.

The non-stock inputs are often collapsed into a single separable fixed factor index known as fishing effort. Not infrequently, fishing effort is defined as some measure of fishing capacity multiplied by the time used, such as kilowatt-days.

A drawback of using a fixed-factor index like fishing effort is that the potential for substituting between inputs cannot be examined and the illusion is created that there is a single readily definable variable which may be used as an intermediate variable to control output.

PROJECT N° 00/018: PATTERNS AND PROPENSITIES IN GREEK FISHING EFFORT AND CATCHES

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SUMMARY

Data on fishing effort (i.e., engine horsepower in KW, gross tonnage GRT, fishing days at sea) and the corresponding catch/day for a large number of species, have been collected by the Institute of Marine Biology of Crete (IMBC) since the second half of 1995. Data were collected over a net of 21 stations throughout the Greek Seas. In the present study we analyzed the monthly fishing effort, total catch/day and catch/day for 12 target species for the 1996-2000 period. The following vessel size groups for each main gear were considered for further analysis: (a) trawlers smaller and larger than 20 m; (b) purse-seiners smaller and larger than 15 m; (c) beach-seiners; (d) long liners smaller and larger than 10 m; (e) netters smaller and larger than 10 m; and (f) "others gears". The mean percentage of vessel sampled for effort ranged from 5.2 to 40 % for trawlers, 5.4 to 75.2 % for purse seiners, 2.4 to 6.8 % for beach seiners, 2.4 to 13.2 % for longliners, 1.5 to 6 % for netters and 1.7 to 3.6 % for other boats. The mean percentage of vessel sampled for catch/day ranged from 4.1 to 40.6 % for trawlers, 6.5 to 66.4 % for purse seiners, 2.1 to 4.6 % for beach seiners, 2.2 to 11.8 % for longliners, 1.3 to 5.1 % for netters and 1.9 to 6.3 % for other boats. Collected data were also aggregated for five fishing subareas, North Aegean, Central Aegean, South Aegean, Cretan waters and Ionian Sea. The analysis of the collected data revealed interesting patterns and propensities. Thus, for all large boat categories, the mean catch/day was generally higher in the North Aegean Sea. For large purse seiners, the catch/day generally declined from north to south. The same was also true of both small and large trawlers, with the exception of large trawlers operating in Cretan waters for which the mean catch/day was the highest recorded. In addition, the large netters and longliners attained the highest mean catch/day in Cretan waters, a fact attributed to the their engagement into the large-pelagic fishery as well as into the deep-water fisheries. The analysis of the time series of catch/day indicated that demersal pelagic resources are declining in the main fishing grounds. All complete purse seine catch/day time series and especially those referring to vessels larger than 15 m, which account for the major part of the small pelagic catch, exhibited a declining trend. Declining catch/day trends are regarded as strong indicators of overfishing especially in the light of the fact that fishers maintain high catch rates by fishing "hot spots". The dynamic regression models built for the vast majority (i.e., >78 %) of the full time series of total and target species catch/day per gear indicated the usefulness of this technique for modeling fisheries time series. The models built allowed us to draw certain general conclusions with respect to the dynamics of the fisheries in concern (i.e., use of effort and lagged catch/day as predictors). The results of the univariate (K-dominance curves, diversity indices) and multivariate analyses (cluster and multidimensional scaling) which have been applied here were in close agreement, complemented each other, and suggested that the different gear/vessel-size/subarea combinations might generally be grouped into clusters corresponding to the different gears, irrespectively of subarea. The different gears differed considerably with

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regard to species composition, species diversity and catch/day rates. The results also showed that despite the gear-related definition of groups among-gear overlap was considerable. This strongly implied the multigear nature of the Greek fisheries. The implications of the results for the management of Greek fisheries resources are also discussed.

PROJECT N° 00/019: COLLECTION AND MANAGEMENT OF DATA FROM COMMERCIAL FISHERIES IN GREECE

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SUMMARY

The study deals with the design and implementation of the large-scale integrated concurrent sample surveys for the allocation of multiple survey fisheries information covering the various domains of interest of the target populations. Other objectives were the synthesis of the attained multiple fisheries data and the construction of the Integrated Database, ID, and the design and application of a Validation Scheme for checking the validity of the results of two samples surveys of the project.

The study presents:

- the levels of integration, which were introduced in the sampling designs of the conducted sample surveys.
- the land based Catch and Effort Sample Survey, CESS, its total survey design, the level of presentation of its area sample and the summarized catch and effort data.
- the land based Fishing Intensity by Sample Survey, FISS, the statistical meaning of the adapted relative measure of fishing intensity as a component of the fishing effort, the total survey design of the sample survey and the obtained results.
- the land based Sample Survey Socio-economic Characteristics, CSSE, the total survey design of the two parallel sampling activities which were initiated for the collection of information on the complementary activities of the active labor force and of the operational cost of the survey fishing and provides the obtained results and cost function.
- the land based Landings Sample Survey, LASS, for the trawling and purse seining fisheries, its total survey design, the estimated length frequency distributions and their statistical features and other biological parameters (sex, maturity).
- the sea going Sample Survey Onboard Commercial Fishing Vessels, SSOC, for the trawling and purse seining fisheries, its total survey design, the estimated magnitudes of gross catch and discards and the estimated associations in the results of the sample survey.
- the constructed Integrated Database, ID, synthesizing the sample data of all the conducted sample surveys.
- the designed and implemented Validation Scheme based on statistical parametric and non-parametric tests for the validation of the results of CESS and LASS by using the SSOC as the control sample survey.

PROJECT N° 00/021: COLLECTION AND MANAGEMENT OF DATA FOR ASSESSMENT OF THE SPANISH AND FRENCH MEDITERRANEAN

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SUMMARY

Most of the stock assessment work carried out by scientific bodies is heavily dependent on information concerning the activities of the fisheries, notably effective fishing effort, landings and discards, as well as the size and age composition of the catches.

Following the assessment of a fishery, a monitoring programme is necessary to collect data, including catch and fishing effort information, and to assess the effectiveness of management strategies.

The Spanish Institute of Oceanography (IEO) has had a Sampling and Information Network (SIN) in the Mediterranean since 1989. This SIN basically gathers data of length distributions from the landings of significant species in diverse harbours for the small pelagics and demersal fisheries of Llansa, Rosas, Barcelona, San Carles de la Ràpita, Castellón, La Vila Joiosa, Alicante, Santa Pola, Aguilas, Almeria, Roquetas, Adra and Málaga. For the tuna fisheries other ports are included in the SIN such as Tarragona, San Carles de la Ràpita, Castellón, Alicante, Cartagena, Aguilas, Garrucha/Carboneras, Motril, Algeciras and Ceuta. In order to build catch and effort data series, landings by boat/species/gear/day are collected. Monthly landings of commercial species by vessel and number of days fished, for relevant fleets are also recorded.

The French Institute for the Exploitation of the Sea (IFREMER) takes samples from landings routinely in Mediterranean sea for a selected number of commercially exploited stocks to provide catch-at-length data, landings, CPUE etc. To this end a limited number of stocks have been selected including the most important valuable species as hake (*Merluccius merluccius*), red mullet (*Mullus barbatus* and *Mullus surmuletus*), sea bass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*), common sole (*Solea vulgaris*). In the same way, some pelagic species which are important in value as tuna (*Thunnus thynnus*) or in weight as anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) have also been taken into consideration. All these species are sampled in fish auctions.

The market sampling scheme has differently been done according to the weight of landings of each species in different ports. Consequently it has mainly been realized in the major fishing ports. In addition to the respective SINs, a programme of observers for this project was developed on board vessels in those fisheries that were considered more complicated to sample due to different reasons, among which were the great multispecificity of the catches, the high price of the specimens, the objections of the sector to handle the specimens once landed and prepared for sale, etc. This experience has been experimental to date. However, with this project it was possible to check in which fisheries it is effective or not to maintain a programme of on-board observers.

This project provides the continuity of the national sampling programmes for stock assessment purposes. The data is used with variable degrees of success in order to

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provide the assessment of the current state of stocks at the GFCM Assessment Working Groups. The present Study Contract implemented the national sampling programmes directed to the main commercial species of Spain and France. This global objective of the project was attained and will be able to improve the basic data for management advice.

Due to the multispecific nature of the species, especially for the trawl fisheries, and the large number of landing ports involved it was difficult to obtain historical series of catches and size or age compositions, even for the species of greater commercial interest.

The result of the project is the improvement in the available sampling data for the most important commercial species of stocks in the Mediterranean. In addition, it is also the base for the establishment of national programmes, within the Community framework, for the collection and management of the fisheries data needed to conduct the Common Fisheries Policy.

In this project, the bases have been established for routine data collection in the majority of the landing ports, both from the respective SINS and by other methods. The data are incorporated automatically into a computerized database which is common to each one of the countries, "SIRENO" in the case of IEO and "ARPEGE" in the case of IFREMER.

The data obtained refer uniquely to the first eight months of 2001 due to the actual length of the project. The data are presented in an aggregate way for the object species of the project and also for other species that were identified as being of interest and that initially had not been considered.

PROJECT N° 00/044: INVESTIGATION OF THE BLUEFIN TUNA FISHERY IN THE EASTERN MEDITERRANEAN

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SUMMARY

The objective of the present project was to study the Greek bluefin tuna (BFT) fishery operating in the eastern Mediterranean Sea. Data were collected from the main fleets operating in the area and included catch-effort statistics and size measurements of a representative number of landed fish. The main objective of the project was to estimate production abundance indices and the size distribution of the catches. The sampling scheme covered the period January-June 2001.

Results indicated that fishermen exploited the BFT stock by means of surface long lines and hand lines. Long lines were used in the Ionian, S. Aegean and Levantine Seas, while hand lines were mostly used in the N. Aegean Sea. The total bluefin tuna landings during the studied period were estimated to be up to 285 MT (dressed weight) in the Aegean Sea and 34 MT (gilled and gutted weight) in the Ionian.

Generally, the mean weight of the landed animals was slightly higher in the long line than in the hand line landings. As animals were mostly landed without head, it was difficult to obtain a sufficient number of length measurements to estimate the representative length distribution of the landings. Thus, and in order to facilitate comparisons among gears and areas, weights measurements were converted to lengths by means of length-weight equations that have been estimated from the cases where full length-weight data were available.

Analysis of the estimated length distributions revealed that long lines target a wider length range than hand lines and that the main bulk of catches was composed of animal having Upper Jaw Fork Length (UJFL) between 110 and 170 cm. Moreover, the mean lengths of the long line landings were generally slightly higher than those of hand lines (150-159 cm for long lines, 149 for hand lines).

Apart from the currently collected Catch Per Unit Effort (CPUE) data, a 3-year series of long line catch rates were analysed by means of Generalised Linear Modelling techniques to examine the spatial and temporal pattern of CPUE. Results indicated that the highest catch rates, in terms of biomass, are recorded in May and June in the S. Aegean and Levantine seas. Assuming that gear catchability remains constant it has been suggested that fluctuations of abundance indices might be related to the spawning migration patterns of the fish.

Sub-domain 2.4:

***Improvement and standardisation
of methodologies***

PROJECT N° 97/007: AT SEA SAMPLING FROM THE DANISH FISHING FLEETS IN THE NORTH SEA AND SKAGERRAK

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SUMMARY

The objectives of the two projects were:

To implement a sampling programme by observers on board commercial fishing vessels.

To estimate quantities discarded and retained of target and non-target species, in the major Danish fisheries of the North Sea and Skagerrak by sampling the catch at sea on board commercial fishing vessels.

To suggest a model for estimation of discards of target and non-target species based on the data collected by the project.

To produce age/length keys of discards of target species, based on otoliths samples from commercial vessels research vessels and through the Danish harbour sampling programme.

Study contract No 94/23 was continued by Study contract No 97/007, which was initiated 1st of August 1998 and ended 31st of December 1998.

The main fishing grounds with in the Danish North Sea fleet is ICES division 4A, 4B and 20, therefore the majority of the data is collected in these areas. Only on few occasions have sampling been done in ICES area 4C and 21.

The Danish North Sea and Skagerrak fishery was divided into 17 fisheries, based primarily on gear, secondarily on target species, fishing techniques and fishing grounds, as shown in Table 1. In the table the definition of the two fisheries, Demersal North and Demersal South is based on the location of the home harbour and not fishing ground.

| Main gear group | | Fisheries | Target species group |
|---------------------|-----------|----------------------------|-----------------------|
| Trawler | 1 | Demersal North | Gadoids/flatfish |
| | 2 | Demersal South | Gadoids/flatfish |
| | 3 | Industrial fishery | Sandeels/Norway Pout |
| | 4 | Pelagic trawls | Herring |
| | 5 | Nephrops/day trips | Nephrops/fish |
| | 6 | Nephrops/freezing trawlers | Nephrops/fish |
| | 7 | Pandalus/day trips | Pandalus/fish |
| | 8 | Pandalus/freezing trawlers | Pandalus/fish |
| Danish seine | 9 | | Gadoids/flatfish |
| Gill net | 10 | Cod gill nets | Cod/other Gadoids |
| | 11 | Plaice gill nets | Plaice/flatfish |
| | 12 | Turbot gill nets | Turbot/Gadoids |
| | 13 | Hake gill nets | Hake/Gadoids |
| | 14 | Sole gill nets | Sole/other flatfish |
| | | | |
| Purse seine | 15 | | Herring |
| | 16 | | Mackerel |
| Beam trawl | 17 | | Plaice/other flatfish |

Table 1 Fisheries covered by the sampling programme.

PROJECT N° 97/034: THE OPTIMIZATION OF THE SAMPLING STRATEGIES OF THE BIOLOGICAL SAMPLE SURVEYS AND SURVEYS OF DISCARDS OF THE COMMERCIAL CATCHES IN GREECE AND DEFINITION OF THEIR EFFICIENCY EXPRESSED IN TERMS OF COSTS: ACCURACY RATIO

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SUMMARY

So far, much attention has been paid to studies of selectivity in relation to mesh size or other gear specifications. This project was designed to examine the economic and other conflicts of selectivity and to investigate how fishermen can influence selectivity by operational decisions. The project was addressed to the selectivity of nets and longlines and was operated in cooperation with two fisheries cooperatives. The analysis of data collected during the field operations revealed a confusing pattern of interaction between biological, economic and technical factors on selectivity. Though gear specifications and fishing rules do have an important effect on selectivity, the major determinants are gear choice and handling, and these are intimately linked with parameters like "profit", "experience" and "vessel's capability". Fishing decisions are largely influenced by the seasonal availability of species, and also by the market demand and prices of the target species. The cost of fishing, which is a function of the cost of buying or maintaining the gear, required crew number, distance from port, trip duration, etc., is an equally important determinant of profitability. Profitability also depends on the number of fishing days, which is lower when the fishing technique adopted requires trips to deep areas and/or areas exposed to adverse weather conditions. For some fishermen, factors restricting the use of certain gear are the difficulty to construct and handle them and the capacity of their vessel. Last, fishing decisions are largely shaped by experience, e.g. in selecting the proper gear for the season, constructing or handling it appropriately, choosing the location of fishing, depth, bottom substrate, etc. The overall assessment is that fishing decisions can influence selectivity more than regulations and enforcement policies. From the administrative point of view it would be useful to define the scope(s) of strategies aiming to selective fishing. With regard to size selectivity, the goal should be to protect juvenile fish. However, regulating fishing mortality simply by mesh size rules has an important economic drawback, the restriction of catches of certain exploitable small-bodied species, with a concomitant economic loss. Therefore, more emphasis should be given to local bans of certain gear or combinations of them with seasonal bans and mesh size regulations. Restrictions on gear types (e.g. the one-net rule) may not be suitable or applicable in the highly multi-species coastal fisheries. With regard to species selectivity, currently there are no rules regulating the fishing effort put on individual species. Lack of such a regulation, coupled with the presently high fishing capacities of the fleets, may have negative effects on some economically valuable species, due to the high capacity of coastal fishermen to fish selectively these species. In the opinion of most fishermen in both study areas, the catches of many high value species are persistently declining. However, there is little usable information on the state of the stocks of interest to the coastal fisheries, nor a sufficient integration of fish ecology studies in fisheries management, in order to decide candidate species for protection and the means to achieve this. A possible "technical" way to promote species selectivity (provided that protected species will be defined) is a

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combination of seasonal and geographical closures to certain fishing gear and prohibition of some fishing techniques. To minimise the negative reaction of fishermen and to ensure their cooperation, the fisheries organisations should be involved in management.

PROJECT N° 97/100: IMPROVEMENT OF NEPHROPS STOCK ASSESSMENT BY USE OF MICRO-SCALE MAPPING OF EFFORT AND LANDINGS

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SUMMARY

This project presents the findings of a collaborative study to improve the stock assessment of *Nephrops norvegicus* (hereafter *Nephrops*) in Scottish (Clyde Sea) and Mediterranean (Central Adriatic) stocks. The project was the first successful attempt to actively involve fishers and non-governmental scientists with government scientists in the stock assessment process for this species.

Nephrops are exploited throughout their geographical range from Iceland to the Mediterranean and Moroccan coast. Annual landings are around 60,000 tonnes (a third of which are landed in Scotland), making this species one of the most valuable lobster resources in the world. TACs for *Nephrops* stocks in EC waters have been imposed since the 1980s.

Assessments of many *Nephrops* stocks in European Atlantic water are conducted by an ICES working group, which provides information on the current state of stocks. The current assessments rely heavily on analytical methods such as virtual population analysis (VPA), based on pseudo-age data, and length cohort analysis (LCA). Both of these methods, which are dependent on commercial catch data, rely on assumptions that are more applicable to finfish such as homogeneity of the stock, equal capture availability and stock redistribution criteria following the capture of part of the stock. It is not surprising therefore that these methods have been shown to be unreliable for some stocks, particularly where spatial heterogeneity in *Nephrops* is marked.

GPS-based position data loggers were installed on 18 vessels in the Clyde Sea area. Vessels were selected to represent the total fleet in terms of size, engine power, gear used and area fished. The data loggers were set to record latitude and longitude at 10 minute intervals. Using the variation in speed throughout the day (vessels trawl at speeds of between 1.5 and 3.2 knots), it was possible to identify the location of individual trawl tracks for each vessel on a daily basis. Such effort data were complemented by a confidential logbook scheme, where fishers recorded their daily landings. From these data, it was possible to build up detailed monthly maps of the spatial pattern of fishing effort and landings for the period November 1998 — October 1999, inclusive.

Spatial parameters of the Clyde stock were investigated using research vessel trawl surveys, underwater television, sediment and the acoustic survey technique, RoxAnn.

These spatial parameters, in combination, with the mapping data were used to stratify the Clyde stocks so that traditional analytical assessment techniques could be run with more

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appropriate biological input parameters applied to each stratum. Generalised linear modelling was utilised in a preliminary investigation into the effect of fishing vessel power on *Nephrops* landings.

Italian scientists acted as observers to the Clyde aspect of the work and carried out their own limited pilot study with two position logger units. A tentative stock assessment based on the information obtained from the mapping project was carried out, and the potential of this technology for application in this multi-species fishery is discussed.

PROJECT N° 98/075: EVALUATION OF MARKET SAMPLING STRATEGIES FOR A NUMBER OF COMMERCIALY EXPLOITED STOCKS IN THE NORTH SEA AND DEVELOPMENT OF PROCEDURES FOR CONSISTENT DATA STORAGE AND RETRIEVAL

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SUMMARY

Western Waters fisheries face major challenges in relation to the depleted state of the fishery resources and in implementing the adjustments required to bring exploitation of these resources on to a more sustainable basis. Fisheries assessments, as carried out by ICES working groups, use data from market sampling of the landed catch, reported landings and effort figures and also research vessel data to assess the state of fish stocks and to produce short term forecasts for setting Total Allowable Catches. Since the discards may constitute a significant source of extra mortality in some fisheries there is clearly a requirement to adequately describe the levels of discarded fish in order to improve stock assessment and the likelihood of sustainability. In deciding a strategy for improved sustainability there is also a requirement to understand the factors motivating the fishers to target and retain, or discard, fish of a given species and to relate this to the current management and market situation. This, and stock assessment information, could be used to guide research into the most appropriate technology and measures to reduce discarding and hence place the harvesting of these stocks on a more sustainable basis.

The project studied the pattern of discarding and retention, using an onboard observer programme, in the main demersal trawl fisheries of the participating nations' in Western Waters (ICES Divisions VIa,b VIIa,b,c,e(western part), f,g,h and k and from VIIIa,b,c,d and IXa) and describes the use of these data in ICES stock assessments. It assessed the feasibility of using these data to understand the economic aspects of discarding and retention, to assess the impact of technical measures and investigated the effects of trawling on ecosystems.

Data on discarded megrim from Spanish Baka trawlers were used in the assessment of the Northern Stock of this species at the ICES Southern Shelf Demersal Working Group. These results show that including discard data in the assessment improved the description of the strength of incoming year classes, growth and spawning stock biomass. The impact of

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technical measures designed to reduce discarding was assessed by examining the effect of the implementation of EC regulation 850/98 on Jan 1st 2000. In the midwater demersal trawl fishery in the Irish Sea there was a reduction in the catch per effort of discarded. For the baka trawlers exploiting megrim in Sub areas VI and VII there was a change in the discarding practices. Discarding and retention is discussed in relation to economic factors and the exploitation pattern. Possible changes in some métiers were suggested but the very Mixed nature some of the fisheries means that what is selective for one species could result in the loss of economically important catch of other species. It was found that discarding practices were most closely related to economic values, which were a stronger influence than fishery management measures. Measures which are designed to reduce discarding without taking into account market forces, are unlikely to succeed. Limited studies of the impact of technical measures were carried out by developing a model designed to predict the returns which could be obtained by improving selectivity, but these were intended only to develop the model not to use it on Western Waters fisheries during this project.

PROJECT Nº 99/009: IMPROVING SAMPLING OF WESTERN AND SOUTHERN EUROPEAN ATLANTIC FISHERIES SAMFISH

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SUMMARY

The main objective of SAMFISH was to provide a framework to improve the assessment of the main fisheries in Western and Southern European waters. The project was built on the achievements of Study contracts 94-043 and 97-0059 (FIEFA). SAMFISH was co-ordinated by AZTI (Basque Country, Spain) and involved 8 partners; AZTI, DOP/UA, IEO, MI, IFREMER, IPIMAR, MARLAB and CEFAS.

The development of SAMFISH project can be regarded as a success in that all the major objectives were achieved and all major tasks were carried out. The overall objective of the project was largely accomplished, i.e. to implement a well designed and integrated international sampling data management and data analysis scheme for the most important commercially exploited stocks in ICES Sub Areas VI, VII, VIII, IX, X.

Sampling levels were maintained and/or improved for many of the major stocks. All partners are now using a similar sampling scheme and the NSPs are in agreement with the requisites of the new EU Regulation on data collection, in terms of stratification and disaggregation levels. In addition, the problem of landings abroad was fully considered in terms of landings (60,000t in 2000), number of vessels (360) and trips (3928), areas and species/stocks. Information on stocks not currently assessed was compiled and analysed in order to allow for stock assessment in the near future.

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The International Sampling Level DataBase (ISLDB) was further developed in the SAMFISH Project. The ISLDB currently stores sampling meta-data for all partners from 1997 to 2000. The ISLDB was intensively used in several tasks and appeared as an useful tool for the analysis of landing sampling.

Uncertainties in the estimate of numbers at age and length were quantified. First, deficiencies in sampling coverage were identified and described. Then, techniques for quantitative estimation of variability on the ultimate sampling output (numbers caught at length/age) were developed and transferred to partners. SAMFISH partners are progressively incorporating these techniques on their data processing in a way that sampling variability estimation is normal practice both at national and international level.

All institutes reported an improved dialogue with their industries. Relationships between industry and scientists have evolved into a more continuous, two-way communication framework where it can be achieved a higher reliance on the basic data and assumptions used in fish stock assessment as well as a better understanding of the uncertainties and facts affecting the fisheries.

SAMFISH partners consider that a framework should be kept to coordinate fisheries sampling at a international level both for sampling scheme implementation and for quality assurance.

PROJECT Nº 99/016: DATA COLLECTION FOR STOCK ASSESSMENT OF TWO HAKES (MERLUCCIIUS HUBBSI AND M. AUSTRALIS) IN INTERNATIONAL AND FALKLAND WATERS OF THE SW ATLANTIC

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SUMMARY

Study Project 99/016 "Data collection for stock assessment of two hakes (*Merluccius hubbsi* and *M. australis*) in international and Falkland waters of the SW Atlantic" ran from January 2000 to December 2001. The main objective of the project was the collection and collation of already existing and newly acquired fishery and biological data needed for preliminary assessment of two hake species occurring in the study area. In addition to this basic remit, additional objectives included the creation of a common database, study of spawning seasons and areas, discard pattern and length-frequency composition of target and non-target species, estimation of annual by-catch rates, analysis of trophic relationships, marine mammals by-catch and sightings, morphometric analysis for stock differentiation, and developing GIS applications for analysis of the data collected.

Historical fishery and biological data series available from IEO and FIGFD (since 1988 and 1987 respectively) were provided to the project. New fishery and biological data were collected by scientific observers provided by IEO, ANAMER and FIGFD, and placed on board Spanish fishing vessels operating in the study area during the project period. Data on fishing activity included effort, catches and discards of target and non-target species on a haul-by-haul basis. Biological information (size, sex, maturity stage, etc) of target and non-target species was recorded on a daily basis. Data on landings and effort were provided by ANAMER to its subcontractor (MG OTERO) for processing and estimation of total catch and effort of the whole Spanish fishing fleet in the area; MG OTERO was also responsible for organisation of observers in collaboration with ANAMER staff in Vigo and Port Stanley. Ancillary data on location, time of fishing, depth, SST, SBT, sea roughness, wind, etc, was recorded on a haul-by-haul basis. This type of information was essential for development of GIS at AU to relate the species distribution to physical and environmental factors. Other information collected was about by-catches and sightings of small cetaceans and seabirds, and biological samples such as otoliths, stomachs and whole specimens of hakes for subsequent studies on growth (IEO, FIGFD), diet and morphometrics (AU).

All the historical and new data collected during the project were collated and integrated into a common database designed by all participants and built at IEO. The information was used for preliminary assessment of two hake populations co-ordinated by RRAG during a workshop held in London in July 2001. All these data will be analysed and written up for future publications. Discard rates of target species were generally low in all areas and seasons with the highest discard rate for *Nototothen* sp. (around 100 % of the catch). *Illex* squid was found to be the major by-catch for hake fishery in the 46 S area. IEO observers reported data on incidental catches of marine

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mammals and sea birds since 1993 and the analysis of this information was made by AU. The observed mortality in the fishing gears comprised small numbers of black-browed albatross, gentoo penguin and the hourglass dolphin. The species most frequently sighted was the Peale's dolphin, although this species did not appear in by-catches, followed by the hourglass dolphin.

The project provided an opportunity to collect and integrate for the first time at European level the necessary fishery and biological data for the development of partial stock assessment for the future rational management of the fisheries in the area. Such management is needed for the sustainability of the commercial fisheries, the conservation of the onshore and offshore jobs and the supply of fish to the most important markets worldwide.

**PROJECT N° 99/019: ECHANTILLONNAGE BIOLOGIQUE
DES CAPTURES DES THONIERS TROPICAUX EUROPÉENS
DANS LES OCÉANS ATLANTIQUE ET INDIEN**

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SUMMARY

In the line of the preceding projects ET (N° 95/37), ORDET (N° 96/41) and TESS (N° 98/062), BIOTHON is a specific action aiming at improving the quality of the biological statistics collected on the European tuna fleet operating in the Atlantic and Indian oceans. The project had three major objectives: to co-ordinate and rationalise the system, to reinforce the actual level of the biological sampling and to provide the biological statistics essential to the scientific community and the tuna regional organisations: International Commission for the Conservation of Atlantic Tuna and Indian Ocean Tuna Commission.

The sampling is conceived to consider simultaneously the species composition (by counting and identification of each individual) and the size composition by measuring them. This procedure is necessary because the commercial categories used for the unloadings as well as in the fishing logbooks are generally gathered according to their size and to their species. The project corresponded to one period of installation and improvement of new sampling procedures and reorganisation of the teams. It utilises permanently on the ground four expatriate technicians of the IRD and IEO/Spanish Fishing Department supervising the permanent local teams on the spot (Abidjan and Victoria) or remotely (Dakar, Antsiranana and Mombasa) by the means of regular missions. The co-ordination at the national level of these activities is carried out from Sète for the IRD and from Canarias Island for the IEO, as well as from regular co-ordination meetings between the principal contributors (IEO, IRD and partners).

In the Atlantic ocean, the total catches of the surface fleets throughout the project were on average 150,000 tonnes, which little more than 110,000 tonnes coming from the European baitboats and purse seiners (Spain and France). They were unloaded and/or transhipped primarily in Abidjan (73 %) and Dakar (24 %). The situation of the sampling in the Atlantic ocean can be regarded as satisfactory as a whole. That of the baitboats in Dakar is acceptable — in particular because of relatively weak catches and very concentrated fisheries whose captures are homogeneous in term of sizes and species composition — an at least seasonal reinforcement of manpower is envisaged into 2003. For the purse seiners the situation is also considered good and in noticeable improvement since 2000; actual manpower are considered to be sufficient, but a detailed attention will have however to be paid on the level of the free schools sampling by the better following of catches in real time.

In the Indian Ocean, the total catches of the surface fleets throughout the project were on average higher than 310,000 tonnes, of which nearly 220,000 tonnes come from the European purse seiners (France, Italy and Spain). They were unloaded and/or transhipped primarily in Victoria (85 %), Antsiranana (11 %) and Mombasa (3 %). After being very degraded in particular in Seychelles, the situation of the sampling of the purse seiners

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(there are no European baitboats in the Indian Ocean) is become again acceptable since 2001, but still requires an improvement and a reinforcement of manpower to become optimal. This one is all the more essential as Victoria became by far the principal port of activity of European tuna fishing, with nearly 60 % of the total captures in the two oceans. A reinforcement of the human means and hardwares seems necessary to Antsiranana while in Mombasa sampling were stopped current 2001, the unloadings having become marginal. These activities continue since June 2002 within the framework of the national program of France and of Spain, elaborated in response to the Council Regulation (EEC) N 1543/2000 of 29 June 2000, establishing a Community framework for the collection and management of the fisheries data needed to conduct the common fisheries policy. The close co-operation between the IEO for Spain, the IRD for France and our partners of the bordering countries of the resource (Ivory Coast, Senegal, Madagascar and Seychelles) is of course maintained within the framework of these new programmes.

PROJECT N° 99/064: PROBABILISTIC MODELLING OF BALTIC SALMON STOCKS

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SUMMARY

The project had the following objectives:

- 1) to develop a rigorous probabilistic assessment methodology for Baltic salmon stocks;
- 2) to apply the methodology developed by estimating the status of salmon stocks in the Gulf of Bothnia (GOB) through an evaluation of Swedish and Finnish river data sets;
- 3) to develop Bayesian decision analysis for the fisheries management of Baltic salmon and to give advice about practical management;
- 4) to analyse the combined use of TAC management and the effort regulation of passive gears in the coastal trap-net fishery of a mixed stock and to assess the information requirements of these management methods;
- 5) to identify the key sources of uncertainty and the most effective management control measures, given the uncertainties.

The project achieved most of the objectives very well. Run-reconstruction models were developed to be probabilistic, and new probabilistic approaches were applied in the analysis of river data sets. The river data sets were found to be informative about future stock development, and the uncertainty estimation of parr densities and smolt production was successful. Practical application of the results was very successful. The ICES Baltic Salmon and Trout Working Group (WGBAST) adapted the new methodology developed by the PROMOS project, and the ICES advice was based on the results obtained. Evaluation of the combined effect of coastal technical measures and TAC was not so successful due to the very complicated nature of salmon migration along the coast. More analyses are needed to model this accurately. The parameter uncertainties of sea models were estimated successfully, and the river data analysis covered both the model uncertainty and the parameter uncertainty. Combined use of these tools is clearly needed to take into account the large uncertainties in the management system. An important conclusion is that the recent improvement in salmon stocks has been due not only to effective management but also to the co-existence of several elements promoting the recovery of stocks (high post-smolt survival, early run, strong coastal regulation, low M74). Should any of these elements have been negative in terms of stock development, the size of the stock would not have increased in the way it did.

PROJECT N° 00/036: MONITORING OF STOCKS IN THE KATTEGAT AND THE BALTIC SEA

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SUMMARY

The aim of the project is improve the collection of catch data from commercial fishing vessels operating in Kattegat and the Baltic Sea in order to get a complete description of the fishing pattern in the area. The data are used as input for fish stock assessment in the area.

Furthermore it is the aim to secure optimal sampling and consistency of the data collected by the countries involved in the project.

Observers collect the data while they are on board the vessels during active normal commercial fishery. The observers are employed at the national research institutes in the countries participating in the project. The following countries participate in the project: Denmark, Estonia, Finland, Germany, Latvia, Poland, Russia and Sweden.

The project covers all commercial important fleets in Kattegat and The Baltic Sea. The observers collect all relevant information concerning the fishery including catch weight per species (separated into landing- and discard part), length distributions, gear and haul information, etc.

The data are stored in a common database, the BALTCOM database. Data are available for scientific purposes on aggregated form for all national scientific institutions on written request to the project coordinator.

The study includes a comparison of age-length-keys obtained from different countries, gears and areas for herring and sprat.

Domain 3: Technical measures (including alternative uses of techniques)



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Sub-domain 3.1:

Fishing Methods and Gear Selectivity to reduce by-catches of marine mammals, non-target species and undersized fish

**PROJECT N° 97/006: ELIMINATION OF HARBOUR PORPOISE
INCIDENTAL CATCHES (EPIC)**

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SUMMARY

The EPIC project addresses methods for mitigation of by-catches of harbour porpoises in bottom-set gillnets, and the area of study focuses on the North Sea and Inner Danish waters. Results should be applicable to other areas and different situations.

The study involved recording and analysing behaviour of harbour porpoises mainly in controlled (enclosed) conditions, in relation to foraging, reaction to obstacles presented and acoustic stimuli, and potential deterrent devices. Research and technical improvements of deterrent devices, signal processing, relevant analysis and engineering on the basis of new data and current research were undertaken. In addition, monitoring of by-catch rate for the harbour porpoise population(s) at risk in set gillnet fisheries in Danish waters through monitoring schemes, and of population structure and diet through biological sampling of by-catches were continued with collation of a biological database and bibliography of by-catch publications for dissemination via CD-ROM and media presentation through videos to the fishing industry.

The study has been undertaken in a semi-natural enclosure ultimately separated from the adjacent fjord in Kerteminde, Denmark only by nets at opposite ends, thus providing both advantages and disadvantages. The former offer near-natural habitat with exposure of the porpoises to tide, natural seawater, climate, local fauna and flora and environmental noise and activities e.g. fishing boats. The latter have centred mainly on problems associated with inclement and unpredictable weather conditions (as normally experienced in the field) which frequently limit the research, but also must include problems with water visibility and difficulties in viewing all parts of the enclosure.

During the experimental periods, two porpoises were available, a male, Eigil, and a female, Freja. Both were in early maturity and aged ca 3 years old initially. During the experimental period, a third porpoise, a female, Nuka, was acquired. She was a juvenile of less than a year when she joined the other animals. Unfortunately she died later in February 2000, less than one year after acquisition, from an infection.

The foraging studies have shown clearly that a significant component of feeding behaviour is the head-down vertical feeding on the seabed — “bottom-grubbing”, especially in the young. Observations showed that preoccupation with bottom —grubbing and catching prey

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made at least one of the animals insensitive to surrounding threats, indicating that bottom entanglement in nets would be very likely unless the animal was alerted to the threat. Examination of stomachs of by-caught and stranded porpoises in the North Sea and Inner Danish waters corroborated the likelihood of bottom-feeding, from the high incidence of bottom-dwelling prey species. The studies also indicated that whilst echo-location was important in foraging, sight was probably also important although this could not be tested directly within the time frame available. It was concluded that passive means of enhancing the acoustic (or even visual) reflectivity of nets would not alone be sufficient to prevent entanglement, as the porpoises did not regularly echo-locate ahead: and, even when they were aware of obstacles in the environment, they did not necessarily pay attention to them while busy hunting prey. Therefore, we conclude that passive enhancement of net "visibility" acoustically may be useful only when backed up by and armed with acoustic alerting devices.

The beacon-mode acoustic deterrents (based on LU's PICE99 TM -AQUAmarkI 00 TM) with multi-signal random emissions (3 different sounds of 3 durations, and 2 different sounds with one duration; see below) proved to be significantly effective -even after persistent exposure over time, thus indicating no compelling evidence for habituation. proved to be significantly effective at encouraging the porpoises to leave the area away from the sound source -even after persistent exposure over time, thus indicating no compelling evidence for habituation. However, post-test recovery was always very rapid, indicating that once the source of stress (sound emission) was removed, the porpoises resumed former activities. This has important implications in the field, where porpoises could be expected to move back into areas once "pingered" fishery operations had finished.

Five sound types in all were tested as deterrent signals, and the most aversive were all non-click sounds. Diminishing the duration (256 msec., 128 msec. to 64 msec.) of the signal emission had no significant diminishing of the aversive effectiveness of the "pinger", so that this factor could be exploited to prolong battery life in pinger manufacture and to increase the variety of signals. In the captive situation it was not possible to see how far the porpoises could be displaced from the deterrent sound source because of the limits of the enclosure, although field experiments using pound-nets off the coast offered a chance to investigate this. Our investigation did not contradict the previously reported findings that pingers may be effective from 125-130 m and even up to 600 m. Presently "pingers" are placed at up to 200 m centres on nets, but this could possibly be increased. Other methods of excluding porpoises from areas were tried, including an interactive "pinger" where the porpoises themselves triggered the device acoustically, and a very limited trial (because of inclement weather) on the different use of sound designed to mask the echo-location frequencies (100-150 kHz range) that would inhibit foraging, creating an "acoustic fog". The former has the consequence of acting as a "wake-up call" encouraging the porpoises to explore the environment by echo-locating ahead. Results indicated a very promising method of acoustic deterrent deployment that could minimise general acoustic emissions from "pingers" into the environment, and further delay possible habituation, although only limited testing was possible. The porpoises responded very cautiously to the powerful "echo" returned from the transducer, and kept away from it during the test period. The recovery was slower than with the beacon-mode "pinger", but was still rather quick. The latter induced the porpoises to stop bottom-grubbing and move away during test noise exposure, although recovery afterwards was rapid. This method could be very effective by creating temporary "exclusion zones" while fishing operations were taking place. The system however, requires heavy-duty continuous power supply -unsuited to long nets and long soak times, and could only be suitable for discrete operations e.g. wreck sites, or in other fishery operations e.g. trawling where the ship would be able to continuously supply power. The continued monitoring of porpoise by-catch onboard the Danish gillnet fleet has not produced new information since the estimate of 6,785 (c. v. 0.12) per year in the Danish North Sea fleet, based on 1993-1998 data. The "drop-out"/loss rate of porpoises from gillnets during hauling is estimated at 5-12 % in the Danish fleet but could be far higher as

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elsewhere, in which case by-catch estimates could be under-estimated. By- catch recovery, augmented by strandings recovered in Danish waters, has enabled a continued updating of the biological database first started under BYCARE (EU FAIR contract CTO5-0523). This database now holds 1966 records, from between 1834 and 2000, with full biological information, including digital photographs in most cases, from dissections of porpoises between 1996-2000 inclusive.

Biological investigations indicate that young juveniles (age 1-2 years) are predominantly the victims of by-catches, that potential life-span may be ca 24 yr, and that the female can remain fecund all through life with a potential for calf production annually. However, life expectancy mostly does not exceed 10 yr. A disturbing but as yet unexplained persistence in sex-ratio imbalance has been found with up to 1.5 males: 1 female in both by-catches and strandings. A segregation by area and/or time is suggested but not verified. Porpoise stomach analyses reveal a catholic diet, with some differences between areas, but bottom-dwelling prey species comprise a significant part of the diet in all.

A reference database on publications and other Literature on marine mammal by-catch-related and harbour porpoise topics has been established where there are currently 1383 references. Hard copies of at least a third are held at the Danish Institute for Fisheries in Charlottenlund, Denmark.

A film of ca 21 min. duration, designed as an instructional video (in English and Danish — eventually also Swedish) has been compiled showing the current international agreements and legislation concerning cetacean by-catches, the problems besetting the fisheries, the current scale of by-catch, research supporting adopted mitigation measures, and practical implementation of mitigation measures and future prospects.

Continuous feedback—both formal and informal between scientists, fishermen and governmental authorities at national and international levels, has taken enabling the improvement of the “pinger” design and its attachment in different national fisheries.

PROJECT N° 97/016: ETUDE SUR LE RÉGIME D'EXPLOITATION ET LA SÉLECTIVITÉ DU CHALUT DE FOND À GRANDE OUVERTURE VERTICALE ET DU CHALUT PÉLAGIQUE DANS LA PÊCHERIE DU MERLU DANS LE GOLFE DE GASCOGNE

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SUMMARY

The goals of this study were to technically characterize the TGOV (Tres Grande Ouverture Verticale or Very High Headline) and pelagic trawls targeting hake in the Bay of Biscay. as well as to determine their fishing pattern, with particular emphasis on codend selectivity.

The two types of trawls share certain design features which determine their large overall size and the magnitude of their opening, one of the key elements which is responsible for their fishing effectiveness. The most relevant common features are: a) design of net with four seams; b) adoption of V shaped tips at the level of the wings. with bridles which connect them to the sweeps; c) use of large mesh near the mouth of the trawl to optimise filtration properties of the net. The opening of the pelagic trawls used for hake fishing was estimated by digital simulation at 36 meters of vertical opening by 160 to 170 m of horizontal spread; that of TGOV trawls was measured with acoustic sensors and varied according to tow conditions between 23 and 32 meters of vertical opening by 78 to 90 m of horizontal spread.

The study of the fishing patterns of the two types of fishing gear was carried out by sampling catches with the help of on-board observers.

The TGOV trawl is specifically designed for catching hake. with a strong dependence on this resource (83 % of the recorded landings). On the other hand, the pelagic trawl is a general-purpose trawl which can be employed for fishing various target species according to their availability. Probably this versatility, associated with the depletion of the northern hake stock, determined the strong reduction of pelagic trawling targeting hake during the last years. The two types of trawls share the characteristic of abundant discards of horse mackerel (*Trachurus trachurus*), 84 % in weight of TGOV trawl discards and 63 % of pelagic trawl discards.

The catch rate of hake by the two types of trawls exceeds on average 50 kg per hour of tow. More than 85 % of the hake captured with the TGOV trawl are larger than 30 cm, with a mode between 32 and 33 cm. The only data available for pelagic trawls targeting hake are from 1994-1995 and show that more than 60 % of hake were discarded due to their small size. The sampling rate in these pelagic trawling campaigns was weak.

Selectivity was only studied in TGOV trawls. due to the little fishing activity for hake by the pelagic trawl fleet. Experimental fishing campaigns on board professional trawlers were done employing an alternate haul technique. The SELECT method was used for estimating the parameters of the logistic selectivity model. Four pairs of alternate hauls from a total of thirteen permitted the fitting of the model. Three of these pairs of hauls had non significant

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L50 % differences, ranging between 30 and 31 cm. The selection factor of these three pairs of hauls was slightly above 4 (average of 4.21). One pair of hauls performed on grounds non fished by the commercial fleet provided selectivity parameters significantly different (L50 % = 27.2 cm; selection factor = 3.68) from the previous parameters. The average selection factor obtained for all four pairs of hauls was 4.08.

**PROJECT N° 97/043: FISHERMEN'S EFFECTS ON SELECTIVITY
BY STRATEGIC DECISIONS (GEAR CHOICE AND HANDLING,
SELECTION OF FISHING GROUNDS)**

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SUMMARY

So far, much attention has been paid to studies of selectivity in relation to mesh size or other gear specifications. This project was designed to examine the economic and other conflicts of selectivity and to investigate how fishermen can influence selectivity by operational decisions. The project was addressed to the selectivity of nets and longlines and was operated in cooperation with two fisheries cooperatives.

The analysis of data collected during the field operations revealed a confusing pattern of interaction biological, economic and technical factors on selectivity. Though gear specifications and fishing rules do have an important effect on selectivity, the major determinants are gear choice and handling, and these are intimately linked with parameters like "profit", "experience" and "vessel's capability". Fishing decisions are largely influenced by the seasonal availability of species, and also by the market demand and prices of the target species. The cost of fishing, which is a function of the cost of buying or maintaining the gear, required crew number, distance from port, trip duration, etc., is an equally important determinant of profitability. Profitability also depends on the number of fishing days, which is lower when the fishing technique adopted requires trips to deep areas and/or areas exposed to adverse weather conditions. For some fishermen, factors restricting the use of certain gear are the difficulty to construct and handle them and the capacity of their vessel. Last, fishing decisions are largely shaped by experience, e.g. in selecting the proper gear for the season, constructing or handling it appropriately, choosing the location of fishing, depth, bottom substrate, etc.

The overall assessment is that fishing decisions can influence selectivity more than regulations and enforcement policies. From the administrative point of view it would be useful to define the scope(s) of strategies aiming to selective fishing. With regard to size selectivity, the goal should be to protect juvenile fish. However, regulating fishing mortality simply by mesh size rules has an important economic drawback, the restriction of catches of certain exploitable small-bodied species, with a concomitant economic loss.

Therefore, more emphasis should be given to local bans of certain gear or combinations of them with seasonal bans and mesh size regulations.

Restrictions on gear types (e.g. the one-net rule) may not be suitable or applicable in the highly multi-species coastal fisheries. With regard to species selectivity, currently there are no rules regulating the fishing effort put on individual species. Lack of such a regulation, coupled with the presently high fishing capacities of the fleets, may have negative effects on some economically valuable species, due to the high capacity of coastal fishermen to fish selectively these species. In the opinion of most fishermen in both study areas, the catches of many high value species are persistently declining. However, there is little usable information on the state of the stocks of interest to the coastal fisheries, nor a sufficient integration of fish ecology studies in fisheries management, in order to decide candidate species for protection and the means to achieve this. A possible "technical" way to promote species selectivity (provided that protected species will be defined) is a combination of seasonal and geographical closures to certain fishing gear and prohibition of some fishing techniques. To minimise the negative reaction of fishermen and to ensure their cooperation, the fisheries organisations should be involved in management.

PROJECT N° 97/095: REDUCTION OF PORPOISE BY-CATCH IN BOTTOM SET GILLNET FISHERIES

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SUMMARY

Objectives:

We investigated means of reducing porpoise bycatch levels in the Irish and UK gillnet fleets working in the Celtic Sea. We initially intended to test the effectiveness of one of the two available types of pinger (PICE) with a double blind trial in which active and dummy pingers were compared with one another to detect differences in porpoise bycatch rates. We also intended to assess the practical problems with use of pingers and investigate the effectiveness of closed areas as an additional or alternative management measure to reduce porpoise bycatch.

The pingers that we initially tested did not function according to their manufacturer's specifications, and we were therefore forced to reconsider our objectives. Our revised objectives were to test the practical effectiveness of the alternative pinger model (Dukane Netmark 1000), and to investigate two possible alternative mitigation measures, the use of closed areas and the use of floating floatropes, which theoretically may be more detectable to an echo-locating animal than traditional floats. We also intended to assess recent changes in fishing effort in the Celtic Sea and revise estimates of current porpoise bycatch levels.

Results

Pinger effectiveness: Independent observers monitored 160 days of fishing activity, covering the hauling of 418 strings of gillnets, or over 30,000 net km.hours of fishing effort. Approximately 40 % of this fishing effort involved strings of nets equipped with pingers. One porpoise was observed entangled in these nets. The remaining 60 % of observed fishing effort, which included both floatrope and traditional nets, were associated with 18 entangled porpoises. The bycatch rate in the pingered nets was 92 % lower than in the unpingered nets, supporting the conclusions of several other experiments that these pingers are effective in significantly reducing porpoise bycatch.

To investigate practical aspects of pinger deployment, we addressed methods of attaching pingers to the nets, pinger durability under real fishing conditions, battery life, and the effects of pingers on fish catches. Pinger attachment methods were refined, and after some initial problems in some cases, where pingers were being lost, we found at least two secure methods of attaching pingers to the floatrope.

The rigorous conditions under which pingers are used in these fisheries led to observed damage in 27 % of pingers over a six-month period. Mostly this involved cracks in the plastic housing and deterioration of the battery housing component. Although many of these

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pingers continued to function, some succumbed to saltwater ingress and we suggest that this will limit the average life expectancy of these pingers in this fishery. We found that battery depletion with duration of usage was highly variable. In 4 out of 16 pingers tested after varying days of usage, we found no battery depletion, suggesting that poor connections meant that these pingers were inoperative. Despite this potentially high rate of inoperative pingers, bycatch rates were very low in pingered nets suggesting the inter-pinger spacing that we used (1 per 100 m approximately) was sufficiently conservative to 'cover' any non-functioning pingers. There were no negative impacts of pingers on fish catches.

The two pingers nearest to the one porpoise that was entangled in a pingered string of nets were found to have almost completely depleted batteries. Despite an audible acoustic output at the time that they were retrieved, we speculate that the signals were probably too weak to deter the animal in this case.

Spatial aspects of porpoise entanglement

We deployed pods (automatic porpoise click detectors) in the vicinity of around 300 deployed nets. We found that porpoise clicks were frequently recorded near to the pods deployed on gillnets. Only one deployment recorded no porpoises nearby. Porpoises were most commonly recorded at least once an hour for 8 to 11 hours per day. This suggests that porpoises frequently forage in the general vicinity of gillnets in the Celtic Sea, and that entanglement is the exceptional outcome of such encounters. We found no relationship between porpoise click rates and porpoise bycatch rate, though the data were limited in this case. The number of porpoise clicks detected on pods attached to pingered nets was much lower than (about 30 % of) the number of clicks detected on unpingered nets.

We examined data from 1992-1994 and 1997-2000 for any areas of consistently high porpoise bycatch. The geographical locations of 47 porpoise entanglements in 986 net hauls were plotted out, but these entanglements were widely dispersed and we could find no evidence that closing specific areas to fishing would result in any useful reduction in bycatch rate.

Use of alternative gear

Floating rope was recorded used in 2218 net hauls. Overall fishing effort with floating ropes amounted to around 5000 net km.hours, in which 10 porpoises were recorded entangled. Traditional floats were recorded in around 10000 net km.hours in which 6 porpoises were recorded entangled. The entanglement rate was significantly higher in the floating rope nets. We do not know why this occurred.

Level of fishing effort

UK fishing effort has changed considerably since the 1992-1994 survey of porpoise bycatch. There has been a significant reduction of effort in the 15 — 20 m vessel class, which covers most of the vessels in the hake gillnet fishery, but increases in effort in the under 12 m and the over 20 m sectors. The overall number of UK based days at sea was almost the same in 1999 as in 1994.

The number of Irish vessels affiliated to the ISWFO using gillnets in the Celtic Sea has declined since 1994, but we were unable to gain access to Irish government data on total gillnet fishing effort. Data on current Irish, French and Spanish gillnet effort are lacking. We cannot predict with certainty what the effects of these changes have been on porpoise entanglements, but there is unlikely to have been any overall significant reduction in total entanglement since 1994.

Conclusion

A substantial reduction in entanglement rate is needed before levels of porpoise mortality in these fisheries are consistent with conservation objectives. A reduction in entanglement of at least 70 % would be required to bring the bycatch level to below 1.8% of the estimated number of animals in the area. If this is to be achieved then the use of pingers appears to be the only currently viable management option. There are however a number of practical problems that need to be resolved, particularly with respect to enforcement and monitoring.

PROJECT N° 98/001: IMPROVING AND ESTIMATING THE SELECTIVITY OF CODENDS FOR THE PELAGIC BALTIC COD FISHERY

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SUMMARY

A selectivity experiment was conducted in the Baltic Sea pelagic cod fishery. A standard nominal 135 mm codend, a codend with a 125 mm nominal bottom window (Danish window codend) and a codend with a 125 mm nominal top window (BACOMA window codend) were tested. Two experiments were conducted from April to June 2000, one from a Danish commercial trawler and one from a Swedish commercial trawler. A kite codend cover was used to collect escaping fish. 32 valid hauls were conducted in the Danish experiment and 18 valid hauls in the Swedish experiment.

Logistic selection curves of each haul were fitted by maximum likelihood procedure and combined in a fixed and random effect model.

The results are presented in Table 1. The selection factor (SF) and the L50/SR ratio in the Danish experiments were estimated to be lowest for the standard codend followed by the codend with the side window whereas the top window codend had the highest values. The SF and the L50/SR ratio were lowest for the standard codend in the Swedish experiments whereas there was no difference in the estimates of the side window codend and the top window codend.

The SF of the Standard codend and the top window codend was relatively comparable between the Danish and Swedish experiments whereas the difference was larger for the side window codend. The L50/SR ratio is comparable for the side window codend whereas the difference between the experiments is marked for the top window codend. The SF of the top window codend was comparable to the results of the Danish experiments conducted in the BACOMA project. The SF of the standard codend was relatively high compared to estimates from the BACOMA project and the literature.

Table 1. Results of Danish and Swedish experiments.

| Codend | SF (ICES gauge) | L50/SR (ICES gauge) | SF (EEC wedge) |
|---------------------|--------------------|------------------------|-------------------|
| Danish experiments | | | |
| Standard codend | 3.74 | 7.00 | 3.61 |
| Side window | 3.86 | 6.66 | 3.71 |
| Top window | 4.05 | 9.46 | 3.89 |
| Swedish experiments | | | |
| Standard codend | 3.68 | 6.40 | 3.55 |
| Side window | 4.12 | 6.61 | 3.96 |
| Top window | 4.12 | 6.61 | 3.96 |

PROJECT N° 98/002: DEVELOPMENT AND TESTING OF A GRID SYSTEM TO REDUCE BY-CATCHES IN NORWAY POUT TRAWLS

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SUMMARY

The main objective of the present study was to develop a grid system for the Danish Norway Pout industrial fishery, which could significantly reduce bycatch of juvenile gadoids when inserted in the trawl codend.

Based on a number of parameters including Faroese and Norwegian experiments with sorting grids; information from the industry about vessel and gear dimensions; IBTS data for the potential bycatch species, a flexible hinged grid of stainless steel with a bar distance of 24 mm was constructed. The chosen design was thought to match the current conditions in the Norway Pout fishery. After construction the grid section was tested in flume tank experiments and afterwards adjusted according to test results.

The grid was tested in the North Sea aboard a chartered commercial vessel, HG 250 SEATEX of Hirtshals. Two sea trials were conducted in November/December 2000, each comprised of three days of steaming and 6 days of fishing in ICES sub-squares 45E9, 45FO, 46E9 and 46FO. The research gear for both sea trials was in principle comprised of three separate collecting bags/codends attached to the grid section. The grid itself was inserted in the extension piece of the employed industrial trawl. During the trials underwater observations were made with a stationary camera mounted in front of the grid.

During the two trials a total of 27 valid experimental tows were conducted, resulting in a total industrial catch of almost 280 tonnes of fish distributed between each of the three collecting bags. The total catches from each haul varied from approximately 6 to a maximum of 25 tonnes. The resulting primary data consisted of numbers of fish in each length size (1 cm groups) measured from sub samples from each of the three compartments of the experimental gear. Due to the very large catches in the industrial fisher, and with that the experimental fishery, it was impossible to measure all fish caught.

The results from analysing the primary data showed reductions in weight percent of the total bycatch of 26 % for Haddock, 47 % for Whiting and 32 % for Cod, as a result of employing the sorting grid in the trawl. The study also demonstrated that it is possible to retain a major part of the larger marketable fish species like Cod, Saithe and Haddock and at the same time, maintain the above given levels for reductions of juvenile fish of the same species. This was achieved by inserting a square mesh window after the grid.

The lower limits for the size of fish sorted out in the grid was assumed to be a strict mechanical selection determined by the bar distance in the grid. This was confirmed by the calculated selectivity curves for the grid, which showed the exact same L₅₀- values of app. 22.6 cm across all three species analysed. This assumption was also confirmed by underwater video film of hauls showing the actual selection in the grid. The picture for the selectivity in the square mesh window was a bit more variable with marked difference in the L₅₀- values, ranging from 30.5 -34.9 cm across species. Also a statistical model describing the combined selectivity of the grid and window was developed. The theoretical reduction levels of bycatch were extrapolated from applying the selectivity model to the tested grid

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system. The resulting figures for Haddock and Whiting were 18 % and 35 % respectively. The catch numbers for cod were too small to allow selectivity estimations. The smaller deviance from the observed values of 26 % and 47 % was simply due to the fact, that the size groups encountered during fishing only represented part of the theoretical integrated size selectivity.

The expected impact on the stocks of Haddock and Whiting in the North Sea by introducing sorting grids in the industrial fishery was evaluated. This was done by transferring the actual reduction percents obtained with the sorting grid from this experiment to the levels of industrial bycatch from the latest ten years as assessed by ICES. The estimated annual reduction of Haddock in the industrial fishery would be 2.7 % of the Spawning Stock Biomass and for Whiting 4.8 % of SSB.

The obtained levels of bycatch reductions obtained in this study are concluded to be marked and fairly satisfactory. The data analyses of the results from the experimental fishing however, state almost without doubt that marked selective improvements by optimising the bar distance in the grid and the mesh size in the window are possible, but further research would be necessary in order to establish the optimal selective design.

The situation for the more technical aspects of the grid also leaves more work to be done. Despite the hinges, the grid of stainless is still difficult to handle and additional development of material and design would be desirable in order to facilitate a possible introduction in the commercial fishery.

PROJECT N° 98/012: REDUCTION OF DISCARDS IN CRAGON TRAWLS (DISCRAN)

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SUMMARY

EU-Study 98/012 "Reduction of discards in Crangon trawls (DISCRAN)" aimed at collecting catch and by-catch data, compare various designs and further develop effective and acceptable selective devices (veil nets and sorting grids) in the European Crangon fisheries. The project started with a literature review and model tests. Over the years 1999 and 2000 a total of 547 valid hauls were carried out in German, Dutch, Belgian and British fishing grounds on research vessels and/or commercial fishing boats. The project was guided through National Advisory Groups consisting of scientists, fishermen's representatives and practical fishermen. Both the sieve net and the grid are devices that can effectively sort out by-catch fish species, but they have to be rigged properly and blockage due to sea weed or jelly fish may impair their effectiveness. The loss in commercial shrimps in the German, Dutch and UK trials was between 5-20 %. However, commercial trials in Belgian waters showed higher losses on average 37 % probably caused by the unique Belgian catch composition and seasonal differences. A mesh size of 70 mm and a grid bar distance of 20 mm demonstrated proper sorting. Some general trends were observed. Grids and sieve nets work well on plaice, flounder, smelt, cod, and to a somewhat lesser extent on dab, bib and whiting. Fishermen expressed a preference for the non-rigid sieve or veil net.

PROJECT N° 98/014: TRAMMEL NET SELECTIVITY STUDIES IN THE ALGARVE (SOUTHERN PORTUGAL), GULF OF CADIZ (SPAIN), BASQUE COUNTRY (SPAIN) AND CYCLADES ISLANDS (GREECE)

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SUMMARY

Trammel net fisheries were studied in four areas: the Cantabrian Sea (Basque Country, Spain), the Algarve (Southern Portugal), the Gulf of cadiz (Spain) and the Cyclades Islands (Greece). Surveys were carried out in order to identify trammel net métiers and to characterise the gear used. Trammel nets were among the most important gears used in the small-scale fisheries, with up to 9 different métiers identified in each area. The most important métiers in the Algarve and the Gulf of Cadiz were those for cuttlefish (*Sepia officinalis*) and soles (*Solea senegalensis*, *Microchirus azevia*, *Synaptura lusitanica*). In the Cantabrian Sea, sole (*Solea vulgaris*), shellfish (several species) and scorpion fish (*Scorpaena* spp.) métiers dominated while a variety of species were targeted in the multi-species trammel net fishery in the Cyclades.

In each area, experimental trammel nets of six different types (combinations of 2 large mesh outer panel sizes and 3 small mesh outer panels) corresponding to the most common métier, were constructed and fishing trials carried out on a seasonal basis (4 seasons in the Cantabrian Sea, Algarve and Cyclades and 2 in the Gulf of Cadiz) using chartered commercial fishing vessels. Overall, 271, 360, 185 and 185 km of trammel nets were fished in the experimental fishing trials in the Cantabrian Sea, Algarve, Gulf of Cadiz and Cyclades Islands respectively.

The trammel nets caught a large number of species: 79, 128, 63 and 79 in the Cantabrian Sea, the Algarve, the Gulf of Cadiz and the Cyclades Islands respectively. In the Cantabrian Sea trials *So/ea vulgaris* (19 %), *Trisopterus luscus* (12 %), *Scomber scombrus* (9 %) and *Trachinus draco* (8 %) dominated the catches. In the Algarve, *Scomber japonicus* (21 %), *Sepia officinalis* (17 %), *Microchirus azevia* (12 %) and *Trachinus draco* (6 %) were the most important species in the trammel net catches. *Sepia officinalis* (43 %), *Solea senegalensis* (8 %), *Sardinapi/chardus* (7 %) and *Torpedo torpedo* (7 %) accounted for most of the catch in the Gulf of Cadiz. In the Cyclades Islands, *Mullus surmuletus* (15 %), *Pagellus erythrinus* (14 %), *Diplodus annularis* (10 %) and *Scorpaenaporcus* (9 %) were the four numerically most important species. Totals of 17041 (Cantabrian Sea), 16574 (Algarve),

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8178 (Gulf of Cadiz) and 9619 (Cyclades Islands) individual fish, crustaceans and cephalopods were caught.

The multivariate analysis (cluster analysis and MDS) showed that there were significant differences in the species composition and relative abundance of the most important species between the seasons, especially in the cases of the Cantabrian Sea and the Algarve fisheries. Catch rates (numbers per 1000 m of trammel net) also showed depth related patterns for most of the dominant species. In general, catch rates increased with decreasing inner panel mesh sizes, whereas the mesh size of the outer panel had no significant effect.

Significant numbers of species and proportions of the catches were discarded in each area. Overall, 65, 105, 46 and 32 species were entirely or partly discarded in the Cantabrian Sea, Algarve, Gulf of Cadiz and Cyclades Islands respectively. The overall discard rate in terms of catch in numbers ranged from 15 % for the Cyclades to 49 % for the Algarve, with the high discard rate for the latter due largely to *Scomber japonicus*. The main reasons for discarding were as follows: 1) species of no or low commercial value (e.g. *Scomber japonicus*, *Torpedo torpedo*), 2) commercial species that were damaged or spoiled (e.g. *Merluccius merluccius*), 3) undersized commercial species (e.g. *Lophius piscatorius*) and 4) species of commercial value but not caught in sufficient quantities to warrant sale (e.g. *Sardina pilchardus*). The number of discarded species and discard rates generally decreased with increasing inner panel mesh size.

Trammel nets generally caught a wide size range of the most important species, with distributions that were skewed to the right and/or bimodal. In many cases the catch frequency distributions of the different nets were highly overlapped, indicating little or no size selectivity. In general, the Kolmogorov-Smirnov test showed that the large mesh outer panels had no effect in terms of size selectivity, while the opposite was true for the small mesh inner panels.

Of the three methods of capture recorded, entangling was by far the most important, with combinations of entangling and wedging and entangling and gilling accounted for the greater part of the catches of all the species in the four different areas.

Six different selectivity models (normal scale, normal location, Gamma, log-normal, bi-modal and Gamma-Wileman) were fitted to data for the most abundant species in the four areas using the GillNet software (Constat, 1998). In general, the bi-modal model provided the best fits for a wide range of species, with the uni-modal models giving poor fits in most cases. For some species, in particular *Sepia officinalis*, where entangling was the method of capture in 100 % of the cases, none of the GillNet models fitted the data, whereas the logistic model fitted by maximum likelihood (Wulff, 1986) adequately described the selective properties of the trammel nets.

PROJECT N° 98/020: LONG-DURATION COMPARATIVE EVALUATION OF THE EFFECTS ON COMMERCIAL FISHING OPERATIONS OF FITTING SQUARE-MESH SECTIONS TO DEMERSAL TRAWLS

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SUMMARY

A long-term series of trials was carried out to assess the effects of fitting square-mesh panels in demersal trawl nets on catches of fish during normal commercial fishing operations. The quantity and size of fish caught by a cod-end fitted with a panel were compared with those taken by a cod-end without a panel. The square-mesh panel tested was made of 90 mm knotless netting, was 3 metres in length, and was fitted between 6.3 and 9.3 metres from the cod-line. Prior to the start of the main trials, observations were made of the experimental cod-end using a remotely operated, underwater television camera. These showed that the panel was correctly rigged and that fish were escaping through it.

A total of 86 pairs of valid hauls, totalling over 785 hours of fishing time, were made by the larger vessel (>373 kW) between November 1999 and October 2000. A total of 14 valid hauls, totalling about 129 hours of fishing time, were made by the smaller vessel (<373 kW) between June and November 2000.

The main trials on the larger vessel showed that the square-mesh panel reduced the catch of undersized whiting by 33 % and of Grade IV whiting by 22 %. However, the panel did not significantly reduce the catch of undersized haddock, either because the haddock did not escape through the panel or because the selectivity of the panel was similar to the cod-end in which it was fitted. Hauls with a small mesh cod-end showed that very large numbers of small fish were present throughout the year in the areas where the trials were carried out. This suggests that large numbers of small fish were escaping through both cod-ends used (i.e. with and without a square-mesh panel). Trials with the smaller vessel did not show that the square-mesh panel was having any significant effect, probably because of the relatively small number of hauls made and the relatively small size of catches.

A model was developed to predict the economic loss that might be caused to fishing vessels in the medium to long-term by using a square-mesh panel. This model takes into account the fact that fish that escape through a square-mesh panel can be caught again after they have grown to a larger size. The model suggests that while square-mesh panels may cause a short term economic loss this may be mitigated in the longer term by increased catches of larger fish.

PROJECT N° 99/007: SELECTIVITY OF SQUARE MESH TOP AND SIDE PANELS IN THE NORTH SEA WHITEFISH FISHERIES

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SUMMARY

Reviews have been made on state of the art on design of square mesh escape windows in trawls and the management tools using square mesh escape windows introduced in the legislation.

Danish sea trials

The Danish trials focussed on comparing the selectivity in a conventional 100 mm diamond mesh codend with codends with an inserted escape windows with 90 mm mesh size. Two different placements of the window were tested. One codend had the window inserted in the side. The other codend had the window in the top panel, which covers the top half part of the codend.

A commercial 520 HP vessel was chartered for sea trials in the Skagerak area. A twin trawl rig was used where one trawl fished a test codend and the other trawl with a Small meshed codend which retains all the catch.

The top window had the highest Selection Factor (SF) for haddock and the steepest selection curve. There was no significant difference in L50 between the side and top window codend for cod. The standard codend had a relatively poor selectivity (low SF) for both haddock and cod and a less steep selection curve compared to the codends with escape window.

The estimated selection in relation to the Danish minimum landing size of cod and haddock is relatively low if minimum allowed mesh sizes are used. Consequently a relatively high discard rate could be expected if fish under minimum landing size encounters the codend when the minimum mesh size specified by the legislation is used.

Scottish sea trials

The Scottish trials concentrated on the effect of inserting a 3 m long panel of square mesh netting in the top sheet of a 100 mm codend. Previous work in the Baltic and the North Sea has shown that such panels can improve conservation by reducing the capture of small fish. The more open square meshes probably give more opportunity for fish to escape than from a normal diamond mesh codend in which the meshes tend to close under tension.

The 960kW Scottish commercial twin trawler Challenge II was chartered to fish for 15 days (7-21 August 2000) on North Sea fishing grounds, 16nm NE of Peterhead, Scotland. A 90 mm panel was inserted in three different positions near the aft end of the net where most escapes occur. The results were compared with those from a codend with no panel.

Haddock and whiting were present on the grounds but unfortunately insufficient numbers of cod. The experiment was designed to give an indication of the numbers of fish caught in the experimental trawls and also the numbers of fish retained when the panels were put in place. The reduction in the numbers of small undersized fish caught represent the benefit

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to conservation and the numbers of marketable fish lost represent the economic loss to the fisherman. Because there were few marketable fish (both haddock and whiting) on the grounds the estimates of losses of marketable fish are less reliable.

For haddock, the percentage of all the small fish in the population that were retained reduced from 46 % without a panel to about 25 % with the panel at either 9-12 m or 6-9 m from the codline, to 14 % with the panel at 3-6 m. No marketable fish were lost from the codend without a panel whereas losses varied between 2 % of marketable fish for the 3-6 m position, 4 % for the 9-12 m position and 18 % for the 6-9 m position.

For whiting, 18 % of all the small fish in the population were retained without a panel and when the panel was at 9-12 m. This figure was reduced to 8 % with the panel at 6-9 m from the codline and 3 % with the panel at 3-6 m. 34 % marketable fish were lost from the codend without a panel but this is likely to be an anomalous result. Losses increased from 5 % of marketable fish for the 9-12 m position to 38 % for the 6-9 m position and to 50 % for the 3-6 m position.

In summary, these trials have shown that inserting a 90 mm panel into a 100mm codend does have a significant beneficial effect on release of small fish. If the panel is placed nearer the end of the codend then the benefit is greater but there is likely to be a greater penalty in terms of lost marketable fish. Because of the lower minimum landing size of whiting the losses of marketable fish are likely to be greater for whiting than for haddock but at the same time a smaller percentage of whiting below minimum landing size is retained.

PROJECT N° 99/008: FISHING POWER AND SELECTIVITY OF NET AND VESSELS TYPES

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SUMMARY

Two parallel investigations on gill- and trammel net selectivity on sole and plaice in the North Sea, and on sole selectivity in Aegean Sea has been conducted in 2001. The investigations were carried out by the Danish Institute for Fisheries Research in Hirtshals and the Greek Fisheries Research Institute in Kavala.

Three Greek vessels of the same size were operating on the same fishing ground at the same time in the Aegean Sea, and three Danish vessels of different size were operating in the North Sea, also on same fishing grounds and same time.

Trammel and gill nets in five different meshsizes (ten different net designs) were mixed randomly in each fleet. This research setup was created in order to investigate possible differences in selectivity and catch efficiency between trammel and gill nets and between vessels.

16,520 Dover soles (*Solea solea*) and 5,340 plaice (*Pleuronectes platessa*) were caught in the Danish trials, and 376 Mediterranean soles *Solea vulgaris* and 86 *Solea lascaris* were caught in the Greek trials. Very few soles were caught in Greek gill nets and therefore an additional trial only with trammel nets and one vessel were conducted to obtain enough results for an analysis. Thus selectivity results exist only from Greek trammels with *Solea vulgaris*.

It was found that there were not much difference in selectivity between trammels and gill nets. The most catching meshsize for a certain fish length of North Sea soles is a meshsize that is equal to the targeted fish length divided by 3.25. For North Sea plaice it is the targeted fish length diverted by 2.7. Also here the difference between trammels and gill nets as well as differences between vessels were without practical importance. All meshsizes catches most soles (relative to population structure) of a length equal to meshsize multiplied by 3.25 as indicated above. But also a small fraction of larger sole was caught. The only real difference between trammel and gill nets was that trammels caught a slightly larger fraction of big soles.

At the coastal fishing ground where this research was conducted a nominal 80 mm full mesh was catching most marketable soles (over 24.5 cm) with a catch of undersized soles of only 8 % (on weight). Not many plaice were caught in this meshsize, but of these the percentage of undersized plaice (under 27 cm) was high. The legal minimum meshsize is 100 mm full mesh. The trammels only caught 60 % as much North Sea Sole as the gill nets did. The trammels caught a little more plaice, but the difference was not significant. However for the research design used, the trammels could not be handled optimal, so regarding catchability the results should be treated with caution.

Because of small catches in the Greek trials only trammels data were here sufficient for analysis. The optimal fish length for a given meshsize was here found to be close to 3.5 times meshsize, indicating the Greek soles being slimmer than the North Sea soles. There were no significant differences between vessels. The largest proportion of total catch in number was caught by mesh size 68 mm and in weight by mesh size 84 mm (full mesh). These mesh sizes are also the most popular in Greek commercial sole fishery.

**PROJECT N° 99/058: MANAGING BY-CATCH & DISCARDS:
A MULTIDISCIPLINARY APPROACH (BYDISCARD)**

AUTHORS

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SUMMARY

The present study is the first multidisciplinary study, where it is considered the specificity of the problem of by-catch and discards in the south coast of Portugal. This study not only considers the aspects of identification, quantification and species biology of the by-catch and discards, but also looks at the ecosystem's dynamic and the possible ways to decrease this problem.

Concerning by-catch and discards, the main focus of the present project was on the trawl fisheries, crustacean and fish, since these two métiers are the main source of by-catch and discards in the south Portuguese coast. The present report presents the results from data collected from the summer 1999 to the summer 2001 from crustacean and fish trawl métiers, and from spring 2000 to summer 2001 from purse seine métiers.

As in previous projects, the data collection has been the direct method with observers on board commercial fishing boats. All data collection was also carried out by fishing operation. The sampling effort in this study was based on 16 fishing boats, (6 crustacean trawls, 3 fish trawls and 7 pelagic purse seines), on which 64 fishing trips and 186 fishing operations (hauls/sets) were made. A total of 247 species were identified from all taxa, of which 135 species were fish, 106 species were invertebrates and 6 species were algae. Of those, 166 species were always discarded or non-commercial (67 %) and 71 were commercial species, with 70 species frequently discarded (29 %) and only 11 species occasionally discarded (4 %). A total of 16 different classes were identified, 2 of which were algae. The métier with the highest discard ratios was the crustacean trawl (33 %-89 %), followed by the fish trawl (27 %-75 %) and the lowest was the purse seine (1 %-5 %). The main cause of discard is economic, since a great number of species are caught for which there is no readily available market. In the case of commercial species, the main reason is legal and administrative.

Based on the considerable amount of information gathered on improvement of the selectivity of commercial trawls for crustacean fishery, two different experiments were tried within this project, the first one being the change in sweep length, and the second the use of a grid sorting device. The first experiment was to determine if a simple reduction in the length of sweeps could improve selectivity. The results showed that geometry at the opening of the trawl was not significantly different between the two sweep lengths examined. The objectives of the second experiment were to develop and test a sorting grid system for the crustacean trawl fishery off the coast of Algarve, which can retain the target species in this fishery, to a higher extent than the sorting devices previously tested, and release a higher fraction of undesirable by-catch species such as blue whiting, among others. The results show that the efficiency of this grid to maintain the catch of the target species, while allowing for the escapement of blue whiting, the most discarded in this

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fishery, was established. The results obtained, are the most encouraging from all experiments where sorting devices were used in Portuguese waters.

To be able to understand the roles of predation and fishing, including the discarding practice, in the structure and flows of the ecosystem in the deeper shelf off Algarve, a preliminary analysis of the community was performed. This ecological approach relied on two types of analyses: a) analysis of diet composition and overlap among a number of fish species (trophic analysis); and b) investigation of the flows of mass among the different assemblages of fish and other commercial and non-commercial groups in the ecosystem (mass-balanced model and network analysis). Prey species were aggregated into 13 major functional groups, taking into account their taxonomy, size and habitat (pelagic, benthopelagic or benthic).

An attempt was made to describe the dynamics of past trawl fisheries in Algarve, given the discarding mortality, and investigate the effects of a continued by-catch and discard practice. Further, it was also investigate the possible biological and economic consequences of the introduction of (highly) selective devices, such as a rigid sorting-grid, in crustacean gear.

PROJECT N° 99/067: AUTOMATED DETECTION OF DOLPHINS AROUND PELAGIC TRAWLS

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SUMMARY

Clear evidence exists of substantial incidental catches of small cetaceans dolphins in pelagic (midwater) trawls in Atlantic and Mediterranean European waters. They are of concern because of potential impacts on the fishing industry, via public reaction, potential impacts on the dolphin populations, and as an animal welfare issue.

Little detail is clear about the numbers of animals, the species involved, and the circumstances leading to incidental capture in these fisheries, or about possible methods of mitigation. An acoustic system for detecting the presence of dolphins around or in these nets could be valuable to identify possible avenues for mitigation efforts and to gain data on when and where dolphins bycatch is most likely — this may vary with the target species of the fishery as well as with season and place. The most consistently produced distinctive detectable sound from delphinids is probably echo-location rather than whistles.

The 'POD' is a self-contained spectrum analyser with analogue filters centred at 135, 90, 50 and 25kHz. It makes continuous comparisons between their outputs. Detection is of narrow-band sounds and is triggered by ratios of values between 2 pairs of filters achieving a user-defined ratio for each pair.

This gives very good specificity in the detection of the narrow band sounds produced by porpoises. Delphinid sonar uses more broadband signals. Tests on the POD showed that it can be configured to detect these. A range of static and towed sea trials, and tank tests showed that the false positive rate is a major problem. The use of higher order data (patterns of click rates) to distinguish dolphins from propellers etc. was considered but does not appear powerful enough to extract a reasonably specific signal of dolphin presence.

Solutions to this problem were evaluated and a decision taken to develop a new version of the POD which logs the time of occurrence and duration of each click to 10µs resolution. This allows the detection of trains of clicks with the rejection of the false detections, greatly increasing the specificity of the system. DSP and analogue systems were evaluated. The 'T-POD' developed uses a complex analogue filter design that allows it to 'scan' through 6 different frequency settings each minute. Train detection is performed on a PC using a pattern recognition algorithm and evaluating possible trains in terms of their probability of arising by chance within a cluster of random clicks having the same mean click rate as that within the time limits of the train (i.e. including all false clicks).

The T-POD has been tested in a range of laboratory and sea tests. Excellent results have been obtained in the detection of bottlenose dolphin and common dolphins when the T-POD is towed behind a small boat. Click trains produced by boat sonars in the frequency range of dolphins can be rejected on the basis of their constant inter-click intervals, associated with low click rates and long click durations.

Deployment from both beam and mid-water trawls has been shown to be practical and dolphins have been detected during deployments on mid-water trawls during which dolphins were seen to be present. The POD is cheap, robust, self-contained and fully automatic.

The T-POD has attracted interest for research on fishery interactions between dolphins and other types of net, and also for habitat monitoring, and development will continue very actively beyond this project.

PROJECT N° 00/046: PAGELLUS BOGARAVEO GILL NET METIER IN IONIAN SEA: GILL NET SELECTIVITY, ASSESSMENT AND BIOLOGY**AUTHORS**

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SUMMARY

Pagellus bogaraveo is a demersal fish common in the Mediterranean (absent from the Black Sea) occurring in the Atlantic from Norway to Cape Blanco, Madeira and the Canaries. It occurs at depths from the inshore waters up to 400 m in the Mediterranean and 700 m in the Atlantic.

There is lack of information on the biology and the assessment of the population of the species in Greek waters. Only some information on the biology of the juveniles in the Thermaikos Gulf and the Thracian Sea and the age and growth in the Ionian Sea exist. Young fish are mainly concentrated in shallow areas (< 100 m), while older individuals can be found in deeper waters.

In Greek waters the fishing of *P. bogaraveo* was carried out since the beginning of 80ties until recently, mainly by long lines. The last years a new fishery with gill nets has been developed, with extremely high catches at the beginning. But soon the catches declined due to overexploitation (of the introduction of the gill nets), the ghost-fishing (lost pieces of net which continue to fish) and the sport-fishing.

The aim of our study was to assess this fishery (fleet characteristics, production, fishing effort) in Greek waters and gather information on the composition of the catch, the productivity and the selectivity of the nets, on the biology of the species (age, growth and reproduction).

The selectivity has been studied for six mesh sizes, (60, 68, 80, 88, 90 and 100 mm). The data collected during three missions using a hired professional fishery vessel, in March, May and July 2001. Observers on professional vessels have been sent to record the professional fishery catch rates and interviews with the fishermen took place along the west coasts of Greece in order to collect data on the fishery.

Various models have been applied to estimate the modal length per each mesh size. As modal length, the length at which the probability of a fish to be caught is maximum. Summarising, the modal lengths of the 60, 68, 80, 88, 90 and 100 mm mesh size gill net were 207.5, 235.2, 276.7, 304.3, 311.2 and 345.8.

The length of the specimens collected during experimental and professional fishery ranged between 160 and 400 mm. The catch of the nets used for selectivity experiments was consisted mainly of fish 3 to 6 years old, while in the professional fishery more abundant were fish 5 years old.

From the examination of the gonads it can be derived that the reproduction of the species is taking place probably during winter. The males were more abundant than the females in the small length classes, while in larger fish the females were more abundant. The species is considered to be protandric which means that when the young fish are born they are males and during their life some of them change sex to females.

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All the interviewed fishermen strongly believe that the catch has declined drastically the last six-seven years. The main reason according to them is overfishing, gill nets, sport- and ghost-fishing. The decline in the catch has forced some of the fishermen in shifting to other activities causing social economic problems.

From the analysis of the data we got the impression that the stock of the species and consequently the fishery is collapsing, due to lack of any management plan and any regulation. This métier is one of the most species and size selective one in Greek waters (with very few by-catch species) and that is why it could be easily regulated.

Our recommendations include the introduction of a minimum mesh size for this fishery of 90 mm minimum, the closure of the fishery from November to April when the reproduction is taking place and further investigation of the biology of the species.

Sub-domain 3.2:

Gear evaluation and the influence of the features of the gear

PROJECT N° 97/064: HAKE SET GEARS FISHERIES IN MEDITERRANEAN AND EASTERN ATLANTIC WATERS

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SUMMARY

The hake fishery is of notable importance both for south Portuguese and Mediterranean demersal fisheries, due to its commercial value and to the number of fishermen involved. Hake (*Merluccius merluccius*), which has been traditionally fished, in some areas, by a single type of gear (long-lines in south Portugal; long-lines and mostly bottom trawlers in Mediterranean waters), have become a source of concern due to the introduction of other gears (gill-nets) within these fisheries. This leads to conflicts among users and moreover, due to the technical interactions, make fundamental for stock assessment models and management options to know where, when, how and what those fisheries actually catch. Moreover it is of paramount importance to collect data on sub-fleets targeting particular stocks in order to estimate adequately the capacity related to the vessels, the capacity related to the gears used and the activity of a fleet, i.e. the utilisation of the available capacity in terms that are relevant to fishing mortality.

The major work areas derive from a general need to evaluate the impact of different gears on the hake fishery. As a result of the above a proposal was drawn up which identified six broad objectives. These were:

- describe the different types of bottom set gears used by hake fishery;
 - describe the fleet and the fishing activities;
 - characterise the commercial catches;
 - compare the catches of hake from different commercial fishing gears;
 - study gill net selectivity for hake
 - investigate the effect of fishing regime (soaking period) on the quality of the hake.
- These objectives were then transpose into a set of three tasks, which were to be undertaken over the two-year programme of work. The relative short duration of the study required that most of the sub-tasks in the working programme had to be addressed from a quite early stage, if not simultaneously.

PROJECT N° 98/069: SEPIA OFFICINALIS: IMPACT OF THREE SET GEAR FISHING TECHNIQUES IN THE ADRIATIC AND THE LIGURIAN SEA

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SUMMARY

Along the Italian coasts *Sepia officinalis* Linnaeus, 1758 represents one of the most important target species for the artisanal fishery which utilises several gears for the exploitation of this cephalopod depending on the different habitats.

The impact of three gears (fyke net, pot and trammel net) commonly used by fishermen to catch cuttlefish was investigated in two coastal areas (central Adriatic Sea and south-eastern Ligurian Sea) in 1999 and 2000, during the period of maximum occurrence of cuttlefish (from late winter to early summer). The impact was evaluated considering the efficiency of each gear both on the target species (*S. officinalis*) and on the bycatch (kept and discard). Comparison among the total catch rates, length-frequency distribution and sex ratio of the target species, according to the different gears and months, were accomplished through statistical tests (ANOVA, Kolmogorov-Smirnov test, chi-square test). A census at field on the local fishing fleets, landings and activities was also performed to get a picture of the importance assumed by the cuttlefish fishery on the overall activity of the small-scale fishermen and to draft a cost/benefit ratio related to the use of the different gears in the two areas. In each area the sampling was carried out either on a sandy and a sand-rocky bottom in order to evaluate the influence of the type of bottom on the gear efficiency and the suitability of the different fishing methods. Moreover, to compare the yields of the three gears differing from each other in technical characteristics and catch modality, an experimental approach of using in each area gangs of the same length and a same permanence at sea was chosen. Therefore, taking into account the different abundance of the target species in the two areas, a gang having a length of 300 m (20 units for each type of trap) was used for each gear in the Adriatic Sea, while in the Ligurian Sea a bigger amount of fishing gears was employed: 500 m of trammel net, 32 fyke nets and 32 traps. The gears were lowered into the water at dawn and pulled in at dawn of the subsequent day for about 24h at sea. Moreover, in 2000 two additional sets of traps (one of pots and the other one of fyke nets) characterised by a longer fishing time (48 hours) were utilised to verify eventual changes in the catch efficiency of the gears due to the set time at sea.

The geomorphologic and hydrological characteristics of the two areas affected the qualitative composition of the catches and the efficiency of the three considered gears. In fact, independently from the type of bottom, all the gears gave the highest yields in the central Adriatic Sea, both in total and in terms of target species, likely because of a higher fish abundance in this area in respect to the south-eastern Ligurian Sea. Moreover, in the Adriatic Sea all the gears caught the highest number of species and gave the highest yields in weight on the sand-rocky bottom, while more abundant catches in number of specimens were recorded at the sandy site. On the contrary, in the south-eastern Ligurian Sea all the gears showed their lowest efficiency on the sand-rocky seabed, both in qualitative and in

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quantitative terms; this was particularly evident for the traps, whose catches were characterised by the complete absence of cuttlefish and by a very few number of species. Most of fyke net and pot catches were constituted by cuttlefish in both areas, while trammel net always showed the lowest selectivity, being its catches generally characterised by high percentages of bycatch. In the Ligurian Sea this last fraction included several commercial species of fish, while in the Adriatic Sea it mainly consisted of non commercial discard. In both areas discard was dominated by crabs belonging within the food chains of the coastal zones; these benthic decapods were generally dead when rejected at sea and this might alter the local macrozoobenthic communities so creating an impact that is very difficult to quantify.

The yields of *S. officinalis* obtained with the different gears evidenced the highest efficiency of trammel net in respect to the traps on the sand-rocky seabed of the Adriatic Sea, while no substantial differences were recorded in the effectiveness of the three gears on the sandy bottom. Differently, in the Ligurian Sea the trammel net resulted to be the most efficient gear to catch cuttlefish both on the sandy and on the sand-rocky seabed. A general decrease of *S. officinalis* catches from April to June was observed for pots and trammel net in the Adriatic Sea and for trammel net on the sand-rocky bottom in the Ligurian Sea. On the contrary, fyke net fishing yields remained either constant or increased, according with the fact that a longer permanence at sea and siltation transform this type of trap in a suitable shelter for cuttlefish. Fishing yields obtained with the fyke nets and pots kept at sea for 48h in both areas did not show appreciable differences with the correspondent gears having a 24h fishing time.

In the Adriatic Sea the cuttlefish caught on the sand-rocky bottom showed a higher mean mantle length and a wider size range in respect to the specimens collected on the sand, while no differences were recorded in the south-eastern Ligurian Sea. Comparison of the size-frequency distributions of catches obtained with the three gears evidenced that in the Ligurian Sea the cuttlefish collected with trammel net were bigger than those obtained with the two traps, while in the Adriatic Sea fyke nets caught smaller specimens than the other gears. In both areas a general significant reduction of the mean mantle length of cuttlefish was recorded during the sampling period but, in spite of this, all the specimens caught in the Adriatic Sea and most of those collected in the Ligurian Sea were bigger than the maturity length. This confirms that in the period late winter — early summer the exploitation of cuttlefish in the coastal zone is mainly focused on adults which migrate inshore for spawning. Therefore, this fishing activity might influence the reproductive potential of *S. officinalis*, but this impact is likely to be very scarce considering that this species seems to spawn only once in its life cycle and that the traps act as suitable substrates for the egg attachment.

An additional analysis based on the frequency of only male or only female catch as well as on the sex ratio of specimens inside each trap was conducted to clarify the catching mechanism of fyke nets and pots. The results showed that in both areas males were attracted by the presence of a female inside the pots, while the entry of females seemed to be accidental and probably related to their spawning. No sexual attraction seemed to affect the entry of cuttlefish into the fyke nets.

Finally, the investigation performed at the landing sites showed that cuttlefish fishery was carried out in the two areas with vessels having similar technical characteristics, but in the Ligurian Sea this activity was conducted all year round, while in the Adriatic Sea it showed a strong seasonal pattern limited to the period late winter — early summer. Nevertheless, the estimated total landings were only slightly higher in the Ligurian than in the Adriatic Sea.

The cost/benefit analysis based on the main factors affecting the artisanal fishery targeting cuttlefish suggested that, independently for the type of bottom, the use of fyke nets in the Adriatic Sea may represent a good compromise among different factors, such as purchase, maintenance and storage costs, handiness, yields and environmental impact. On the contrary in the Ligurian Sea trammel net seems to be the only suitable gear because of the negligible catches of traps.

**PROJECT N° 99/035: THE PURSE SEINE LANDING COMPOSITION
IN EASTERN AND CENTRAL MEDITERRANEAN SEA**

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SUMMARY

The purse seining is a traditional fishing method used in the Mediterranean in the last 100 years. It has been associated from the beginning of its evolution, with lights for fish attraction and until the 80's, when the mid water trawl was introduced in the Western part of the Sea, was the main fishing method used to capture small pelagic species. Two species *Sardinia pilchardus* and *Engraulis encrasicolus* provide the largest total landings of the gear in the Mediterranean. The present study aimed to investigate the landing composition of purse seine fishery in Greek and Italian waters, to investigate the effectiveness of purse seine in comparison to the pelagic trawling, a method targeting the same stocks and to assess the impact of fish populations to the existed management measures. The study was carried out in three Greek ports, Kavala, Volos and Patra, situated in the Northern Aegean Sea, the Pagassitikos and Patraikos gulfs and in the port of Sciacca in Sicily.

Landing data analysis indicates that sardine was the most abundant catch during the period 2000-2001 in Kavala. In the CPUE analysis, outliers and extreme values of CPUE values for the total landings were recorded almost for all the months for both fishing seasons pointing out that the daily catches were highly influenced by external factors as the environmental conditions. In the same area, the length distribution of sardine shows that the catches mainly consisted of 2nd and 3rd age classes, with sizes above the estimated length at first maturity LSO (133 mm). The length distribution of anchovy showed that catches mainly consisted of the 2nd age class, with sizes above LSO which was calculated to be 106 mm for females.

In the landing ports of Volos in Pagassitikos gulf and Patra in Patraikos Gulf, according to the analysis, about 80 % of the catch was composed of sardine and anchovy in both areas, but the proportion of the two species in the two areas varied, where in Pagassitikos 33 % was sardine and 45 % anchovy and in Patraikos 71 % was sardine and only 11 % was anchovy. The sardine catch of Pagassitikos was composed of five age groups (0 to 4th year) and four in Pagassitikos where the 0 group was not included in the catches. Age group 1 was the most abundant in both areas. For anchovy also the most abundant catch consisted of age group 1 in both areas, but the catch was composed of three age groups (0 to 2 years). In Pagassitikos gulf there were not observed discarding practices. In the Greek areas only a reduced number of young *Trachurus* sp. specimens and *Sardinella aurita* was discarded.

In the port of Sciacca in Sicily sardine and anchovy were also the most abundant species caught during the period of the project. Daily CPUE shows high degree of variability due to

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availability of resource and to weather conditions. The sardine size distribution indicate a 76 % of the whole sample, ranged between the lengths 130-160 mm but from market data the percentage is 90 %, this suggests a discard of sardine under this sizes of almost 15 %. Anchovy size distribution in the whole period did not show significant difference between market and deck data, with the 86 % of the sampled population ranges between 120 and 140 mm. From these data appear that the smaller sizes anchovy discarded specimens are less than for sardine. In this area the sardine catch consisted of age 1st and 2nd classes respectively, represented by 110-160 and 120-160 size ranges. The same analysis of anchovy population gives similar results as for sardine. The comparison of the two fishing methods, purse seine and midwater pair trawling, was made in Sciacca where both methods are used. Regarding their economic feasibility, purse seine appeared to be slightly more profitable than pelagic trawling. Regarding the catch comparison, pelagic trawl appears to be more critical, particularly for anchovy, in terms of lower mean size and in terms of higher discards. Even if these results could be considered as preliminary, due to the short period of the experiments, a conservative approach would suggest to undertake the appropriate actions for the promotion, the preservation and the development of the purse seine as a traditional and more selective method.

Sub-domain 3.3:

Seasonal & spatial closures

**PROJECT N° 97/031: EVALUATION DU STOCK DE CREVETTES
PENAEUS SUBTILIS DU PLATEAU CONTINENTAL DE GUYANE
FRANÇAISE DE NOUVELLES CONTRAINTES. INFLUENCE
DES FERMETURES SPATIALES ET SAISONNIÈRES.**

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SUMMARY

The shrimp fishery of the French Guiana is harvested by 63 licensed boats. A precautionary TAC of 4108 tonnes decided by the European Union covers all species of Penaeidae shrimps. *Penaeus subtilis* represents 90-95 % of the total landing and *P. brasiliensis* 9-14 %.

A spatial closure forbids any trawling inside the isobath of 30 meters. The sampling procedure is based on the monthly compositions of the landings by boats and by companies, three of them covering 90 % of the total production. Input parameters for growth and natural mortality are from Brazilian works

The CPUE's series of the shrimps fleet shows seasonal trends, fluctuating around 230 kg/day. For the period 1990-1997, there is an important increase in yields per day, probably due to a change in strategy towards smallest categories in shallow waters.

In that preliminary work, numerous trials are made for assessing the stock of *P. subtilis*. The production model and several analytical models are used.

The biomass of the shrimps stock calculated by the production model has been increasing over the last few years, as the effort has decreased since the early 1980's. Recently (1996-1998) average annual biomass has been at around 10000 tonnes, close to 2/3 of the estimated virgin stock biomass of 15000-16000 tonnes. The 1994-1998 effort levels were at around f 0.9 MSY and therefore close to levels that are recommended under "responsible fishing" principles. The estimated catch at 90 % of MSY is close to 4000 tonnes consistent with the present TAC of 4108 tonnes established for this fishery. The likelihood ratio estimates suggest that MSY estimates and thus catch at 90 % of MSY are estimated with sufficient precision to be used in establishing the TAC. Estimated CPUE at 90 % of MSY is around 250 kg per fishing day, close to present catch rates in the fishery.

Three sets of cohort analysis have been used, on a monthly basis: (i)- a length cohort analysis according to the method described by Jones. (ii)- a tuned length cohort analysis, based on the calculation of total mortality by linearization of the catch curve. (iii)- a tuned age cohort analysis, the monthly age compositions being generated by slicing of the length compositions.

These investigations are preliminary, but it seems obvious that:

- The recruitment takes place all over the year with a maximum at the beginning of the second half (VPA).
- The landing per unit effort is directly affected by the level of recruits and there is a coincidence of peak abundance with CPUE trends (Tuned length cohort analysis).
- There is no statistical relationship between effort and fishing mortality.
- The Y/R for males and females is optimistic and shows that the present level of F is adequate. The general diagnose argue for a stock, if not well managed, but out of overexploitation. The trends of SSB and Recruitment for both males and females, as

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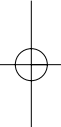
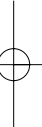
given by the age based assessments, show that there is no immediate reason for concern about this fishery. The length-based assessments confirm that opinion and lead to the conclusion that fishing mortality is moderate.

The spatial or seasonal closures modify the distribution of the fishing effort in the time and in the space and protect or forbid the access to the area, coastal or estuarian for penaeidae shrimps, of the fishery devoted to the juveniles. Between the pattern of the fishing effort and the stocks dynamics exist relations for determining the success or the failure of the fishing strategies.

The equatorial shrimps grow quickly, their span of life is short and are subjects to a high natural mortality. Their marketable value increases with their length. If the recruitment periods are foreseeable and well definite, seasonal closures are an effective method for protecting the juvenile component. However, if the recruitment process is staggered in the time, thus, the undersized individuals are spatially distinguishable and cannot be protected only by seasonal closures.

Equatorial shrimp fisheries are considered as multi-specific because they correspond, according to the depth, to different area for various species. Biological parameters of recruitment vary from a species to another and it is very difficult to protect the recruits that are mixed to the adults of others species, even by applying strictly seasonal closures. Most of studies indicate that small shrimps are strongly stratified, that explains the reason why the spatial closures are the better ways for protecting them.

The simulation model for the management of the fishery used here shows that, in any case, the adoption of seasonal closures added to a traditional regulation of spatial closure of the coastal nurseries and the use of licenses, lead to losses in weight.



Sub-domain 3.4:

Alternative Fishing Techniques

PROJECT N° 98/009: MISE AU POINT DE TECHNIQUES DE PÊCHE ALTERNATIVES POUR LA CAPTURE DU THON GERMON (THUNNUS ALALUNGA) EN ATLANTIQUE NORD-EST

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SUMMARY

Le projet vise à étudier des solutions alternatives à la pêche du thon germon en Atlantique Nord-Est, en dehors de l'utilisation du filet maillant dérivant pratiquée actuellement par les navires français du golfe de Gascogne et dont l'interdiction est programmée au 31 décembre 2001.

De nouvelles techniques de pêche doivent être testées. Ces techniques se doivent de minimiser les captures accessoires, en particulier celles de cétacés. Elles doivent aussi être susceptibles d'être adaptées aux navires actuels de manière à en assurer la diversification. Pour cela, elles doivent pouvoir assurer des rendements de pêche économiquement acceptables au regard des conditions sociales et économiques des entreprises de pêche concernées.

Cette étude est une première étape qui visera à tester les possibilités de pêche du germon à la senne tournante, à la palangre, et à la ligne traînante automatisée. Pour ce faire, les compétences des moyens existants dans des pêcheries voisines ou analogues seront utilisés au cours des saisons de pêche 1998 et 1999. Ce sera l'objet de la présente étude. En fonction des résultats obtenus, les possibilités techniques de diversification devront être étudiées, dans une seconde étude qui pourrait être menée en 2000 et 2001.

La zone de pêche concernée s'étend du 37° parallèle nord (zone des Açores) au 53° parallèle nord (ouest de l'Irlande), et du talus continental au 30° méridien ouest.

Ligne traînante automatisée: les performances des ligneurs américains dans le Pacifique devront être testées dans la zone concernée, par une campagne de démonstration réalisée par un navire californien au cours d'une saison de pêche (1998 ou 1999).

Senne: la senne tournante sera testée par un navire sennier de Méditerranée au cours de la saison 1998.

Palangre: différentes adaptations de la palangre seront essayées à partir de navires de la zone, équipés et ciblant habituellement le requin-taupo. Ces essais prendront place en 1998 et 1999.

Les résultats des différentes expériences feront l'objet d'une évaluation économique, permettant d'apprécier la viabilité et la rentabilité des nouvelles techniques, ainsi que les effets de leur introduction sur les pêches communautaires.

PROJECT N° 98/010: DIVERSIFICATION TRIALS WITH ALTERNATIVE TUNA FISHING TECHNIQUES INCLUDING THE USE OF REMOTE SENSING TECHNOLOGY

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SUMMARY

The summer driftnet fishery for Albacore tuna has become increasingly important for the Irish fleet since 1990 and has resulted in reduced fishing pressure on traditional quota species during the summer months. However the driftnet fishery has also been the cause of much controversy, resulting in a total EU ban by the end of the year 2001. In order to offset the negative social and economic repercussions of this ban, dedicated commercial trials funded by the EU to establish alternative tuna fishing techniques including pair pelagic trawling, mechanised trolling and surface longlining were carried out as part of a two year project. This project also aimed to assess whether remote sensing technology being used in other parts of the world to identify optimal fishing area to aid catching of Bluefin tuna, could be applied to specifically target Albacore tuna in the North Atlantic.

During 1998 and 1999 four pairs of Irish vessels were chartered to fish with tuna pair pelagic trawls. These vessels fished off the South-west coast of Ireland and also in the Bay of Biscay. In 1998 catches were poor with only 65 tonnes of Albacore landed, although these preliminary trials concentrated on perfecting the trawling techniques. Largely due to improved understanding of the fishery and fishing methods in conjunction with extensive gear modifications, catches increased to 166 tonnes of Albacore tuna in 1999. The vessels achieved daily catch rates of 1 — 1½ tonnes per vessel per night, which are consistent with catch rates reported by French pelagic vessels participating in the same fishery.

For the two years of the project three vessels participated in commercial trials with mechanised trolling equipment. In 1998 catches were poor with only 1½ tonnes caught. Again due to a better understanding of the fishery and methods including a better understanding of fish detection and location, catches in 1999 increased to 12 tonnes. However, economic analysis showed that for this method to be viable daily catch rates of around 400-500 kg are required, compared to the best catch rate obtained of only 258 kg for 6 days during the trials. Therefore it was concluded that further work was required to perfect this technique fully in order to be able to compete effectively with the Spanish trolling fleet.

In 1999 one vessel was fitted with a surface longline system but based on the results of this trial and from the results from similar experiments carried out by IFREMER in France, this type of gear does not appear a viable alternative to driftnetting for Albacore. From a thirty day period only one Albacore was caught, with a by-catch of Blue shark, Bluefin tuna and Swordfish.

Biological data routinely gathered over the two years showed that pair pelagic trawls tended to target older, 4, 5 and 6 year old Albacore in contrast to driftnets in the fishery off the South-west coast of Ireland. From a stock management perspective this is considered highly desirable given the concerns expressed by ICCAT in recent years at the state of the Northern Albacore stock. In the Bay of Biscay the catch from the pair pelagic vessels was

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largely made up of 1 and 2 year old fish. This applies equally, however, to the trolling, pole-and-line and gillnet fleets that exploit this stock as well as the pair pelagic vessels in this area. The biological data for the trolled caught Albacore showed a similar length frequency distribution to the driftnet data, with the catch made up of predominantly 2 and 3 year old fish.

The analysis of catch data from the 1999 results indicate that Albacore catches are influenced by temperature fronts and that catches are higher closer to the fronts. This would strongly indicate that sea surface temperature information would be beneficial to fishermen. However, cloud cover in the Northern hemisphere, which prevents consistent data being gathered would seem to be a limitation to employing remote sensing technology in the tuna fisheries off the South-west coast of Ireland.

To conclude the project a final workshop was held in November 1999, and fishermen, Irish and French netmakers, sales agents and fishermen's representatives met to discuss and review the findings of the project. It was clear from the results that while surface longlining was not worth further consideration, pair pelagic trawling and trolling are viable alternatives for Irish fishermen to pursue when the driftnet ban is introduced in 2002.

PROJECT N° 99/030: FISH AGGREGATING DEVICE (FAD) FISHERIES IN THE EASTERN MEDITERRANEAN: AN ALTERNATIVE TECHNIQUE TO ENHANCE PELAGIC FISH CATCHES AND DIVERSIFY FISHING EFFORT?

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SUMMARY

The objective of this project was to gather the appropriate data, which could provide a description of the major characteristics of the FADs fishery in Greek and Italian waters, clarifying certain aspects related to fish communities associated with FADs. In particular, FADs fisheries do not take place in Greece and hence this project is considered to be a “pilot” one, dealing with the investigation of the possibility to introduce this practice in Greek waters. Different constructions of FAD units (i.e. with palm branches, polystyrene blocks and frayed ropes) were deployed in selected areas off southwestern Peloponese, in the Thracian Sea and off southern Sicily.

Field operations took place from September 2000 till November 2001, and comprised fish samplings using a commercial surrounding net, and/or underwater visual census. Total fish abundance, number of species and length range of the species that conformed the FAD community were significantly related to season (recruitment period), resulting in a sequential colonization of the FADs along the study period. Certain abiotic parameters and particularly temperature, seemed to have also a strong impact on fish assemblages associated to FADs.

A total of 7 families and 15 species were recorded beneath FADs in central/eastern Mediterranean Sea waters. The fact that those species were not collected in control (open sea) areas, suggests that they are typical of FAD communities. Pelagic fish dominated the fauna, with certain Carangidae species and *Coryphaena hippurus* accounting for over 70 % of the individuals associated to FADs in the three study areas. Almost all specimens of the fishes associated to FADs were juveniles.

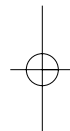
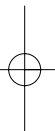
Among the different FAD types used in this study, the one with palm branches seemed to be the most effective in aggregating fishes, with certain species appearing to take refuge between or under the fragments of the submerged palm branches and others exhibiting trophic relations with floating structures. The commercial net used appeared to select relatively large fishes, (particularly *C. hippurus*, *Naucrates ductor*, *Sarda sarda*, *Seriola dumerili*) limiting by-catches, coinciding with small-sized juveniles.

Our data suggested that FADs in central/eastern Mediterranean waters seem to be effective in attracting several fish species, and can be regarded as temporary habitats shared between those fishes. These data, however, provide preliminary indications and underline the necessity of further research to be conducted, in order to elucidate specific matters



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associated to FADs aggregations and clarify certain trends, that would then possibly allow the extraction of reliable conclusions in the context of developing a respective sustainable fishery.



Domain 4: Miscellaneous Data Collection and Assessment



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Sub-domain 4.1: Data Collection of Poorly Studied Species and Areas

PROJECT N° 99/055: DEVELOPMENT OF ELASMOBRANCH ASSESSMENTS (DELASS)

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SUMMARY

Fisheries research has traditionally focussed on commercially important teleosts, whilst elasmobranchs (sharks, dogfish, rays and skates) and chimeras have received less attention. In recent years, however, there has been increased interest in elasmobranchs from both fishermen looking for alternative fish resources, recreational anglers, various NGO's and the wider public.

The Ministers of North Sea countries explicitly mentioned their concern about elasmobranchs when they met in 1997 (DAM, 1997). FAO has asked the European Community, as well as all individual countries, to prepare a Shark Action Plan. Compared to commercially important teleosts, little is known of the elasmobranchs taken in European fisheries. If landings statistics are available, these are usually for several species combined (e.g. "skates and rays") and species-specific data are rare.

Due to their biological characteristics (slow growth, late maturity, low fecundity) elasmobranchs are particularly vulnerable to over-exploitation. Even when they occur as a relatively unimportant by-catch, there is a real risk of severe depletion or extinction of rare species with a consequent loss of biodiversity. In 1997, the ICES Study Group on Elasmobranch Fishes (SGEF) was asked to carry out analytical assessments of the major elasmobranch stocks in the ICES area, but could not do this because its meetings were poorly attended, and because insufficient biological and fisheries data were available.

As a consequence, SGEF initiated the DELASS project. First, two meetings were held in 1999 as part of an EU-funded Concerted Action, to prepare a research proposal for the development of elasmobranch assessments. This proposal led to the 3-year DELASS project, which started in 2000. In all, 15 research institutes, plus two subcontractors, participated in the project. The study area was the Northeast Atlantic from the Azores to Norway. The Mediterranean Sea was not included. As an aid to developing appropriate assessment methodologies for elasmobranchs, DELASS has focused on 9 case study species that can be considered representatives of larger ecological groups: deep-water sharks (4 species), pelagic sharks (1), coastal dogfish and catsharks (2), and skates and rays (2). The stock areas which have been considered ranged from the Cantabrian Sea for the lesser spotted dogfish *Scyliorhinus canicula* to the whole of the North Atlantic for the pelagic blue shark *Prionace glauca*. These species were chosen because they were known to have some commercial importance, and importantly, it was expected that relevant data for these species existed in one or more countries.

Chapter 2 describes the objectives and the design of the project. The main objective of DELASS was the improvement of the scientific basis for the management of fisheries taking elasmobranch species. The major tasks identified were: 1) species identification and sampling, 2) description of stock identity, 3) data compilation and exchange, and 4) to carry out preliminary assessments of the 9 case study species.

Chapter 3 provides details on the fisheries taking elasmobranchs. Part of the project consisted of exploratory sampling of catches and landings and this is described in Chapter 4, including the results of some additional biological sampling. Stock discrimination approaches and information used to choose stock assessment areas for the case study species are given in Chapter 5.

Chapter 6 presents the actual assessments. The synthesis and conclusions of this study are given in Chapter 7, whilst Chapter 8 focuses on data requirements for future assessments and proposals for further research.

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There are 11 Appendices. Appendix 1 lists all elasmobranch species that are known to occur in the area covered by DELASS, Appendix 2 provides references to the literature on the case study species, and Appendix 3 provides a maturity key for elasmobranchs. Appendix 4 describes the format for data exchange developed in the project. Appendix 5 lists all reports and papers produced as part of the DELASS project and the papers that are intended to be written as a result of the project. Appendix 6 gives a detailed description of Portuguese elasmobranch fisheries, and Appendices 7 to 10 cover stock identity and biology of some of the case study species. Appendix 11 provides a review of available assessment methods. Conclusions: During the DELASS project, exploratory sampling of landings and catches has resulted in a qualitative and quantitative description of elasmobranch catches in Northeast Atlantic fisheries, and considerable progress has been made in making data available for stock assessment of elasmobranchs.

Preliminary assessments were carried out for 8 of the 9 case study species, for which the following conclusions can be drawn on their status: — The status of the stock of blue shark *Prionace glauca* (North Atlantic) is unknown and a more comprehensive assessment for the North Atlantic stock should be conducted, using data from NMFS (USA), DFO (Canada), ICCAT and EU. — Data on Portuguese dogfish *Centroscymnus coelolepis* and leafscale gulper shark *Centrophorus squamosus* (Northeast Atlantic) indicate a decline, but since much of the data for these two species are combined, the species can not be assessed independently. — The stocks of spurdog *Squalus acanthias* (Northeast Atlantic), kitefin shark *Dalatias licha* (Azores), and thornback ray *Raja clavata* (North Sea) have shown severe declines, and may be depleted. — Cuckoo ray *Leucoraja naevus* (Celtic Sea) has shown signs of increase and then decrease in the 1990s. — Lesser-spotted dogfish *Scyliorhinus canicula* (Cantabrian Sea) has shown an increase over the period 1991 to 2001. — For blackmouth catshark *Galeus melastomus*, not enough information was available to draw conclusions.

For any assessment to be carried out, it is essential that countries routinely identify the species composition of their elasmobranch catches. Species composition must either be known from the catch statistics themselves, or from reliable sampling programmes. It is apparent that sampling intensity for sharks and rays as indicated in the current EU Data Regulation Programme is inadequate, and, should significantly be increased. The DELASS project has given considerable momentum to the development of assessments of elasmobranchs in the Northeast Atlantic. There is now a sound methodological competence for assessing these species within the Community.

It is recommended that advantage should be taken of this situation through a follow-up project, which should focus on making good the biological data deficiencies for the most important species and of recent and historical catch levels, that have been identified in DELASS. It is considered that taking a more simple life history approach to assessing vulnerability to fishing might be the best approach for the many elasmobranch species that are mainly caught as a by-catch and often discarded, but form an integral part of the elasmobranch biodiversity. For most of these species, there will be no landings data and the only quantitative data available will be certain life history information and, for some species, research vessel catch indices.

PROJECT N° 99/063: DATA COLLECTION FOR ASSESSMENT OF CEPHALOPOD FISHERIES

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SUMMARY

The specific objectives of the study were:

- 1 — To collect basic fishery and biological data on cephalopod stocks not previously assessed;
- 2 — To collect data on previously studied cephalopod stocks to extend time-series of assessments for those stocks for which depletion methods have been shown to be appropriate; to determine stock trends and allow between-year and between-area comparisons;
To conduct interview surveys at fishing ports with fishermen and to conduct a limited number of onboard observation trips at appropriate locations for:
 - 3 — (a) estimation of unreported catch and effort and;
 - 4 — (b) basic economic description on the studied fisheries;
- 5 — To collect data for improved estimates of natural mortality;
- 6 — To estimate the amounts and condition of cephalopods discarded in the studied fisheries, particularly in countries with landing regulations;
- 7 — To evaluate alternative assessment methods (depletion methods, production models, etc);
- 8 — To maintain previous and newly acquired data to ensure the continued use of a widely employed database thus improving future availability;
- 9 — To create regional committees to exchange information between the study participants, the administration and fisheries representatives.

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All of the objectives were fulfilled by the different partners in ways that specifically met characteristics of the fisheries and data availability in each area, in order to level the development of the common knowledge in this field.

Results

Results of co-ordination meetings and of an assessment workshop indicated that the most important research path was the exploitation of the potential of depletion methods, due to the type and temporal coverage of the data series. In Aberdeen and Caen, partners produced real assessment exercises which are in the process of constituting published reference material. In Vigo, the IIM (CSIC) partner possessed data which permitted the use of productions models, which was hence exploited by that partner. In other areas and with different stocks, the work progressed to the stage where good data series allow the use of depletion models but important tests to the data have to take place before assessments can be finalised.

The socio-economic investigation of the fisheries constituted an important result in that it allowed a better understanding of the interactions between the resources and the communities, permitting the incorporation of otherwise unavailable data in the assessment exercises and allowing better future management perspectives.

The exercise of placing observers in fishing vessels was very successful since good working relations were possible. The smallest vessels in the fishing fleet which constitute the bulk of the fisheries in southern and Mediterranean countries are inaccessible to the deployment of observers and the use of friendly fishing masters filling in log-books is essential. Unfortunately, since it has been demonstrated that widespread use of these does not work in all fisheries, it can only work on a restricted level such as was the case within this study contract.

The communication of results to the interested public (specifically fishermen and fishing associations) may not easily be undertaken by any party without the specific consent and collaboration of those institutions officially given the task and it still requires the collaboration of the target audience. The success of that task was thus limited from the moment this was realised and it thus proceeded on a more personnel and informal way, done in conjunction with data collection activities in ports and auction sites and while collecting socio-economics data. It nonetheless constituted an important achievement of the study contract.

PROJECT N° 00/039: EXPLORATORY SURVEY TO COLLECT DATA OF THE EXPLOITED AND VIRGIN STOCKS OF DEEP-SEA SHRIMP *A. ANTENNATUS*, OF INTEREST TO THE CFP

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SUMMARY

The main objective of this project was to collect data regarding the maximum depth range distribution of rose-shrimp (blue or violet shrimp) in the Mediterranean sea. It represents an important target species in the fishery due to its economic importance. During this project, the rose shrimp was caught until 3300 m depth. It is the unique known commercial species that have this extraordinary depth distribution.

Rose shrimp was detected during 90's until 2200 m depth in western Mediterranean. In order to find rose shrimp at deeper waters, the research vessel Garcia del Cid of the CSIC and the trawl gear OTMS, were used. In the western basin of the Mediterranean Sea a maximum depth near 2900 m can be reach (off Algeria and Tunisia coast). But, in the Ionic Sea, depths up to 4000 we can be reach. Hence, a survey to explore these grounds was prepared. Number and weight of rose shrimp decreases with increasing depth. Maximum number and weight are found near 800 m at rates of around 1000 individuals per km². At around 1000 m depth the number decrease down to 200 individuals/km² and the presence of individuals decrease at levels of <10 specimens up to 3300 m. This last depth is the maximum where rose shrimp was detected. No significant differences were found between other biological parameters like, size frequency, maturity development or sex-ratio. Recruitment is suggested to take place at around 1500 m of depth, which is an other extraordinary finding in a commercial species.

Selachians species and other invertebrates were also counted and weighted and data of number and weight were also collected. The differences between areas and depths are bigger that differences observed between exploited and non-exploited population. The role of this species in order to compare the fishery impact between exploited and non-exploited populations is discussed. However, this data will be important as basis for future comparisons and as first data of density in deep-sea Mediterranean.

Hence the following main recommendations are made:

- I) we recommend that the fishery of rose shrimp maintain restricted areas above 900 m for a sustainable management.
- II) we recommend that studies that relate environmental conditions with deep-sea shrimps spatio- temporal movements and behavior be encouraged.

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- III) in relationship with selachians and other invertebrates We recommend that the deep-sea Mediterranean should be maintained unexploited in order to resource and diversity conservation.
- IV) we recommend to report the dumping of waste and to proclaim more restrict laws and punishments.

Sub-domain 4.2:

Optimisation and Standardisation of Data Collection for Management models

PROJECT N° 97/075: PREPARATION OF A PROPOSAL TO REVISE AND UPDATE THE ICES 'ATLAS OF NORTH SEA FISHES'

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SUMMARY

In 1993, the 'Atlas of North Sea Fishes' was published as ICES Cooperative Research Report nr. 194 (Knijn et al. 1993). The project was partly funded by the Commission of the European Communities, under the FAIR programme. Since the publication of the Atlas many new data have become available as well as new media to present this sort of information. Therefore a meeting was planned to discuss the production of a new Atlas. The meeting was funded by the EU (contract CFP 97/0075).

The principal topics discussed during the meeting were:

1. to compile a list of data sources and to review their suitability for inclusion in a revised Atlas,
2. to identify possible technical problems that might arise from changing the existing layout,
3. to consider the production of a CD-ROM which would contain both an electronic version of the Atlas together with additional features which this medium provides for presentation and retrieval of the data,
4. to draft a proposal 'for the update, revision and expansion of the ICES Atlas of North Sea Fishes' to be submitted to one of the calls for proposals of the EU in 1998.

The main source of information for a new Atlas will be the quarterly IBTS surveys (1991-1996). Additional information will be derived from other sources such as: summer and winter IBTS surveys in previous years, the Norwegian Pandalus survey, the ICES offshore beam trawl survey, the ICES demersal inshore beamtrawl survey, the ICES 0-group gadoid survey and the ICES acoustic herring survey.

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The first Atlas gives comprehensive information, including references to recent literature, for most of the common North Sea fishes. By including more information in the new Atlas, such as length-weight relationships, von Bertalanffy growth parameters etc., it will be tried to make the new Atlas THE source reference for all basic biological information concerning North Sea fish.

No technical problems are anticipated in preparing the new Atlas. However, because results of the IBTS surveys can not be easily merged with the other surveys, the additional information will be presented separately.

The production of an electronic version of the Atlas on CD-ROM is certainly feasible. This version would essentially follow the paper version but with the addition of features only available in digital media (i.e. animated charts, selective retrieval of data behind points etc.), and an extensive dataset of which flexible selections can be made and downloaded. The digital format of the CD should be platform independent as far as possible and allow publication of selected items on the Internet.

PROJECT N° 97/107: DEVELOPMENT OF SOFTWARE TO ESTIMATE UNREPORTED OR MISREPORTED CATCH AND EFFORT DATA AND TO APPLY FISHERY MANAGEMENT MODELS

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SUMMARY

The aim of this study is to develop a software for estimation of unreported or misreported catch and effort data using the approach developed by Gomez Munoz (1990), and successfully applied to a small-scale squid hand jig fishery of the NW Iberian peninsula (Simon et al, 1996). The target species of this study were hake, megrim, monkfish and commercially exploited cephalopod species (long-finned squid, short-finned squid, cuttlefish and common octopus) mainly from areas VI, VII and VIII of ICES but also from some divisions of the areas IV and V were the Scottish fleet operates. A total of 82 fishing ports along the Galician coast (NW Spain) and 25 ports in Scotland were studied from January 1998 to December 1999. Fleet and data on catches of the above mentioned ports were obtained for 1997 and 1998. A total of 32 Galician and 4 Scottish ports with catch of the target species was selected. Monthly catches of the target species for 1997 and 1998 from landings in these ports were obtained. A sampling fieldwork in the ports with highest target species landings (8+4) was undertaken to get direct landing data. An interview protocol was created and improved. On the whole, 504 interviews were made in the 32 Galician ports and 26 interviews in Scotland, respectively. The whole set of data (fleet, landings, direct catch data and interviews) were analyzed, classified and introduced in a database created for this purpose. A software named CELTA was developed. This software allows to introduce fleet data for each port and interviews data, and to obtain:

- 1) Categorization of the ports by fishing ground and fishing gear to select the model port;
- 2) Total catches by species, fishing ground and gear in the model ports;
- 3) Total catches in the remaining ports from results obtained in each model port, considering the number of vessels of the same characteristics in each port;
- 4) Catches per unit effort for each gear, fishing ground and species in each model port;
- 5) Catches per unit effort in the remaining fishing ports. A minimum of 30 interviews for each combination of species, gear and fishing ground is necessary to obtain realistic catch and effort data.

Accuracy of the catches obtained from interviews processed by the software was assessed by comparison with direct catch data. Bias between landings and data from the model is discussed. The results of comparison can be summarized as follows:

Galicia. Hake for 1997. From fishing market (FM)=13,403 tonnes; from the model (M)=16,329 tonnes; bias=17.9 %.

Cuttlefish for 1997. From FM=790 tonnes; from M=1,167 tonnes; bias=32.3 %.

Common octopus for 1997. From FM=3,835 tonnes; from M=4,668 tonnes; bias=17.8 %.

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For the remaining target species is necessary to undertake more visits to the post to get more accuracy for fleet categorization. Moreover, it is also necessary to make more interviews for obtaining more accurate results from the Gomez-Munoz model.

Furthermore, the bias found between landings from fishing market and the sampling network developed for this project considering the eight most important posts (sampling network always found higher landings than fishing market statistics) for 1997 were: 13.3 % for hake, 14.0 % for monkfish, 15.2 % for megrim, 14.7 % for long-finned squid, 30.1 % for short-finned squid, 19.3 % for cuttlefish and 24.8 % for common octopus.

Scotland. Hake for 1997. From fishing market (FM)=1,396.29 tonnes; from the model (M)=1,758.54 tonnes; bias=20.6 %.

Long-finned squid for 1997. From FM=308.7 tonnes; from M=324.08 tonnes; bias=4.6 %.

Megrim for 1997. From FM=2,242.24 tonnes; from M=2,512.20 tonnes; bias=10.7 %.

Monkfish for 1997. From FM=5,335.08 tonnes; from M=4,884.48 tonnes; bias=8.0 %.

On the whole, after the analysis of the data from all possible sources and the knowledge of the fisheries it can be concluded that CELTA software works properly. However, more interviews and visits to the port are necessary to obtain more realistic data. This study will be undertaken under the study project CE 99/063.

**PROJECT N° 99/002: ALTERNATIVE USES OF DATA FROM
SATELLITE MONITORING OF FISHING VESSEL ACTIVITY
IN FISHERIES MANAGEMENT: II EXTENDING COVER TO AREAS
FISHED BY UK BEAMERS**

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SUMMARY

Recently a large number of European fishing vessels have to transmit through satellite communications permanently their positions at sea.

A research project was carried out between mid 1998 and mid 2001 in order to investigate further applications and uses of the data obtained by this satellite monitoring system. These applications could become to a wider field than the firstly aimed information on positions at all time. One of this further applications could be in the field of fish population studies.

In 1997 a Commission Regulation laid down rules for the application as regards satellite — based vessel monitoring systems. Satellite-tracking devices were installed on board of fishing vessels had to ensure the automatic transmission during each fishing trip to their fisheries monitoring centre at all times (at least every two hours) of the date and time of the fishing of the position of the vessel. Although these schemes were aimed primarily at monitoring the activity of the vessels, they provide a unique opportunity to be also used for fishery biologists as input data for their studies.

One of the most vital parameter in the models used for the assessment of exploited fish stocks consists in the determination of the fishing pressure (= hours fishing, days at sea, number of vessels, etc). Fishermen's logbooks were the only pieces of information so far on this fishing pressure. These data are unfortunately sometimes liable to errors (unreported or misreported catches) and might therefore in many cases underestimate the effective pressure and subsequently the effective number of removals from the sea. Thus the underestimates could undermine the advice on stock exploitation prospects.

This project is directly linked into another with the Netherlands and Belgium enabling the fully covering of the three main beam trawl fleets.

The original proposal contained a long list of possible uses for the scientific community. Therefore the wide range of project objectives and tasks were distributed amongst both projects to ensure that all aims of the project were fulfilled over the two reports.

First of all, the most important information needed for scientific purposes and for management purposes was the geographical description of the fishing activities. This project provided for the first time a clear and unbiased coverage of the spatial distribution and activity of the major beam trawl activities in the North Sea and surrounding areas. This picture became thus available by season and by country and enables managers to determine — if needed — areas to be closed for fisheries or suitable for changes regulatory

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measurements. It may also be used as a guide for the other fishing methods used in the area.

In addition this project showed the possibility to enlarge the initial applications from this research as unbiased catch performances, environmental indicators, fleet behaviour and research vessel data.

The project thus provided an extensive review of future applications of the "satellite based vessel monitoring system" (VMS) in the biological studies concerning fish population exploitations.

**PROJECT N° 99/040: COLLECTION AND EVALUATION
OF ASSESSMENT DATA FOR KEY EUROPEAN EDIBLE CRAB
(CANCER PAGURUS L.) STOCKS**

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SUMMARY

Although the edible crab, *Cancer pagurus* L., supports valuable fisheries throughout NW Europe there are no satisfactory examples of recent assessments as to the status of these stocks. Although there are a number of possible options available for the assessment of this species, their application is often hampered by a lack of suitable input data relating to species biology, behaviour, distribution, or fishing data. Here we describe and evaluate existing catch and effort data sets for England, Ireland and Wales. Temporal and spatial variability in these data indicated they may not be representative of the stocks as a whole. The limitations of existing data collection schemes, including the EU logbook system, are discussed. Development and trials with electronic logbooks showed potential in providing 'real-time' data collection that could be used to validate the accuracy and reliability of other data sources. Suitable protocol for routine collection CPUE data to assess stock status is addressed. Controlled and semi-controlled depletion experiments were conducted in an attempt to estimate crab population density. Depletion catch data and mark-recapture information on movement rates and variations in catchability were combined to provide population estimates from a specifically designed open population model. Data suggested that stocks are extremely mobile at certain times of the year with varying catchability. Although it may not be feasible to conduct these designed experiments for routine fisheries monitoring due to labour-intensity, it may be possible to develop models for use in conjunction with logbook data where depletions have been recorded in the course of normal fishing. Length-based assessments are a further management option for edible crab stocks. Existing length distribution data were analysed to ascertain the correct spatial and temporal scales on which future data should be collected to provide a representative index of the sub-populations that constitute each stock as a whole. Sample sizes required to obtain these representative length distribution data are discussed. Only when suitable data collection regimes have been fully established can the next steps towards suitable robust stock assessment take place. The data presented and evaluated in this report provide a sound basis on which to proceed with such programmes, and is likely relevant to all fisheries for *Cancer pagurus* in Europe.

Domain 5: Fleet studies (fleet behaviour)



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Sub-domain 5.1:

Economic Performance/analysis

PROJECT N° 00/032: DATA ON ECONOMIC PERFORMANCE OF FISHERIES SECTOR

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SUMMARY

Since 1994 a gradually expanding group of research institutes and consultants has been working on the development of a common approach for economic evaluation of the performance of fishing fleets and the corresponding collection of the required data. Between 1994 and 1997 the Concerted Action on 'Co-ordination of research in fishery

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economics (AIR2 CT94 1489) had agreed upon the basic principles of analysis, data definitions and presentation of the report. In the subsequent period 1998-2000, the Concerted Action 'Promotion of common methods for economic evaluation of EU fisheries (FAIR PL97-3541) this work was continued. The number of institutes was expanded from six to fifteen, covering not only the entire EU, but also Norway and Iceland. This project focussed on two main activities:

1. Preparation of the Annual Economic Report (AER) on the 'Economic performance of selected European fishing fleets. This report contained statistical time series and analysis of some 50 segments of fishing fleets.
2. Economic Interpretation of the ACFM Advice (EIAA), based on a model, which was developed by the two projects.

The results of these projects were evaluated annually by the Scientific, Technical and Economic Committee on Fisheries (STECF) and used by national as well as European authorities. Particularly, use was made in second part of the EU Green Book on the Review of CFP in 2001.

The work of these projects was to be continued as of October 2001 in a third Concerted Action 'Economic Assessment of European Fisheries (EAEF). However, the second Concerted Action terminated in January 2001. Consequently there was gap between January and October, during which data regarding the year 2000 to be included in the 2001 Annual Economic Report could not be collected and the preparation of the report would have been jeopardised. In order to prevent this discontinuity, the present project 'Data on economic performance of the fisheries sector' was proposed, with the primary aim to allow the data collection and preparation of the 2001 report.

Objectives

General objective of the project was to contribute to Collection and management of data required for fisheries assessment, particularly in the following areas as specified in the call for proposals:

Ad 1. Evaluation of various fishing fleets activities and changes in fishing power

Ad 2. Data from commercial fisheries

Ad 4. Collection of the prices associated with the various landings

Ad 5. Data for economic monitoring of fishing enterprises and the processing industry in order to evaluate the economic state fishing fleets:

Specific objectives of the project is to up-date and expand time series on costs and earnings of specific fleet segments and set-up time series on monthly and annual prices and landed volumes by country and species.

Originally this project also foresaw to collect data from the fish processing industry, but this task had to be abandoned due to the imposed cuts on the proposed budget.

The project aimed to compile data regarding the year 2000. Already at the outset the project team was aware that collection and processing of data on the year 2000 during the first eight months of the following year was an extremely ambitious task. In many cases the accounting of the companies is only consolidated in the first or even second quarter of the following year. Subsequently, the first priority of the firms is evidently to make their fiscal declarations. This implies that the for example costs and earnings data on fleets becomes available for research purposes at the earliest in the course the second quarter of 2001 and in many cases even later. The specific problems encountered in the various countries are elaborated upon in their respective chapters.

The chapters of this report present the work programme of each partner together with the results obtained. The report presents costs and earnings data without further analysis. Analysis of the fleet performance was carried out in the context of the 'Annual Economic Report 2001', which was prepared under funding from the Danish SJFI in October 2001

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Costs and earnings data by fleet segment

For each of the distinguished fleets segments the following costs and earnings data are presented in the statistical tables. This regards the annual values for the fleet segment as a whole. Number of vessels involved is also presented so that per vessel averages can be calculated.

- value of landings
- fuel costs
- other running costs
- vessel costs
- crew share
- depreciation
- interest

On the basis of the above values various indicators on economic performance are calculated further:

Gross value added: Value of landings minus cost paid to other (supplying) industries. The remaining amount is the reward for labour and capital, employed in fisheries. It is the sum of cost of labour, depreciation, interest and the net profit. The gross value added is also expressed per employed, for reasons of comparison.

Gross cash-flow: Value of landings minus all expenses, except depreciation and interest. This indicator shows the amount available for interest payments and repayments of loans and also for depreciation and interest regarding own capital.

Net profit: Value of landings minus all cost, including depreciation and an imputed interest amount. This balance is the reward for entrepreneurship.

Employment and technical data by fleet segment

Furthermore the tables present other more technical indicators, which are usually of relevance, for example for analysis in relation to Multi-annual Guidance Programmes (MAGPs)

- employment on board
- invested capital (national currency of EURO)
- fishing effort (1,000 days at sea)
- volume of landings (1,000 t)
- fleet — number of vessels
- fleet — total GT (1,000)
- fleet — total kW (1,000)

Price information

Finally, monthly and annual prices by species are presented in the various national chapters, depending on the kind of data available. Price information is evidently highly relevant in the context of economic analysis. It allows, inter alia, to determine the expected revenues at a given level of TACs.

Considerations on data collection

Some EU Member States have developed their own systems to collect economic data on the performance of fishing fleets. Other countries do not yet have a consistent data collection system. In the last chapter of the report a proposal for such system has been elaborated, based on experiences in the United Kingdom.

Conclusion

Institutes involved in the project have managed to compile and present data, definitions of which are based on one common method. Continuity of the EU-wide data collection system, established under the earlier Concerted Action has been maintained, reinforcing the European scientific integration in this area.

Sub-domain 5.2:

Fleet Capacities

**PROJECT N° 97/033: EVALUATION ET ÉVOLUTION
DES PUISSANCES DE PÊCHE DES FILEYEURS FRANÇAIS**

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SUMMARY

When using the fishing days as a unit of fishing effort, the fishing power in a fishery depends on the quantity of nets hauled each day. The length of nets is an important factor explaining the variability between vessels. Three french netting fisheries were investigated: one targeting on crustaceans (spider crab), three others on fish (anglerfish, hake, sole). This study is a contribution for the evaluation and the evolution of fishing power. For the evaluation we used the years 1996-97. For the evolution we studied periods included between 1986-1997.

We carried on the studies by working directly with samples of log-books correctly filled by fishermen. So the number of boats selected are weak.

The evaluation of the influence of net length hauled in a day was assessed by Component Principal Analysis for data concerning a predetermined fishing area and season. This analysis indicate that the length of nets is depending on the size of vessel for the fin-fish fisheries. The number of crew men is also related to the length of nets. No direct link with CPUE expressed as the catches per net length was established, this means that there is no link between length of nets and local abundance.

The evolution during a recent period of years shows different results according to the ween 1992 and 1997. This increase is not due to the progress in technology. For the fisheries. For the spider crab fishery the net length per day increased from 3 to 5 km bet anglerfish fishery a variability between vessels was observed and globally no significant increase was detected between 1986-97. For the hake fishery an increase by 6 à 7 % per year was observed in the quantity of nets hauled in a day between 1986-97. In the sole fishery, an average increase of 16-18 % per year was detected and is probably an overestimate. Others informations suggest an average increase of 15 % per year which seems more realistic for the sole fishery.

PROJECT N° 97/047: INVESTIGATION OF THE INTENSITY OF FISHING ACTIVITY AND THE CORRESPONDING CATCHES OF THE GREEK FISHING FLEET

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SUMMARY

The commercial fisheries are both the final users of stock assessment studies and the source of some of the most important data used in these studies. Among the main types of data coming from the commercial fisheries, the amount of fishing effort and the corresponding catch are the most vital information without which any management scheme of the fisheries resources is meaningless.

For the purpose of the present study the fishing fleet was stratified in 5 segments on the base of the gears used: Trawls, Purse seines, Beach seines, Drifting and bottom long lines — Gill nets. Moreover, provided that fishing capacity is greatly correlated with the length of vessels, the total fleet was stratified in 5-meter length intervals. During the time of investigation 7,064 samples of fishing effort on a monthly basis were collected while 5,120 landings were sampled and 10,441 vessels were monitored.

Fishing effort has been recorded in terms of days at sea and corresponding catches in Kilograms of total catch per vessel and day. The sampling time was around 10 days per month. Moreover the socio-economic component of the fishing activity was monitored, to evaluate the impact of this factor to the fishing effort.

The data were collected during the years 1998 and 1999 based on a system assisted by a computer network consisting of 21 sampling stations. In addition to these main sample stations, a large number of landing sites making a total of 177 (including the main stations), spread over the whole coastal area of the country, were sampled.

Estimates of the fishing effort in the various fleet segments indicated that trawls and beach seines spend less time at sea than all the other fleet segments. The distribution of fishing effort in the main fishing grounds clearly shows that the most active fishing fleets operate in the North Aegean followed in turn by those in the Central Aegean, the South Aegean and the Cretan shelf. This is in line with the general trend of productivity decline from North to South in the Aegean Sea. A similar trend from North to South is shown for the parameter of average catch per day of all fleet segments operating in the aforementioned fishing grounds.

The fishing effort data in relation to the size of the vessels indicated that trawlers utilise all their fishable time almost independently of their length. On the contrary a trend of more days at sea for larger vessels is obvious for purse seines and beach seines, while no any correlation of effort to vessel's size has been identified for the drifting long lines and artisanals. Concerning the catch per day at sea in all fleet segments, excluding purse seines, it is obvious that the larger the vessel the higher their catch per day.

The results of this study indicated that Greek fishing fleet could be divided into two major groups of vessels: The first group includes the trawlers, purse seines beach seines and drifting long lines. This group displays a professional character by using the maximum number of the fishable days. The second group, which constitute the Greek artisanal fleet, display a semi professional profile, since only about 55 % of those display full time activity. Further an investigation of the socio economics of the fleet showed that the largest contribution to the production cost is the labour.

PROJECT N° 99/005: MEASURING CAPACITY OF FISHING INDUSTRIES USING THE DATA ENVELOPMENT ANALYSIS (DEA) APPROACH

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SUMMARY

The overall purpose of the project has been twofold: methodological and empirical. The application of the Data Envelopment Analysis (DEA) method to analyse fishing capacity is very recent and still not fully developed towards fishery applications. Therefore during the work several methodological issues were treated, issues that have not been handled before in the literature. Empirically, the DEA method has been applied to many EU fisheries, all of very different nature. The results from the various stages of the analyses provide a useful insight into capacity utilisation and levels of excess capacity. Two different approaches were undertaken, the firm level and the industry level approach. The individual vessel analysis provides information about the capacity utilization, while the industry analysis shows possible reduction in the fleets. The data requirements of DEA analysis are not very high because the analysis can be done with a minimal dataset; however, the main barrier is that the data needs to be at firm level.

Generally, the analyses have been privileged by the comprehensive and detailed amount of data available. The DEA analyses have provided realistic and reliable results, which highlight interesting and usable characteristics of the capacity development. It is thus the general belief that the DEA analysis, and related utilization of the considered fleet segments. The second stage and the industry level analyses moreover yield interesting results, and seem to have considerable potential for further analyses, may be a valuable tool in future management of EU fisheries.

PROJECT Nº 00/024: STANDARDIZATION OF THE SPANISH BAIT BOAT CPUE SERIES FOR EASTERN ATLANTIC JUVENILE BLUEFIN TUNA

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SUMMARY

The Standing Committee for Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT) assesses the eastern stock of bluefin tuna by means of the model ADAPT VPA. This model uses Catch Per Unit Effort (CPUE) series from different bluefin tuna fisheries as relative abundance indices for its calibration. In the last assessment in 1998, 5 CPUE series were used, of which the Spanish baitboat index, used as a recruitment index of the eastern stock (i.e. as an index of incorporation to the fishery of age 2) was the only non-standardised series (nominal CPUE). The SCRS-ICCAT working group made a strong recommendation to standardise the CPUE series for the Spanish baitboat bluefin tuna fishery of the Bay of Biscay.

Nominal CPUE employs nominal effort, which is the measurement of the set of elements which fishermen use to catch fish in a given time. Nevertheless, it is the effective effort proportional to fish mortality due to fishing activity which is of relevance to assessments. Through the standardisation of nominal CPUE, this effective effort is obtained and catch rates are used to take changes in efficiency of the fleet into account. Additionally, this process provides a measure of error in the estimate of abundance indices at age (coefficients of variation) which means that they will have a greater or lesser effect on the tuning of the assessment model according to whether they are low or high, i.e. an inverse relationship.

The aim of this project was to standardise the abundance index of age two, and at the same time those of the remaining ages caught by this fishery. To this end it was necessary to use new information, additional and different to that which has been used to date in order to obtain the nominal index of age two.

New catch and effort data on bluefin tuna from two sources were used in this study: catches by trip and catches from logbooks. The processing of these two relational databases together with the revision of fleet characteristics and the creation of a new database with oceanographic data permitted changes in fishing power and the influence of the environment to be taken into account in the abundance indices.

Relative indices of abundance for bluefin tuna of all well represented age classes in the fishery were estimated. The coefficients of variation of these indices for ages 2 to 4 are small, whereas those of ages 1 and 5 onwards are high. In the case of age 1 this is due to the irregularity of the annual presence of this class, which mainly appears at the end of the

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fishing season, making it the last to disappear. The changes in migratory behavior of the ages over 4-5 years, related to spawning in individuals reaching sexual maturity, may explain their scarce appearance in the area. The different migratory behavior of different ages determines their temporary appearance in the Bay of Biscay.

Analysis was performed on the catch rate data in order to get a better understanding of which factors significantly explained the observed variability. Abundance at age throughout the fishing season are reflected in the explanatory factors of the selected final model used in standardisation: Year, Age, Year*Age, Month and Year*Month interaction. The other two significant factors, crew number and number of bait tanks, also reflect their importance on catches due to the fishing system itself. Regarding the crew number, the use of rods which may be handled by one or three men depending on the size of the tuna, gives this factor great importance. On the other hand, the number of bait tanks determines the quantity of bait available, both to attract fish and to bait hooks, which enables longer periods with the possibility of fishing without having to break off and go in search of bait.

The models selected for the standardisation of the two databases, trips and logbooks include the same explanatory factors. Overall, both year trends and coefficients of variation were similar from both datasets by age-class.

The baitboat fleet targeting bluefin tuna in the Bay of Biscay from 1975 to the present is described. The total number of vessels has remained constant at around 25, all based in the port of Hondarribia except from 1996 to 1998, when boats from the port of Guetaria were incorporated. A total of 78 boats participated in the bluefin fishery throughout the study period, which were divided in 3 groups. The use of black and white sonar became generalised at the end of the 70's and other technological advances have increased throughout the study period at a more or less similar rate throughout the fleet.

In general, the standardisation procedure showed that vessel characteristics and fishing related instrumentation have a relatively minor explanatory effect on the observed catch rates for bluefin tuna in this fishery. Geographical distribution had no explanatory effect on the observed catch rates. The concentration of catches in such a reduced area (90 % in 2 to 4 W and 43.5 to 45.5 N) does not permit the discrimination of this variable.

No statistical differences were found between historical nominal CPUE (currently used as a recruitment index of the eastern stock) and the nominal CPUE of age 2 obtained in the present study. Nevertheless, when this historical index for age 2 was replaced by the new standardised indices for ages 1 to 4 (and their corresponding coefficients of variation) in the calibration of the Virtual Population Analysis, a large influence on recent perceptions of the stock was observed, showing a more optimistic view in particular for the younger ages.

Relationships between bluefin tuna daily catch rates in the Bay of Biscay and remote sensed environmental variables, onboard recorded temperature and spatial variables (latitude and longitude) were tested for the period 1997-2000. Some environmental variables were selected and added to the final model selected to standardise the bluefin catch rates. The model explained 50 % of the variability of catch rates, and 4 % was due to environmental factors.

Sub-domain 5.3:

***Assessment and Development
of Fishing Power***

PROJECT N° 97/027: PUISSANCE DE PÊCHE ET RELATIONS AVEC LES CARACTÉRISTIQUES TECHNIQUES DES NAVIRES. EXEMPLE DE FLOTILLES PRATIQUANT LES ARTS TRAÎNANT EN MANCHE OUEST, ATLANTIQUE ET MÉDITERRANÉE

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SUMMARY

Three fleets of the French fishery are investigated: the dredge fleet of the Western part of the Channel, the bottom-trawl fishery of South-Brittanny harbours, and the Mediterranean trawl fishery. Landing and effort data by species, vessel and trip lead to yields (catch per unit of effort) which are analysed by a multiplicative model with two or three factors. Individual fishing powers are then quantified for some given years, together with variation in relative abundance of the stock within area and/or period strata. Attempts to explain these fishing powers by vessels characteristics are made.

After the study of the Mediterranean trawl-fleet, which takes Year into account in the model, two multi-annual series are analysed, and some conclusions on fishing power variations along time are obtained.

The amount of total variance explained by the model depends on fisheries and stocks. The three factors retained for the South-Brittanny study (Vessel, Month and Areas) account for 50 to 80 % of the total variance. For the Mediterranean data, 15 to 50 % of the total variability of yields are explained by a three-factor (Vessel, Month, Year) model. Whatever the model retained, the quality of the model mostly depends on data quality. Biased data of landings or effort usually leads to bad fits. It is also noted that the quality of the fit decreases when the stock abundance decreases.

If the fishing powers (Vessel effect) mostly stand for the main explicative factor of the yield variability, the engine power of vessels does not appear as the main source of variability of vessel efficiencies.

A multi-annual study of the yields of warty venus shows that sudden increases of individual efficiency seem to be explained by changes of skippers or changes of engines.

For Saithe off the West Coast of Scotland, the 1983-1997 period has been divided in two in order to take into account the dramatic decrease of this stock abundance since 1990. The two main fleets involved in this fishery show different ways of variations: the most powerful vessels have lost part of their efficiencies, while the less powerful have increased their fishing powers. Engine powers seem to explain rather well the individual values of fishing powers. However, it is important to note that fitted models do not show any variation in the differences between fleets. Furthermore, differences in fishing power still exists between vessels within a fleet, despite the fact that they are quite similar in terms of technical characteristics.

Any further study requires a good knowledge of any technological and human changes which have occurred during each vessel life.

**PROJECT N° 97/073: IL CONSUMO DI CARBURANTE QUALE
METODO DI MISURA DELLO SFORZO DI PESCA**

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SUMMARY

It is unanimously accepted that over the last years, the biological equilibrium of some marine species has been altered by several factors. The European Union, in order to reduce or, at least, keep constant, the fishing effort, stated several law measures either encouraging the fishing vessels demolition and/or their assignment to an extra-community country or preventing the building of a new fishing vessel unless replacing another of same registered tonnage or equally powered.

The power equivalence put in evidence a number of problems (de-rating, equivocal interpretation of the maximum power supplied by the engine etc.) which led to issuing a lot of law measures.

Up to now, however, this complex matter did not receive any convincing and definitive answer so that the Commission is still facing difficulties in establishing the true fishing power of vessels and gears.

This research is aimed at giving a proper and concrete answer to the EC needs as to checking and quantifying the fishing effort.

Moving from a review of the main fishing methods carried out over the Community waters, a careful examination was made of the main relevant parameters in order to identify, among them, which are mostly influenced by the fishing effort.

Some analysis, supported also by the results of several experimental fishing trips, led to conclude that the fuel consumed over the whole fishing trip could be a valid measure of the fishing effort since it takes into account either the fishing vessel catch capacity or the time which this capacity is exerted over.

PROJECT N° 97/092: AN ECONOMIC AND TECHNICAL ANALYSIS FOR IMPROVING THE EFFECTIVENESS OF EFFORT CONTROL IN THE CFP

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SUMMARY

This study examines the composition, structure and relationship of fishing effort to catch in the Scottish demersal bottom otter trawler fleet and the Greek open-seas trawler and seine net fleets. It also analyses the relationships between fishing effort and the targeting of different species within these fisheries. The fleets are of economic importance nationally. The Scottish fishing fleet accounted for over 60 percent of UK landings by weight and 55 percent by value in 1997 and the Greek open sea fleet 50 percent of total catch by volume and 39 percent by value. A common underlying theoretical approach to deriving effort catch relationships in both fleets is adopted through the hypothesis of vessel quasi-profit maximisation. Analysis of the Greek fleet was based on a survey of 140 vessels, whilst that of the Scottish fleet used vessel log book records for 10,400 individual fishing trips in 1997.

Cobb-Douglas production and input demand function estimates for the Greek fleets indicate inelastic catch response to quasi fixed factors of vessel power and vessel size for both fleets. The elasticity of days fished is greater for both fleets, and highly elastic in the purse seine fleet. Translog cost share functions were estimated by SUR maximum likelihood methods and indicate that the substitution elasticities amongst the major components of effort in the Greek fisheries are high. Catch elasticities estimated jointly by SUR for the major species sought by each fleet are low, but high for those fish species of lesser importance. Own and cross-price elasticities of demand are low for most species caught by the open sea fleet and price flexibilities consequently high.

Cost functions were estimated by OLS from previous survey data in order to simulate vessel profit per trip for the Scottish fleet. Generalised linear estimation and multi-layer perceptron neural network modelling techniques were applied to the Scottish trawler fleet data. Both produced comparable estimates that revealed inelastic and non-linear response to vessel power and length, negative response to vessel size (tonnage), and elastic response to both trip frequency and trip duration. Profit and catch-effort elasticities were greater for smaller vessels. OLS estimation of catch composition and effort showed that pursuit of species which might involve gear change at sea generally led to increased effort.

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Regulation of effort must focus on a range of fishing inputs where substitutability is high. Low quasi-fixed input catch elasticities imply the need for proportionately larger reductions to achieve a given reduction in catch. Regulation of fishing time should focus on both trip duration and frequency. Regulation of catch by species must take into account spillover-effects between major target species and on other non-primary target species, although economic complementarity tends to be dominant and implies that effort reduction will lower overall catches.

PROJECT N° 98/046: THE IMPACT OF CHARACTERISTICS PASSIVE GEAR ON FISHING POWER

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SUMMARY

One of the major conservation objectives of the EU fisheries policy has been to control/reduce the fishing effort in the biologically sensitive coastal zone. To reduce fishing effort, decommissioning schemes have been introduced, and limitations on the engine power and tonnage of vessels have been implemented. Although such limitations seem to be biologically justified, they have considerable economic and social trade-offs, due to the unavoidable reduction of the fishing opportunities. In particular, the limitations on engine power and tonnage influence adversely the fishermen's income, because they affect the capability of vessels to perform long exits, to reach distant fishing grounds, to withstand bad weather conditions and to handle bulky gear. In addition, small vessel size does not satisfy the modern needs for hygiene conditions.

Despite the socio-economic drawbacks of restrictions on tonnage and engine power, it is not clear how, and to which extent, changes in tonnage and engine power affect/modify fishing effort and catches. The present project was designed to investigate how engine power and tonnage of vessels employing passive gears affect some parameters of effort (number and duration of exits, fishing time, amount of gear, etc.) and the quantity and quality of catches. The project was undertaken in close cooperation with professionals, namely members of the fisheries cooperatives of the towns of Alexandroupolis and Kalymnos. More than 96 % of the fishing vessels in these two areas employ passive gear (nets, longlines and traps). In the frame of this cooperation, samples of vessels from each cooperative representing a wide spectrum of engine power and tonnage characteristics were selected and arrangements were made to study the impact of the length, tonnage and engine power of vessels on fishing effort. According to the sampling frame, the following groups of data were recorded for each trip conducted from each individual vessel of the sample: trip details (distance from the home port, duration of the trip, etc.), gear details (mesh size and other characteristics of net, number of hooks in longlines, fishing depth, etc) and catch details (volume and composition of the catch, species discarded, attained prices, etc.). However, it was not possible to keep records of all trips conducted by all sample vessels in the reference period due to that some vessels occasionally landed in ports other than the home port.

Alexandroupolis is a medium-size town in the northeastern part of Greece with sub-urban and urban characteristics, situated near the highly productive estuaries of R. Evros. The continental shelf is wide, with a biologically uniform and shallow coastal zone extending a long distance from the shore. Kalymnos is a small town in the rocky and dry island Kalymnos in the oligotrophic southeastern part of the Aegean Sea. The continental shelf is extremely narrow and most fishing areas are deep with hard substrate. Kalymnos is heavily dependent on fisheries and forms one of the most important fishing centres of Greece. In both areas most vessels are less than 9 m between perpendiculars. However, the biological, geomorphologic and socio-economic characteristics of the two areas reflect to particular patterns of resource exploitation.

In Alexandroupolis, the small depths, the smooth bottoms and the structure of the fish community have favoured the development of the fishery with nets. Although some large vessels perform fishing expeditions to more distant and deep areas, the overwhelming

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proportion of the local fleet remains in shallow waters and practice fishing in a highly productive fishing zone extending from Alexandroupolis to the R. Evros estuaries. Despite considerable seasonal variability of the target species, the fishing conditions in this zone are more or less predictable. For this reason, most vessels sail from the port having only one (pre-determined) gear and head towards a pre-decided fishing position. Due to the proximity of most potential fishing areas to the home port, small vessel size and low engine power do not restrict access to favourable fishing grounds. Effectively, when only vessels of small and medium size and engine power are considered, no strong effect of vessel size or engine power on travel distance, depth of fishing, trip duration and quantity and value of catches is evident. When the group of largest vessels (which, however comprise a small portion of the local fleet) is included in the estimations, the depth of fishing correlates with distance from the home port and both correlate with vessel size and catch volumes. These correlations are interpreted to suggest that deep fishing grounds are accessible only by large boats, which have high travel capabilities. Indeed, large vessels show a different type of activity than smaller ones, performing distant trips to deep fishing grounds where they use preferentially longlines and conduct bulky catches. Overall, for the greatest portion of the Alexandroupolis fleet, vessel size and engine power do not play a major role in the determination of the favourable fishing area. However, they become important regulators of fishing effort in two other major ways: through affecting the number of fishing days (small vessels are more sensitive to adverse weather conditions) and through determining the type and amount of fishing gear.

In Kalymnos, the great depths, the bottom topography and the biological conditions have favoured mainly the development of the bottom longline fishery. Generally, there is high heterogeneity of fishing conditions along spatial and seasonal gradients as regards depths, bottom substrates, weather regimes, fish species composition and local fisheries resources. The vessels are larger on average than the vessels of Alexandroupolis and are equipped with engines of higher capacity, reflecting the need for longer trips to areas where strong winds and rough sea conditions are commonly encountered. The depth of fishing showed no specific trend with vessel size. This is because deep waters can sometimes be found just outside the home port, and therefore are equally accessible by small and large vessels. Unexpectedly, the travel distance decreased with increasing vessels size. The reason for this unexpected relationship is that while the small vessels usually perform daily trips from and to their home port, larger vessels perform seasonal shifts to other ports that are close to favourable fishing grounds. Due to the proximity of the new ports to the fishing grounds, the daily trips are short and do not last long. Vessel length, tonnage and engine power were positively related to the quantity and quality of the catch. To some extent only this relation is influenced by the better capacity of the largest vessels to perform more distant and less exploited areas. A more important factor is the better capacity of the large vessels to use a greater variety and a greater amount of gear in comparison to smaller vessels.

In both study areas most fishing activity and catch parameters showed a better relationship with tonnage than with vessel length, implying that tonnage is a better indicator of vessel size than is length, and is also a reliable predictor of fishing effort and fishing capacity. The reason probably is that tonnage does not depend only on vessel size, but also on the design characteristics of the vessel. The engine power is not a reliable monitoring parameter of effort, first because it is not an independent variable (rather, it is empirically adjusted to vessel size), and second because under the current fisheries management regime they are unfair and discriminating against owners of small vessels.

Note that in Greece the engine power is a major tool for monitoring the reduction of the fishing capacity of the fleet and achieving the targets of the national MAGP. As the rules now stand the owners of fishing vessel are not allowed to replace their engines with other engines of higher capacity than that recorded during the fishing census of 1989. Due to frequent misreports of the engine power during the census, many small vessels were registered with a nominal engine power much lower than that actually needed for safe trips

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and profitable fishing activity. Because of the existing restrictions on engine power, the latter has turned to become an important regulator of effort. When, however, the engine power is below a necessary minimum determined primarily by vessel typology and vessel size, the vessel does not constitute an economically viable unit. Many fishermen have illegally replaced their engines with ones of the proper power for the dimensions of their vessels. Concluding, both the existing restrictions on power and the current use of the engine power as a monitoring parameter are not biologically and socially justified.

PROJECT N° 99/077: TECHNICAL IMPROVEMENTS IN THE ASSESSMENT OF SCOTTISH NEPHROPS AND ADRIATIC CLAM FISHERIES

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SUMMARY

This report presents the results of a study in which GPS-linked position recording units (PRUs) were used to study the behaviour three fishing fleets, two in Scotland and one in Italy. The Norway lobster (*Nephrops norvegicus*) is by far the most important shellfish resource in Scotland where one third of the total European catch is taken. PRUs were fitted to 18 vessels representative of the trawler fleet fishing for *Nephrops* in the Clyde Sea area and adjacent Sound of Jura on the Scottish west coast, and in a preliminary study on six vessels fishing the important Fladen Ground on the NE coast of Scotland. In Italy, the fleet studied was that fishing for clams (*Chamelea gallina*) in the Ancona District of the Central Adriatic, where this fishery is of major importance: PRU data were obtained from 17 vessels fishing by means of hydraulic dredge. Such spatially resolved data were used to generate high resolution maps of fishing effort and landings in all three areas.

For *Nephrops*, there may be considerable stock heterogeneity within relatively small areas. Population characteristics (e.g. density, animal size, growth) vary in a manner that correlates with the type of sediment present. Assessment methods that fail to take this variability into account when investigating spatially heterogeneous stocks may be prone to error. The present work has applied spatially resolved fishery dependent analytical methods at a resolution otherwise impossible. In addition to using data from market and discard samples, research-vessel-based underwater television (UWTV) cruises were used to estimate abundance from *Nephrops* burrow counts on sediment strata of differing granulometry. Trawl samples on these grounds yielded different mean animal size data for each of the different sediment categories. Such data were used to refine the input to analytical assessments. A preliminary investigation into depletion modelling as an analytical stock assessment tool for *Nephrops* showed promise in the Clyde (but not in the Sound of Jura), with abundance estimates generated for the Clyde that were consistent with those from more traditional approaches. This outcome may reflect the fact that fishing activity was more intense in the Clyde and was four times that in the Sound of Jura.

The Fladen Ground investigation was pilot in nature and suggested that most effort was occurring on the southern edge of the ground on sediments that were intermediate in the range of granulometries occupied by *Nephrops*. UWTV-based stock assessments indicate the Fladen to be the largest *Nephrops* ground in Europe with an estimated stock biomass of at least 100,000t for which the harvest ratio was around 6 % in 2001.

In Italy, PRUs on the *Chamelea* dredgers enabled the spatial pattern of effort to be identified. This indicated that the whole area of clam ground in the Ancona District was

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exploited by the fleet during the fishing year. The environmental impact was such that every square metre of suitable ground was dredged at least once during this time. The amount of target species and non-target species discard was evaluated. Spatially resolved data identified the detailed pattern of fishing on clam banks and the seasonally varying behaviour of the fleet. Total clam biomass and commercial biomass (those above legal landing size) both declined markedly in 2001 compared with 2000. In addition to traditional methods, a depletion method was used with variable success to estimate biomass in sub-regions of the District.

For the Clyde and Ancona fleets, Generalised Additive Modelling was used to investigate the effect of vessel, gear and other characteristics on landings per unit of effort (LPUE). Time of year and area fished had a significant influence on landings in both fisheries. Vessel size (length, GRT or engine power) were also important factors. In the Clyde, skipper effect was also important.

Domain 6: Fish stock population Studies



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Sub-domain 6.1: Biological Studies on reproductive biology, spawning and migration patterns of commercial and non-commercial species, and population dynamics (modelling and simulations)

**PROJECT N° 97/011: CAMPAÑA DE MARCADO DE PEZ ESPADA
Y ESPECIES ASOCIADAS EN EL ATL. EN: SW098**

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SUMMARY

This study describes the traditional tagging activities targeting the swordfish and other species associated with this fishery carried out in the NE Atlantic on board a commercial surface longline vessel. A total of 404 fishes representing approximately 17,147 Kg. round weight were tagged and released live and in good condition for future recatch. At the time the final version of this document was written, 2 recaptures of *Prionace glauca* have already been reported.

PROJECT Nº 97/015: NEW ASSESSMENT AND BIOLOGY OF THE MAIN COMMERCIAL FISH SPECIES: HAKE AND ANGLERFISHES OF THE SOUTHERN SHELF DEMERSAL STOCKS IN THE SOUTH WESTERN EUROPE

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SUMMARY

The DEMASSESS project had two main aims: the improvements of biological knowledge and inputs for the models applied to the assessment of hake and anglerfish; and fresh assessments of hake and anglerfish of the Southern stocks. The main improvements regarding these objectives were the following:

For Southern hake, the fishery was described and current trends in landings were updated. Spanish landings from the Gulf of Cádiz were included for the first time in the hake landings matrix.

An exchange of hake otolith collections was organised and a workshop on hake ageing was held. For the first time a consensus ageing criterion among age readers was elaborated, a protocol for age reading was established and an international standard ageing method for the first 6 ages of hake from their otoliths was obtained. As a result,

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empirical age-length keys of Southern hake were constructed, and used in stock assessment.

A new length-weight relationship for Southern hake was obtained for sexes combined ($W = 0.00659 L^{3.0172}$) and a new maturity ogive for sexes combined was also estimated.

A new analytical assessment of Southern stock of hake was performed using new biological inputs (length-weight, maturity), empirical age-length keys and revised fishery data. The results of this assessment are considered more reliable than previous ones and indicate a situation of overexploitation. Landings have been decreasing continuously, the figure of 7700 t in 1998 being the lowest value of the time series available (1972-1998). SSB and recruitment show decreasing trends with current low levels of 19900 t and 33 million respectively. The current level of F (0.24) is below the series average (0.43), probably associated with the decline in landings. For management purposes the following biological reference points are proposed: B_{lim} : 180000 t; B_{pa} : 29500 t and F_{lim} = 0.48.

For Southern anglerfish, fisheries data were updated. An exploratory analysis of fishing effort and CPUE in artisanal fisheries was carried out. Knowledge relative to the biology of anglerfish (growth and fecundity) has been improved.

An exchange of anglerfish illicia collections and ageing workshops were held. For white and black anglerfish an ageing criteria was established and annual age-length keys for 1996-1998 were obtained. Preliminary results on black and white anglerfish fecundity were obtained, indicating a relative fecundity of 124 and 45 oocytes per gram of fish respectively (corresponding to a mean length of 62 and 102 cm respectively).

Assessments of both anglerfish species were performed using biomass dynamic models. The results suggest that both anglerfish stocks are outside safe biological limits, and that in order to recover stock biomass, fishing mortality should be reduced by over 50 %.

Complementary studies on hake and anglerfish of Northern stocks were carried out, focussing on growth and reproduction. In the framework of the project, experimental tagging of hake and anglerfish was carried out, in which a total of 152 hake, 202 white anglerfish and 350 black anglerfish were tagged. Although few recoveries were made, this technique may be a useful tool, above all in the case of anglerfish, to open new research lines.

PROJECT N° 97/029: MAJOR IMPROVEMENT IN OUR KNOWLEDGE OF EASTERN ATLANTIC BLUEFIN TUNA IN THE MEDITERRANEAN**AUTHORS**

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SUMMARY

With catches reaching 53,000 MT in 1996 and more than 47,000 MT in 1997, bluefin tuna is one of the species for which difficulties are encountered in assessing East Atlantic stock. These difficulties are mainly due to the complexity of fishing and landing operations, especially in the Mediterranean Sea. To respond to the increase in the demand of the Japanese market, new fisheries have been developed and the effort of traditional ones has been expanded in the last few years. Fishermen in a lot of countries, have turned to catches of largest fish. Mainly purse seiners and long liners exploit the Balearic Islands fishing grounds as well as other well-known reproductive areas for bluefin tuna. In this free market-induced evolving context, the creation of data bases to be used for the assessment of the stock has become more difficult mainly because of landings in non foreign ports and/or transshipping activities at sea.

The description of fisheries by areas emphasizes the diversity of bluefin tuna exploitation. This description includes the analysis of boat characteristics per class of length. The main gears used are purse seine and long line in different models, but there are a lot of other little gears, targeted or not targeted to bluefin tuna as trap, driftnet, baitboat, troll line, hand line and other surface gears. A more in-depth description of the French purse seiner evolution shows that the increased boat efficiency can be mainly traced to advances in technology. The present study also emphasizes the highly time-consuming nature of prospection operations.

It is difficult to collect statistical data on bluefin tuna within a context regulated by quotas. What is more scientific evaluations can differ from administrative ones. In addition the free

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landings in any EEC or non EEC port do not facilitate the elaboration of statistics on both catches and efforts. In this context, the best estimates of total catches by reference squares (5 x5) and by gears show that purse seiners produce most of the catches in the western part of Mediterranean Sea, whereas hand line remains the main gear in use in Greece. CPUE series indicated that the best yields are obtained by the majority of gears around June, even if some differences still remain according to gears and areas.

The biological studies focus on size composition, growth, and reproduction. Monthly size frequencies have been obtained for a lot of fisheries around the Mediterranean Basin. The growth curves of the first 3 years of life in the different areas seem almost overlapping. Larger fish present decreasing numbers in the range 160 — 190 cm in the whole Mediterranean Sea regardless of the gear used.

When sampling is sufficient, the analysis of the sex-ratio shows that the percentage of females decreased from a length of 190 cm onward. The gonado-somatic index varies as a function of either the month or the length class (max.=120-140 cm), or the age class.

The histological, histochemical and immunohistochemical analyses carried out on BFT gonads allowed the identification and characterisation of six periods in the reproductive cycle. The maturity of the gonad starts in May and ends late in June. The first sexual maturity seems to occur between 110 and 120 cm of fork length.

The hormone and vitelogenin studies have given poor results due to insufficient and difficult sampling. The ELISA test for both steroid hormones and Vtg can be successfully adapted to measure the low concentrations of the muscle tissues. A reproductive window from May to June was found. The difference in hormone and Vtg levels between Western and Central Mediterranean areas has to be confirmed by further studies. Sex determination from plasma samples through the SSF method is reliable and can be enhanced by Vtg measurements. The correlation between hormone and Vtg level and the stage of histological maturity is strong, especially during the maturation period.

PROJECT N° 97/030: NURSERY GROUNDS IN THE COASTAL ZONE OF THE EASTERN ENGLISH CHANNEL; TYPOLOGY AND MANAGEMENT MEASURES

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SUMMARY

Coastal zone systems are highly productive areas which support a large part of the World's living marine resources, and particularly feeding grounds, spawning areas and nurseries for many marine species of commercial importance. The constant demands on the coastal zone by a wide range of human activities, which includes fishing but also aggregate extraction and others potentially harmful activities, suggests that the continued function of the natural communities in some areas may be under threat. The most environmentally sensitive areas will be those where the resource (such as a fish nursery area for example) is restricted to one or a few sites, and where it provides a large proportion of the total resource available to that species. Protection of these nursery areas from potentially harmful activities will be more beneficial than protection of sites that are equally affected, but which form only a small proportion to the total resource available to a population. The need to establish protection for threatened coastal areas has already been recognized and encouraged by the Convention on Biological Diversity (1992 Rio de Janeiro Earth Summit).

The inshore waters of the Eastern Channel (ICES Division VIId) support nursery areas for several commercially important species, as well as targeted fisheries for a number of demersal stocks. The majority of the fisheries are subject to high levels of exploitation, and, therefore, the potential yield of many of these stocks is not realized. In order to increase the probability of success of recruitment in these stocks, it is necessary to monitor the level of interaction between all different users of the coastal zone.

The first part of this project identified and described the coastal and estuarine nursery grounds of commercially important flatfish (the sole *Solea solea* and the plaice *Pleuronectes platessa*) and gadoid species (whiting *Merlangius merlangus* and cod *Gadus morhua*), using data from different surveys for the two last decades (including 5,000 coastal trawl hauls) throughout the Eastern Channel coasts. Multivariate analyses were used to study the interannual, asynchronous fluctuations in the distributions of juvenile fish. This approach allowed us to separate the Eastern Channel into homogeneous sectors with regard to these fluctuations in juvenile abundance. The physical parameters which contributed to the observed juvenile distributions were identified and the distributions modeled using Generalized Linear Models. The results, including the areas of the different populations derived from a Geographic Information System, were used to compare the respective importance of the coastal nursery grounds.

The aim of the second part of the project was to identify and describe the main areas within the coastal zones of the Channel where potentially harmful human activities occur.

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With these two sets of data it was possible to identify areas of greatest overlap between fishing activities and key sites of importance to the early life-history stages of commercial populations, and to identify possible sources of conflict with other types of potentially conflicting activities. The productive, shallow inshore waters of the Eastern Channel activities provide both a favourable environment for juvenile fish development, and support recruited fish populations which are the target of a number of demersal fisheries. All of the coastal nursery grounds identified in this report are affected by at least one fishing metier. The conclusion of the programme identifies a prioritized list of sites for development of future integrated management of coastal zones in the Eastern Channel. Some management measures already exist in the Channel, and so the project includes a compilation of existing management measures and explores whether such measures have or should have benefits for resources such as nursery grounds.

PROJECT N° 97/054: ANALYSIS AND EVALUATION OF THE FISHERIES OF THE MOST COMMERCIALY IMPORTANT CEPHALOPOD SPECIES IN THE MEDITERRANEAN SEA

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SUMMARY

Cephalopod fisheries of the five most commercially important species, i.e. *Octopus vulgaris*, *Sepia officinalis*, *Loligo vulgaris*, *Eledone cirrhosa* and *E. moschata*, were studied in Eastern (Thracian sea, Greece), Central (N. Tyrrhenian sea, Italy) and Western Mediterranean (Catalan sea, Spain).

In the Mediterranean areas studied there is a multi-gear exploitation of cephalopods which are mainly caught as a by-catch. In Spain and Greece an important artisanal fishery is developed targeting octopus (fyke nets, pots and traps). In Italy there is also an important artisanal fishery (trammel net) fishing *O. vulgaris* and *S. officinalis*.

Cephalopod landings the last ten years show an increasing trend in Greece, a fairly constant in Italy and a decreasing one in Spain. In terms of quantities landed, *O. vulgaris* is the dominant species in all fisheries; *S. officinalis* follows in Greece and Italy and *L. vulgaris* in Spain.

Trawl is the dominant gear in cephalopod catches but fyke nets, pots and traps are also very important in Greece and Spain. There is a marked seasonality in catches due to the biology of the species studied and migration patterns of *L. vulgaris* and *S. officinalis* are evident.

In the fishing period studied, the catch and effort analysis by the use of the no recruitment model is inefficient in most cases. The biological features of the species and the likely environmental changes seem to be the main limiting factors.

In general, there is no or little interaction between the gears fishing the species studied indicating that each gear affects a certain size range. Trawls generally catch small sized individuals and artisanal gears catch the larger ones.

Cephalopods are commercially important in all areas studied. In the Greek area they consist the 19 % of the trawls sales and the 16 % of the artisanal. In the Italian and Spanish areas, cephalopods represent about 30 % and 20 % of the trawl income respectively.

It is premature to consider cephalopods as overexploited but there is certainly a need to monitor these fisheries more closely with emphasis on the artisanal gears used.

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In the Greek area it seems necessary to implement a seasonal ban from July to September for fyke nets and traps. Restriction to the number of the fyke nets and traps used is also needed. It is worth mentioning that the abolition of beach seines (after 2002, E.C Reg.1626/94) will greatly reduce the production of *L. vulgaris* in this area and consequently the fishers income.

In the Italian area regulation of trawl activity and seasonal bans in areas where juveniles aggregate is an important measure needed to reduce the fishing mortality of juveniles especially for *E. cirrhosa* and *L. vulgaris*.

In the Spanish area it seems difficult to suggest specific measures considering the complexity of the fisheries involved (mainly trawl multispecies fisheries).

Despite the difficulties involved our study provides the basis of a better understanding of these complex fisheries and offers certain options to improve the current situation. It is important to continue and widen our studies and examine also more accurate estimates of stock levels on a frequent basis, the impact of environmental changes on the species abundance, the gear selectivity, the fecundity and the stock recruitment relations.

PROJECT N° 97/061: OPTIONS FOR OPTIMIZING EFFORT PER RECRUIT PERFORMANCE IN IRISH LOBSTER (HOMARUS GAMMARUS) FISHERIES

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SUMMARY

New information on the size at maturity and size fecundity relationships for Irish lobster populations was used in egg (E/R) and yield per recruit (Y/R) simulations to show how E/R and Y/R would respond to changes in current minimum landing size (MLS) or changes in exploitation rate. The size distribution of the landings in each of 4 coastal regions was constructed and analysed by length cohort analysis (LCA) to estimate the current annual rate of fishing mortality. The relative reproductive value (RRV) and relative reproductive potential (RRP) by size class was compared to the size distribution of the landings. New sea water temperature data was collected in order to define geographic differences in the annual temperature regime that could control size at maturity or spawning frequency.

The mean size at maturity was similar in each region at about 96 mm carapace length. The size fecundity relationship was also similar across each coastal region. The size distribution of the landings was dominated by lobsters 1 moult above the current MLS. Over 60 % of the landings were below the size at which 50 % of females were mature. Highest RRV existed in size classes approximately 10 mm above the modal size class of the landings.

Winter sea water temperatures varied latitudinally although summer temperatures were similar in each region. No correlation between the small observed differences in size at maturity or in the significant between region differences in the prevalence of ovigerous females in the landings and temperature was demonstrated.

Short term effects of increasing MLS from 85 to 90 mm would result in a 35 — 40 % reduction in catch by number and a 25 — 30 % reduction in catch by weight depending on the coastal region. A higher proportion of larger lobsters was present in the landings on the northwest coast. These lobsters originated from offshore grounds, however, and were atypical of the size distribution of inshore lobsters in the same region. Estimated annual fishing mortality rates (F) varied from 0.34 in the north west to 0.71 in the west. An average of 0.6 was regarded as representative nationally for inshore stocks. E/R and Y/R simulations indicated that any reduction in F in particular or an increase in MLS would substantially benefit current EIR. Y/R would increase only if natural mortality was < 0.1. E/R at current F of 0.6 was less than 10 % of E/R in unexploited stocks. Increases in E/R were particularly responsive to reductions in F and any measure that reduced F on all size classes above MLS was more beneficial than increasing MLS. This was particularly the case at low values of F. Imposition of a maximum landing size of 115 mm in addition to the current MLS of 85 mm increased E/R only at low values of F but lead to substantial reductions in Y/R.

The v-notching technical conservation measure currently enforced in Irish fisheries was shown to be equivalent to reducing F across a range of size classes. In the absence of any existing mechanisms by which to control effort this measure provides a better reproductive refuge in size classes with high RRV relative to that provided by modest increases in MLS

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and a higher relative benefit to E/R. Egg production of v-notched lobsters was shown to be 37 % of population egg production based on size and numbers of v-notched lobsters released. Based on the size distribution in the year 2000, by which time lobsters were shown to have grown substantially compared to their size at release and discounting for natural mortality this increased to 59 % of egg production in the year 2000.

Catch rates in Irish lobster fisheries have fallen over the past 30 years during which time F appears to have varied between 0.3 — 0.6. This suggests that exploitation rates of 30-50 % per annum are not sustainable in these fisheries and that the slope of the stock recruitment relationship is shallow. Management should therefore maintain a relatively high stock level to increase recruitment and profitability in these fisheries. Increases in catch rates of undersized lobster and in the legal size classes occurred in the Wexford fishery in 1998 and 1999 (data not shown). This indicates that if egg production and recruitment are locally correlated then additional technical measures such as v-notching probably do have beneficial effects on recruitment. The information to demonstrate local correlation between these processes is not available however. Nevertheless it suggests that in the absence of adequate control either through technical measures or effort limitation that egg production will limit recruitment in Ireland's lobster fisheries.

PROJECT Nº 97/081: SEASONAL CHANGES IN BIOLOGICAL AND ECOLOGICAL TRAITS OF DEMERSAL AND DEEPWATER FISH SPECIES IN THE AZORES

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SUMMARY

This project aimed to continue and complement the studies initiated in 1995 under the projects "Design Optimization and Implementation of Demersal Survey Cruises in the Macaronesian Archipelagos I and II" (Study Contract 94/034 and Study Contract 95/05) and "Biology of some Macaronesian Deep-sea Commercial Species" (Study Contract 95/032). These projects co-financed by the EU, took place in the Azores and Madeira aboard the R/V "Arquipélago" (University of Azores). The first two projects permitted the implementation and optimization of a cruise design which is now consistently used in running regular surveys in the Azores, as a way to obtain estimates of abundance that are used in monitoring the main demersal species exploited. These cruise surveys were also important for the collection of biological material and for the study of the ecology of those species. The project "Biology of some Macaronesian deep-sea Commercial Species" (Study Contract 95/032) provided relevant information on the biology of various demersal species with commercial interest in Azores, Madeira and the Canary Islands.

However, the previous information obtained from the annual spring cruise surveys is not sufficient to fully understand species biology and ecology. In fact, during an annual cycle, there are, among others, changes on growth, reproduction, distribution, feeding habits and behaviour which can only be detected and studied on a regular basis (seasonal surveys) along the year.

In particular, previous results obtained in the anterior projects have indicated significant gaps of information namely in biology and ecology of some species. Other aspects, like spatial scales of genetic differentiation in deep-sea fish, as well as vertical and horizontal migrations along the year. Aspects related with the ecology of seamount/bank and island areas need also to be better characterized and understood.

Fish abundance can change by a number of combining of natural factors. Fish ecosystems have many season-dependent processes such as spawning and feeding migrations, migration from deep to shallow water, hatching of larvae, etc, being difficult to separate innate seasonal behaviour and behaviour triggered and/or modified by environmental changes (Laevastu, 1993). The availability of fish for capture can also change without any significant change on their abundance (mainly if we use baited gears), due to fish behavior related factors. These and other factors put some problems in the use of longline CPUE's as an index of abundance of demersal species (Ferno et al. 1994, Bjordal A. & S. Løkkeborg, 1996). However, when fixing certain variables, longline catch rates can be comparable and used to study spatial and temporal trends in species abundances.

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The longline monitoring surveys have been in the last years an important way to study the exploited demersal species in the Azores. The amount of biological material collected as been used to study several aspects of biology and ecology of a number of species, which in most of the cases are in general poor studied. The increasing interest and exploitation of the deep water species, due to the overexploitation of other traditional fish species from the continental platforms, had bring many concerns on their assessment and management. (Anonymous, 1994, 1996, 2000, Gordon, 1997, Merret and Haedrich, 1997, Menezes et al. 1997, 1999).

It is generally recognized that deep-water species have some biological and ecological characteristics that make them more vulnerable to overexploitation. On the other hand, their knowledge is, in many situations, insufficient and time series data for assessment and management very short to produce acceptable populations assessments (Anonymous, 2000). The fishing research efforts were more concentrated to the more important fisheries. Only recently it was created a Study Group under ICES, to study the deep-water fisheries and the biology of deep-water species. Most of these fisheries in the Northeast Atlantic have been recently developed and in a few years total catches will increase significantly (Merrett and Haedrich, 1997, Anonymous, 2000). Nowadays, some of them have symptoms of overexploitation (Anonymous, 2000).

This project has the overall objective of gathering information that would allow improvement and validation of the current knowledge on growth, reproduction characteristics of some fish species. It would also give some contribute to the knowledge on the stock structure and management units of selected species, and a better understanding of the general structure of demersal assemblages and ecological dynamics of some commercially important demersal and deep-water species exploited in the Azores.

PROJECT Nº 97/106: BIOLOGICAL ASSESSMENT OF THE BIVALVE STOCKS OF “RUDITAPES DECUSSATUS” AND “CARDIUM EDULE” IN THE SOUTH OF PORTUGAL (RIA FORMOSA)

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SUMMARY

Bivalve larvae were sampled during thirteen months. During Spring and Summer months, when more intense spawning was expected, samples were taken at weekly intervals. Moreover, bivalve larvae samples were collected at 3 different location in the Ria Formosa, ranging from a more exterior station, near the bar communicating to the ocean, towards a more interior station.

Bivalve larvae of *R. decussatus* and *C. edule* are uniformly present at the plankton of the Ria Formosa. No significant differences were found among spatially separated sampling stations. This can be also attributed to the homogeneity of the environmental parameters inside the lagoon. For all the parameters analysed there were no significant differences among sampling stations.

Temporal fluctuations of larval abundance were significantly correlated with water temperature. The analysed environmental parameters ranged within normal values and no direct relation was found with larval abundance and distribution. Phytoplankton abundance was never a limitation for larval growth. In fact, Nanoflagellates and Cryptophyceae, cells with small size and therefore more adequate to be used as food source by bivalve larvae occurred abundantly. Also, the presence of large beds of macrophytes in the lagoon will provide large amounts of particulate and dissolved organic matter that can be used by larvae. Thus, bivalve larvae abundance and distribution in the Ria Formosa do not seemed to the limited by food availability.

In fact, calculations of the growth rates indicate the existence of optimal environmental conditions. Mortality rates were more difficult to determine and must be analysed carefully, since larvae can be lost by advection or can be “searching” for the adequate substrate for settlement, and therefore be considered as dead, simply because they are not present in the samples.

Post-larvae and juvenile distribution along 5 spatially separated sampling stations did not evidence any particular pattern. This can be related with the small differences in sediment characteristics, granulometry and organic matter content, determined among stations. Moreover, abundance of target species (*R. decussatus* and *C. edule*) were very low. This results from the fact that post-larvae and juveniles are caught and used as “seed” in the concessioned clams grounds, by fishermen. Thus, post-larvae and juveniles abundance and distribution in the Ria Formosa is conditioned by fishermen activity. This fact hampered the proposed growth and natural mortality calculations. To overcome this difficulty post-larvae obtained at an hatchery were placed in containers covered with net to avoid predation, what allows to calculate the growth rate for the first month of benthic life, in the Ria Formosa.

As for the post-larvae and juveniles, adults were not captured in the sampling stations, despite sampling effort with that objective. Results presented were obtained with juveniles and adults obtained from the concessioned clams grounds and caught by fishermen. Clams and cockles were always originated from the same place. Monthly analysis of

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juveniles and adults of the two species permitted to characterise the species reproductive cycles. Differences were observed between species. Reproduction of *R. decussatus* is more limited by water temperature and therefore the spawning period was more defined. However, *C. edule* probably due to a less susceptibility to water temperature can have individuals with mature gonads throughout the year and spawning can occur almost continuously, despite a major spawning period in the Spring and Summer. Physiological condition ratios evidenced that the condition of the adult population was high and only punctually dropped below the critical level. For both species, RNA/DNA and Neutral/Polar lipids ratios increased before the spawning period and decreased immediately after. Adult age was calculated based on the acetate-peel technique. Thus, more consistent length-to-age data were obtained. These data were adjusted to different growth models and the growth rate was estimated. Juvenile and adult mortality in the Ria Formosa are mainly caused by predation of crabs (*Carcinus maenas*) and birds, during the low tide. In order to analyse the predation impact on the juveniles and adults of different size classes of both species, an exclusion cage experiment was performed. Results highlighted the importance of the crabs as bivalve predators and evidenced the existence of a prey size selection. In fact, crabs preferred smaller *R. decussatus*, but did not show such a selective behaviour with *C. edule* individuals. Thus, the use of nets to protect bivalves until they reach a larger size may be important to reduce natural mortality by predation.

Growth and mortality rates integrate all the events and influences upon individuals during each life cycle phase. Because these phases are interdependent, e.g. the number of adults depend on the number of juveniles that reach the adult phase, an integration of all equations (and rates) will permit to estimate the future abundance based on the abundance of individuals from a more earlier phase. A mathematical model with this integration was developed and the results of its application are according to biological expectations.

PROJECT N° 98/021: MONITORING BIODIVERSITY OF DEMERSAL FISH AND EPIBENTHOS IN THE NORTH SEA AND SKAGERRAK

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SUMMARY**Introduction**

This two-year project was designed to monitor biodiversity of demersal fish and epibenthos of the North Sea and Skagerrak in accordance with Article 7 of the Convention on Biological Diversity (Rio de Janeiro, 1992).

Objectives:

- collection of biodiversity data from national GFS survey vessels of Denmark, England, Germany, the Netherlands and Norway in their 3rd quarter surveys of the North Sea and Skagerrak
- compilation of commercial fishing effort for all otter and beam trawler operations in the same sea areas
- relate biodiversity data to fishing effort, sediment type and other environmental parameters and report annually
- to improve standardisation of collection protocols and the quality control of animal identification.

Results

The 5 participating nations sampled a total 240 and 270 stations using the 2 metre beam trawl in 1999 and 2000 respectively and this data, along with data from the main GFS trawl, was analysed and published in 2 annual monitoring reports. As much fishing effort data as reasonably possible was collected and related to diversity and community data, which suggested that sessile epibenthos was negatively correlated with beam trawl effort.

The species identification database (SID) was improved in operation by including a search engine and increased in the number of species covered.

An acoustic transmitter to convey real-time information regarding tow length from beam trawl to towing vessel was designed, built and tested.

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Discussion

Similar to previous surveys of North Sea epibenthos a distinction between communities in the southeast and the central North Sea was noted, separated by the 50 m depth contour, with a higher number of species inhabiting central and northern regions. There was also a latitudinal change in species composition. Water depth and diversity of free-living epibenthos was positively correlated. Fishing effort data proved difficult to obtain and variable in its quality, but suggested a negative relationship with diversity of sessile epibenthos, which is a finding of some concern and demands further monitoring. Free-living fauna showed no such correlation, but a domination of scavenging species suggesting a higher level of disturbance, may have masked any such correlation.

The development of the species identification database has improved the accuracy and standardisation of epibenthic identification between countries.

The prototype acoustic transmitter was successfully produced and tested, and will improve the quantitative nature of sampling with trawl gears.

**PROJECT N° 98/025: MODELLING POPULATION DYNAMICS
OF SANDEEL (AMMODYTES MARINUS) POPULATIONS
IN THE NORTH SEA ON A SPATIALLY RESOLVED LEVEL**

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SUMMARY

Results of statistical analyses of the relationship between sandeel densities and environmental variables, based on survey data, and information about seabed type and depth, was used to produce a map of the sandeel habitat in the North Sea. The sandeel fishing grounds in the North Sea were mapped by plotting data on the exact fishing locations. Sandeels were found to concentrate on the upper slopes of banks, close to fished areas. Only a fraction of the areas with suitable habitat are fished. Further, important fishing grounds are located in areas with relatively poor habitat. Both the habitat and the fishing grounds are patchy distributed and are only found in a small part of the North Sea. Analyses of side-scan observations showed that the sandeel fishing grounds were situated in areas with very large bedforms present (very large dunes, wave lengths >100m). The sediment bedforms in these areas indicate bottom peak flow events in the order of 70-100 cm/sec.

The contraction and expansion of sandeel distribution was found to be centred around sites of preferred sediment type. As the commercial sandeel fishery was found to occur on the bank edge adjacent to the areas of coarse sand sediments sandeels prefer, movements of sandeels from a less to a more preferred habitat may thus be enhanced by the commercial fishery. Local migrations of sandeels may allow fishermen to maintain high catch rates up to a level where densities in less preferred sediments had severely declined.

A pilot study was carried out, where data on catches of sandeels in the commercial fishery was mapped on a haul level. Significant differences in the length distributions between fishing grounds was found. A smooth transition in the length compositions was found between fishing grounds lying close to each other. Further, comparisons of survey data from 22 banks showed marked differences in the size at age relationships between banks.

Considerable regional variation in maturity at age was found, which could largely be explained by the regional differences in weight at age. A significant proportion of sandeels from stock area 2 (Fisher banks, Outer shoal and Klondyke banks) are likely to spawn at age 1, whilst not all sandeels from stock area 3 will spawn at age 2.

A dynamic age and spatially structured mathematical model for the identified sandeel sub-stocks, was constructed. The model was used to evaluate the suitability of various assessment methodologies and the most important range of possible management strategies. All versions of the model that were run indicated that increasing fishing effort

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causes a decline in mean spawning stock biomass of sandeels (SBB), thus increasing the likelihood of SSB falling below the precautionary limits of total stock biomass Bpa and Blim.

The effects of fishing upon recruitment suggest that recruitment may decline at both very low and very high fishing levels. Low fishing effort may actually cause recruitment to decline, whereas high fishing effort may result in similar, or elevated, recruitment compared to assessment levels observed over recent years.

Recruitment functions that incorporate both SSB and I-group sandeel abundance as independent variables lead, in the model simulations, to (i) negatively auto-correlated recruitment at lag-1, and (ii) a negative relationship between recruitment and total stock number. Thus, incorporating the density-dependent effects of I-group sandeels leads to population trends that are consistent with those observed in the virtual population assessments of North Sea sandeels.

PROJECT N° 98/034: ANALYSIS OF SWORDFISH FISHERIES DATA SERIES IN THE CENTRAL AND EASTERN MEDITERRANEAN

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SUMMARY

Swordfish fisheries data from the main Greek and Italian fleets, which have been collected within the frames of past European and national projects, have been analysed to study the dynamics and exploitation pattern of the Mediterranean swordfish stock. Data covered the period from middle 80's till the end of 1999 and included catch per effort statistics and information on the length distribution of the catches, separately for each fishery (Greek long line, Italian long line and Italian drift net).

Analysis included examination of annual differences in the age and size composition of the catches and estimation of total mortality rates through the use of catch curves. Assuming that the catch rates and the length composition of the examined fleets are representative of the Mediterranean situation, assessments of the whole Mediterranean stock have been made through the application of the non-equilibrium stock production model ASPIC and a separable virtual population analysis (SVPA) model.

The consistent recruitment rates and stable year classes estimated from the Separable VP A are in agreement with the catch numbers at length for each of the fishery units, which exhibit a very stable distribution throughout the recorded time series. The number of fish in the largest length and age classes has not been reduced over time and the catch numbers at length and age have similar rates of decrease beyond the modal catch classes. This indicates a stock with stable levels of exploitation and recruitment.

Both ASPIC and SVP A models estimate that the population is currently increasing. The stock production model, which has projected into 2000, predicts that, at the rate of exploitation currently seen in the fishery, the population will continue to recover.

The stock production model estimates fishing mortality to be just below F_{msy} and both models estimate the current fishing mortality rates to be in the region of 0.4 and to have declined from higher rates (0.6-0.7) estimated in earlier years.

However, the SVPA findings are considered as preliminary since further investigation is needed on the assumption that the length composition of the examined fleets is representative of the Mediterranean situation. Refinements of the models used to calculate the time series may also affect the estimated levels of exploitation and biomass.

**PROJECT N° 98/076: MANAGEMENT OF THE EUROPEAN EEL:
ESTABLISHMENT OF A RECRUITMENT MONITORING SYSTEM
(GLASS EEL)**

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SUMMARY

0.1 This project, aims, set-up

Recruitment of the European eel has declined markedly in the last few decades and development of a stock recovery plan is urgently recommended. The aim of the current project is to develop tools required by management aimed at recovery of the stock, i.e. monitoring of the recruiting life stage, the glass eel. Existing recruitment indices have been based on national monitoring series or incidentally available information. The current project has made an inventory of these information sources and has considered options for standardisation and integration into an international network. To this end, all existing monitoring efforts have been described in detail, common themes have been extracted and extensions have been planned in regions where no monitoring yet exists.

0.2 The eel and its fisheries

The European eel, *Anguilla anguilla* (L.), is found and exploited in fresh, brackish and coastal waters in almost all of Europe, as well as in N. Africa. Large-scale eel fisheries are rare and make up less than 5 % of the total European catch, the remaining ones are small-scale, located in rural and coastal areas throughout Europe. Fisheries for the growing (yellow) and (nearly) mature (silver) eel are found in coastal and inland waters throughout the distribution area. Additionally, freshly recruiting glass eels are fished in the southwestern part of the distribution area. These are sold for direct consumption, for on-growing in (European or Asian) aquaculture and for re-stocking inland waters, predominantly in northern countries.

In contrast to the small scale of the typical eel fisheries, spawning takes place in international waters, far out in the Atlantic. Spawning has never been observed but it is assumed only one spawning population exists. It is not (yet) possible to reproduce the eel artificially.

0.3 The decline of the stock

A steep decline in recruitment has occurred over most of the continent since the early-1980s, to about 10 % of former levels, with lowest values yet recorded in 2001. The yield in most fisheries has also declined and the stock is officially considered to be outside safe biological limits. Several hypotheses have been proposed for declines, but no unambiguous cause(s) identified. These observations have raised fears that current management might not adequately ensure sustainable exploitation of the eel stock and show that international concerted actions are a prerequisite for sustainable management.

0.4 Sustainable management

The Precautionary Approach dictates that, unless proven otherwise, a relationship between fish stock and recruitment should be assumed to exist. Anthropogenic impacts (exploitation, habitat loss, pollution) exceed reasonable limits in many places and the Precautionary Approach implies a need for management actions to reduce these impacts. For full life cycle management, both local measures in rural/coastal areas and international collaborative action for the shared spawning stock are essential. Elaboration of measures involved in a stock recovery plan is outside the scope of the current project. However, the choices of measures and assessment of their success requires information on recruitment from an internationally-coordinated monitoring network.

0.5 Recruitment monitoring

Ideally, the biomass of the spawning stock and the strength of the year-class of youngest larvae should be measured annually. Analysis of their relationship then enables the derivation of threshold conservation criteria. Since both spawning stock and youngest progeny are found in the ocean, far beyond our horizon, the nearest surrogate will have to be used; that is escapement of spawners and recruitment of glass eel, respectively. Monitoring of stock-wide spawner escapement is very difficult and the current project

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focuses on recruitment only. Additionally, results of local monitoring will involve and inform local managers, and might contribute to (national or regional) management of the local stock and fisheries.

0.6 A monitoring network

Recruitment monitoring data are available from many stations, using a wide range of catching methods, relating to more than a single life stage. Information was obtained from various sources, related to different management frameworks, over time spans varying from more than 100 years to not yet begun. The principal achievement of the project is the compilation of a comprehensive and consistent overview. Diversification in monitoring methods is related to local characteristics of recruitment, stock and environment. Furthermore, local anthropogenic or natural changes at each of the monitoring sites influences monitoring results. Therefore, the scope for standardisation is very limited. Only a network of monitoring stations will be able to discriminate local effects from global changes in recruitment to inform both local and international management.

0.7 Prospects for the way ahead

In contrast to the well-established technical starting point for recruitment monitoring described in this report, the organisation of the management process aiming at the compilation of a stock rebuilding plan might pose serious problems. Current management of eel stocks rarely relates to stock protection. Therefore, this project has effectively set the stage for the managers and all other parties involved, to address the key issues in management aimed at conservation of the stock.

Development of a stock recovery plan will undoubtedly require more than the recruitment monitoring tool developed in this report. This will most likely comprise: monitoring of spawner escapement, assessment of continental exploitation levels, the extent of habitat degradation on the continent, development of target levels and harvest strategies for exploitation, etc. Unlike recruitment monitoring, these other subjects will require the development of new expertise and will involve extensive fieldwork. Evaluation of the current project indicates a set-up based on international concerted and co-ordinated actions, extending the knowledge base where required, can effectively bridge the gap inbetween the small-scale, scattered fisheries found everywhere in rural Europe and the information needs for an international stock recovery plan urgently required to rebuild the rapidly declining eel stock.

PROJECT N° 98/096: DISTRIBUTION AND BIOLOGY OF ANGLERFISH AND MEGRIM IN WATERS TO THE WEST OF SCOTLAND

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SUMMARY

The anglerfish (*Lophius* spp.) and the megrim (*Lepidorhombus whiffiagonis*) are important commercial species in the waters to the west of Scotland. There are two species of anglerfish (*Lophius piscatorius* and *L. budegassa*) but the latter is not abundant in northern waters. *L. budegassa* is an important species off the Iberian peninsula and in the Mediterranean. There are also two species of megrim but only *L. whiffiagonis* is important in northern waters. The four spot megrim (*L. boscii*) is more abundant and is exploited in the waters of southern Europe. Although the title of this project is the distribution and biology of anglerfish and megrim in waters to the west of Scotland (ICES Sub-area VI) it inevitably includes data, especially on megrim, from the west of Ireland (Sub-area VII). The work on stock discrimination of anglerfish, by DNA and otolith microchemistry, also utilises material from other areas. Both species have a wide depth distribution and are a component of both the long established shelf fisheries and the more recently developed deep-water fisheries.

Objectives

The objectives of the project were:

To obtain information on the fine scale distribution of anglerfish and megrim, and on environmental factors which may influence their distributions.

To obtain indices of abundance for anglerfish and megrim within and close to areas exploited by the fishery.

To improve the knowledge of the biology, particularly spawning, maturity and growth of anglerfish and megrim.

To validate the age determination methods for anglerfish and megrim. To improve knowledge of the origin of pre-recruit stages of anglerfish.

Results

To achieve these objectives the project was divided into four tasks.

Task 1: Depth distribution

The data on depth distribution were collected from dedicated research surveys, charters of commercial vessels and by placing observers on commercial vessels. To determine whether high catches of anglerfish were being maintained by serial depletion and exploitation of new areas, standardised catch data were analysed by depth, latitude and year. Within the limits of the data and experimental design, it was not possible to detect any clear sign of serial depletion. Depth distribution was described from research vessel

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and commercial charter survey data. The data were stratified by latitude and males and females were analysed separately. The most obvious result was an almost complete absence of mature female anglerfish in all surveys. There was a consistent indication that males were more abundant in deeper water. Logbook data were used to analyse the monthly landings of megrim between 1995 and 2000 for ICES Divisions VIa and VIb. Landings per unit of effort (LPUE) were highest in January and May in VIa and in the summer months in VIb, although clear seasonal trends were not apparent. LPUE have steadily declined in Division VIa but have been more stable in Division VIb. Some variations in Division VIb may have been associated with gear changes and weather conditions. Discarding of megrim, including fish of over the minimum landing size, was often substantial in Division VIa but was negligible in Division VIb. The sex ratio of megrim was highly biased towards females.

Task 2: Biological data collection

Sub-task 2.1: Distribution and origin of pre-recruit stages.

Early life history studies of anglerfish indicated that the pelagic phase, as revealed by otolith incremental analysis, is relatively long. A particle tracking model was used to predict the origins of young fish. The distribution of the demersal stages suggests that the anglerfish spawns in deep-water. The transition from the pelagic to the demersal phase takes place in relatively shallow water, with most recruits entering the North Sea from the north and west. Otolith microchemistry, which relies on a chemical signature of a water mass being incorporated into the otolith, has proven to be useful for stock discrimination in some fish species. The analysis was carried out on otoliths from young anglerfish sampled over a wide area. Although some differences were detected between sectors, the overall conclusion of the study was that there were limited exchanges between areas during some period of the early life history. Microsatellite DNA in anglerfish was analysed to investigate the nature and extent of sub-structuring of the stocks into distinct genetic populations. The results showed that there was no structuring of the anglerfish stock into multiple genetic populations within or among the samples from ICES Divisions IVa, VIa, Sub-area VII and Rockall. This complete lack of genetic differences in a large number of microsatellite markers, suggests that the current stock divisions of anglerfish have no biological basis and could be inappropriate for management. The results also suggest that the anglerfish in deeper water could be supplying the recruits to the western shelf and the North Sea. The sizes at maturity of male and female anglerfish were very different and indicate that the combined data currently used for assessment are meaningless from a biological viewpoint. New data on gonadosomatic indexes when plotted against recorded maturity stages, suggest that the assignment of some females may have been incorrect, pointing to the need for a more reliable macroscopic maturity key based on histological studies. Despite the lack of spawning females there were sufficient data on maturing and spent fish to conclude that in Sub-area VI spawning extends over many months, mainly during the first half of the year. The distribution of pre-spawning females along the shelf edge and at Rockall is suggestive of spawning in deeper water. A comparison of age estimates using whole and sectioned sagittal otoliths and illicia showed that presumed annuli counts were higher in sectioned sagittae. Edge state and marginal increment analysis was used to identify the annual cycle. The opaque (growth) zone had begun to be formed in 50 % of fish by July and was seen in 90 % by August. A similar cycle, but less well defined, was seen in the illicium. The results suggest that the estimation of age using illicia may lead to smaller size at age, because of an incorrect interpretation of the time of translucent zone formation in the illicium. Female megrim grow faster and attain a larger size (and maximum age) than males. The population growth parameters obtained in this study were within the range found in other studies. Some evidence of density dependent growth was detected from the relationship between LPUE and estimated growth rates of megrim from the various areas studied. An analysis of the seasonal nature of the otolith edge confirmed previous knowledge about the annual periodicity of megrim otolith ring formation. A

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digitised image collection of megrim otoliths was compiled for use in future investigations of stock discrimination by otolith shape analysis. Ovarian maturity stages were assessed both macroscopically and through histological analysis. The peak spawning period in the study area was found to be in April. There was a general agreement between macroscopic and histological estimates of maturity stages. There were substantial differences in the size at maturity of female and male megrim. This has implications in the use of pooled data for assessment purposes.

Task 3: Data storage and analyses of megrim data.

All the new data and data from other databases on megrim were compiled into a new Microsoft Access database.

Task 4: Review of historical survey data and bibliography of megrim.

The historical data on megrim from both Irish and Scottish surveys were analysed. The Irish West Coast Groundfish Surveys suggested that megrim are more abundant off the southern west coast of Ireland, than off the northern west coast of Ireland and the west of Scotland. However, differences in the selectivity of the vessels carrying out the surveys might explain much of the geographical differences observed in megrim catches. The size composition of megrim caught on the Irish surveys were remarkably similar between 1993 and 1997. Catches of megrim during the Scottish west coast ground fish surveys were relatively low in the beginning of the time series. Catches, although variable, increased over the time series and reached a maximum during 1998. Some of the variability may be explained by a change in research vessel in 1998 and a tendency for a seasonal migration of megrim into deeper water. The analysis of the Irish and Scottish commercial landings of megrim were inconclusive and may have reflected differences vessel size, degree of targeting and mis-reporting. A review of the biology of megrim in northern waters was compiled.

PROJECT N° 99/022: STROMBOLI: SPATIAL AND TEMPORAL TRENDS IN CATCH OF MEDITERRANEAN BLUEFIN TUNA: HISTORICAL OBSERVATIONS AND LATEST INQUIRIES

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SUMMARY

STROMBOLI mainly aimed to: (i) collect and analyse historical data from the ancestral Mediterranean bluefin tuna traps, (ii) compare the life history traits of the main tuna species and their relative resistance to exploitation and finally (iii) test the feasibility of direct assessment through aerial spotting.

The analyses of the historical data indicated that the Eastern Atlantic bluefin tuna population displayed conspicuous long-term fluctuations of about 100-120 years, together with cyclic variations of about 20 years. Further numerical analyses showed that these variations appeared to be negatively and significantly related to long-term trends in temperature.

STROMBOLI validated, among other things, that tropical tuna sustain higher levels of fishing mortality than bluefin tuna. Concerning the biological reference points, our study pointed out the difficulty of using traditional benchmarks for bluefin tuna, because of the nonstationarity of the abundance and stressed the importance of reinforcing the current measures and controls on the size limits.

The various aerial surveys carried out within the frame of STROMBOLI showed that the results appear clearly dependent on the weather and oceanographic conditions and the relative stability of the spatial dynamics of bluefin tuna. Contrary to prior information, our results clearly indicated that aerial spottings towards BFT spawners are unsuitable to compute a fishery-independent index of abundance. However, the surveys towards juveniles BFT are encouraging and could be used in future to obtain useful fishery-independent information.

PROJECT N° 99/023: HISTORIQUE DES CAPTURES DE CIVELLES, INTENSITÉ ACTUELLE DE LEUR EXPLOITATION (RELATION ENTRE EFFORT DE PÊCHE ET TAUX D'EXPLOITATION), VARIATION DE LEUR CAPTURABILITÉ PAR LA PÊCHE PROFESSIONNELLE MARITIME ET INDICES DE COLONISATION SUR LE BASSIN DE L'ADOUR

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SUMMARY

Chapter one entitled "The characteristics of the glass eel fisheries in the Bay of Biscay" estimates the production of glass eels in 1999 at 245 tons, with a turnover of 33 million euros for the whole of the French Atlantic coast. The historical analysis of the series of captures concerning the principal catchment areas of the Atlantic coast highlights a fall of the glass eel productions starting in the Eighties.

Chapter two analyses in detail the fluctuations of glass eel catches in the basin of Adour, the historical series of which also show a fall of the catches from the beginning of the Eighties, related to the decrease of production of yellow eel by the beginning of the Seventies. In the basin of Adour, this period was marked by some modifications of agricultural practices: increase in the cereal cultures, increase in drainage and irrigation, increase in the use of chemical products. This chapter shows that the variability of the glass eel captures over the recent period (1985 — 2001) seems especially related to the fluctuations of hydro-climatic conditions.

Chapter four of the report proposes a "Modelling of hydro-climatic conditions on the variability of the glass eel catches". The principal results showed shifted effects of the air temperature and tide coefficient. A predictive model of CPUE makes it possible to describe the environment influencing the CPUE like a linear function of the level of rain, of the cosine of lunation, the tide coefficient of the previous day and the level of flow of the Adour river of two days before the last.

Chapter five presents two approaches for estimating the biomass, using a sampling protocol of the glass eel run based on a behavioural model. The first approach uses a sinusoidal model of the speed of the water flow to establish a stochastic model of the variations of the density observed according to the current velocity of flood, a given day. The estimates of biomass provided by this method are generally precise and not very sensitive to the division of the water column. The second approach connects measurements of the observed glass eel concentrations to the initial local concentration via a statistical model obtained by aggregation of the local concentrations: the goal here is to express the biomass of the glass eel run in terms of the initial concentration. The estimates

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provided this latter way are generally of the same order of magnitude as the preceding ones.

Chapter six deals with the development of mono and two-dimensional hydrodynamic models. Such models are used for estimating the biomass of glass eel; they are also used in a behavioural model which allows the simulation of trajectories of glass eel groups which stick to the bottom as soon as the current moves towards downstream with an intensity of more than 0.3 m/s. They remain at the bottom as long as the daylight persists.

Chapter seven describes the intensity of colonization and the variations of yellow eel densities on the catchment area of the Adour river and Gaves. Analysis of data generally shows a gradient of densities increasing from the source towards the sea. However, it is not possible to conclude about a trend in the variations of glass eel densities in this area, starting from 1977, due to the fact that sampling protocols has varied a lot throughout this period and has focused on demographic distributions of migratory salmonids rather than those of glass eel.

Prospects for this work are evoked; they are related to the valorization and the transfer of knowledge towards the managers within both the framework of the ICES and the framework of the INTERREGIII program. The development of this work should also include the problem of the impact of contaminants and degradation of eel habitats on the future of this resource.

PROJECT N° 99/029: EXPLORATION OF PRISTINE RED SHRIMP RESOURCES AND COMPARISON WITH EXPLOITED ONES IN THE IONIAN SEA (RESHIO)

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SUMMARY

In the framework of the present project (RESHIO), the distribution and abundance of the red shrimps, *Aristaeomorpha foliacea* and *Aristeus antennatus*, were investigated in the deep waters (300-900 m depth) of the south-eastern side of the Ionian Sea (Greek waters). A preliminary study of the biological characteristics of both target species in this area was also attempted. In addition, the CPUE, abundance, distribution, population structure and biological characteristics for both species were compared between the above mentioned unexploited area (Greek Ionian waters) and an exploited one in the Italian Ionian Sea. Finally, the composition, abundance, distribution and population structure of the by-catch were studied in both areas.

The random stratified design was used for the sampling and three depth zones (300-500, 500-700 and 700-900 m) were considered. One explorative bottom trawl survey was carried out in the Greek Ionian Sea in September 2000. In addition, two more cruises were carried out, one in the Greek and the other in the Italian Ionian waters, during July-August 2001 for comparison purposes between the two areas. Two commercial trawlers were hired, a Greek (explorative cruise) and an Italian one (comparative cruises), equipped with trawls of 20 mm codend mesh size.

The results from the present study showed that in the Greek Ionian Sea there are possibilities for the development of a deep-water fishery. The depth stratum of 500-700 m was the most productive in terms of commercial catch (48 Kg/h). The highest CPUE values of the commercial crustacean (13 Kg/h) and fish species (33 Kg/h) were found in this depth stratum. Discards consisted only 29 % of the total catch. Several commercial species, such as *A. foliacea*, *Helicolenus dactylopterus*, *Galeus melastomus*, *Lophius piscatorius*, *Centrophorus granulosus* and *Plesionika martia*, presented high CPUE values. Considering the abundance, some of the above species, particularly *A. foliacea*, remained important in numbers also. The red shrimp *A. antennatus* showed quite lower values. Besides the abundance of resources, other problems that should be resolved in the case of the development of a deep-water fishery in the area are (a) the ability of the fishermen and the adequacy of the vessels to fish in these grounds and to preserve the fishing products and (b) the market operations that are needed in order to promote the commerciality of species unknown to the Greek consumers, although very appreciated by their Mediterranean counterparts.

On the other hand, in the Italian Ionian Sea, *A. antennatus* was important in terms of weight or numbers, whereas *A. foliacea* was found in very low quantities. Depth was found to play an important role in the deep-water community structure of both study areas, distinguishing two main faunal assemblages; one in the depth stratum 300-500 m and another in depths ranging from 500 to 900 m. Moreover, the geographic area, affected by both environmental and fishing conditions, characterized the structure of these assemblages. Generally, the

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deep-water resources in the Italian area showed much lower CPUE and abundance values and smaller sizes in their population structure, indicating the effects of intensive fishing activities which resulted in overexploitation of some species. This is the case of *A. foliacea*, a very sensitive to the fishing pressure species, for which the estimated exploitation rate showed that management measures are required to be established in the Italian Ionian Sea. In fact, a greater mesh size, a closed period during recruitment and the protection of nursery areas can represent the main proper management measures. These should be taken into account in the case of development of a Greek deep-water fishery, particularly because *A. foliacea* is the main fishing resource in the area.

PROJECT N° 99/034: FISHERIES & POPULATION STRUCTURE OF SCOMBER SPP. IN THE MEDITERRANEAN AND S. IBERIAN ATLANTIC WATERS

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SUMMARY

The fisheries and population structure of *Scomber scombrus* and *S. japonicus* were studied in well-defined and separated areas of the Mediterranean (Greece, Italy, Spain) and S. Iberian Atlantic waters (Portugal).

The gears fishing these two species are mainly purse seines for the four countries, followed by trawls in all countries except Italy. Artisanal vessels in Spain and Portugal also catch the two *Scomber* species.

The two *Scomber* species are mainly caught as by-catch in Greece and Spain. In Portugal, *S. japonicus* is third in importance and in Italy the second among the pelagic species. In general, for all countries, *S. japonicus* seems to be more abundant than *S. scombrus*.

The trend of values for the main pelagic species, for all countries, generally follows the trend of their landings. The CPUE generally follows the same trend with the landings. In general, the economic importance of *S. scombrus* is higher than that of *S. japonicus*.

For the one-year period studied (April 2000 — March 2001), the two *Scomber* species are mainly caught by purse seines. In Italy and Portugal the purse seines were the only gear that fished the two *Scomber* species.

In Greece, the maximum production appears for both species in June. Except from Italy, where the production was generally very low, the trend of the landings of the two *Scomber* species seemed to be similar. They showed two peaks for *S. scombrus* (between March until June the first and August until November the second). In Italy, only one peak appeared in July. Concerning *S. japonicus*, the highest production period was between August and November.

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Migrations, schooling, target fishing and the limited studied period render difficult the study of biology of the two species. The recruitment of the two Scomber species seems to be extended. The estimates of the growth parameters ranged between the study areas. The spawning period for *S. scombrus* is in winter and for *S. japonicus* in spring-summer.

The morphometric comparison for *S. scombrus* showed that the most differentiated group corresponded to Kavala individuals, and Faro and Messina were the two morphologically related groups. For *S. japonicus* the most differentiated group corresponded to Kavala and Faro. Barcelona and Messina were the two morphologically related groups.

The genetic analysis based on the sequence comparison of the mtDNA D-loop region, suggests that a single panmictic population exists for *S. japonicus* in the Mediterranean. In contrast, the populations of *S. scombrus* are split along an East-West axis with the Greek and Italian populations forming the East-Central Mediterranean genetic stock and the Spanish and Portuguese populations forming the Western Mediterranean genetic stock. In addition, we have shown that the Mediterranean populations of *S. scombrus* are genetically distinct from the North Atlantic ones.

The discrepancy observed between the morphometric and genetic analyses implies that environmental parameters may influence the morphology of the two species as well as their biology, as this is inferred by the differences observed in the spawning season in the different localities examined.

**PROJECT Nº 99/061: RECRUITMENT OF SEA BREAMS (SPARIDAE)
AND OTHER COMMERCIALY IMPORTANT SPECIES
IN THE ALGARVE (SOUTHERN PORTUGAL)**

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SUMMARY

A two year study of the juvenile fishes of the Ria Formosa lagoon system (southern Portugal) was carried out. The objectives were to study: 1) species composition, distribution and relative abundance in relation to different habitat types within the Ria, 2) the time of settlement/recruitment and the life cycle during the juvenile phase of the most important species, 3) the factors affecting habitat use, 4) the movements of juvenile fishes and 5) the comparison of present day (2001-2002) species composition, diversity and abundance with that of an earlier period (1981-1986).

In order to accomplish these objectives intensive sampling was carried out with two sizes of beach seine, a beam trawl, a push net, a throw net and lift nets at more than 50 locations in the western part of the Ria Formosa. A total of 4315 fish, of which the most important were *Diplodus vulgaris* (2606), *Dicentrarchus labrax* (575), *Diplodus sargus* (511), *Spondylusoma cantharus* (448) and *Diplodus annularis* (100) were tagged and released.

The results show that the Ria Formosa is an extremely rich and important nursery habitat for many species. The fish species can be classified as either resident, migratory or occasional. The commercially important species (Sparidae and Moronidae) are in the migratory category, for the most part appearing in the Ria in the spring as very small juveniles, growing rapidly during the warmer months and then leaving the Ria before the end of their first year of life.

A total of 112 species were caught, many of which have not previously been recorded for this area, with highest diversity in the summer and autumn and lowest diversity in the winter. The species composition, distribution and abundance were found to depend on a number of factors, namely habitat type, state of the tide and time of day/night. Sea grass beds (*Ulva lactuca*, *Zostera* spp and *Cymodocea* spp.) were found to be of fundamental importance as a habitat for juveniles, especially those of commercial species, with shallow, sea grass covered, protected areas having the greatest diversity and greatest abundance. The length frequency distributions allowed the identification of juvenile cohorts, the determination of the time of settlement/recruitment as well as the following of the progression of the cohorts for some of the most important species. The commercial species (sea breams and sea basses) enter the Ria mainly in the spring or late winter, growing rapidly in the summer and leaving the Ria for the coastal zone by the winter before completing their first year of life. High site fidelity was observed, with most tagged fish recaptured short distances away from or even in the same location where they had been released.

The comparative study indicates that in general, the fish biomass has not changed significantly since 1981-1986, although there were changes in relative abundance at the species level. The observed increase in species diversity compared to the early period may be due to the greater sampling intensity with more gear at more locations in the current study, the appearance of new species due to recent (decadal) warming trend and the fact

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that some non-commercial species may not have been identified or quantified in the earlier study.

This study has shown that the Ria Formosa is of enormous importance as a nursery and essential habitat for juveniles of more than 100 species, many of which are of commercial value. Continued monitoring of the ichthyofauna of the Ria Formosa will provide vital information on recruitment dynamics and possible changes due to global warming and the impact of human activities.

Sub-domain 6.2:

Genetic Studies

PROJECT N° 98/039: EVALUATION OF THE SOUTHERN GREEK SARDINE STOCKS

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SUMMARY

The sardine (*Sardina pilchardus*) stocks of the central Hellenic seas were studied during 1999-2001. The objectives of the study were:

The detailed genetic characterization of the stocks: To advance the study of the sardine populations in the central Aegean and Ionian Seas, in order to identify genetic groups, to define the stocks, and to access their genetic interactions.

The distribution of the spawning grounds: To identify spawning aggregations and to delimit the spawning grounds of sardine in the studied area.

The estimation of stock biomass: To assess the abundance and the reproductive biomass of the sardine stocks using two independent techniques: The Daily Egg Production Method and Hydoracoustic Method.

The collection of fisheries data at the main landing ports of the central Aegean and Ionian seas.

Length frequency distribution data were sampled on a monthly basis to estimate the representative annual size distribution of the catch. The growth and maturity of sardine were studied through the collection and analysis of the appropriate biological material. Additionally, data on landings and fishing effort have been collected. Monthly production, length frequency distributions and estimated von Bertalanffy growth parameters were used for a third biomass estimation using analytical methods (Length based Virtual Population analysis).

The two types of markers used in this study for the analysis of genetic variation of the populations produced different patterns. Mitochondrial DNA (mtDNA) revealed no genetic heterogeneity between all the pairs of samples. On the contrary, three microsatellite DNA loci revealed some statistically significant differences between some pairs of samples. This could be simply the result of the fact that microsatellite DNA has higher resolution power, because of its faster evolutionary rate. However, the fact that there is no apparent geographical or temporal basis in the heterogeneity revealed, prompts for a careful interpretation of the results and for a more detailed and systematic future analysis, in order to draw more sound conclusions regarding the population structure and migration patterns of the species.

The results of the egg and larvae surveys as well as results obtained through the acoustic sampling indicated that spawning is mainly taking place in shallow areas usually characterized by enrichment processes (e.g. river outflow) and these spawning sites are relatively stable from year to year.

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For both reproductive periods studied (1999-00 and 2000-01), the spawning activity pattern in the Ionian Sea was different from the Aegean Sea. Specifically, peak spawning occurred later in the Ionian (late January — March) than in the Aegean Sea (late November — January). Hence, two differently timed DEPM surveys were conducted in these seas.

The estimated sizes of the sardine stocks, as obtained by the application of three methods, were quite similar. Biomass estimates in the survey area ranged from 20,000 metric tons (spawning biomass estimated by the DEPM) to 24,000 metric tons (total biomass estimated by the acoustic method). Total biomass estimated by the length based VPA was 27,000 to 30,000 metric tons. The Y/R-curve had a maximum exploitation rate that was much higher than the estimated exploitation rate.

PROJECT N° 98/041: STATE OF THE STOCKS OF EUROPEAN WRECKFISH (POLYPRION AMERICANUS)

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SUMMARY

Reduced catches of coastal species have increased fishing pressure on deep-water fishes throughout the world. This increasing trend implies the requirement for management measures to be implemented for these stocks, especially if the hypothesis of shared stocks will be demonstrated. The wreck-fish (*Polyprion americanus*) is such as deep-water fish for which knowledge of its biology and fisheries potential is very limited.

The main objectives of the present project were the following: (1) The collection of data concerning wreckfish fisheries and landings in the eastern Mediterranean (Cretan waters [Greece] and Ionian Sea [Italy]); (2) The collection of population dynamics data from these fisheries and the study of the age, growth and maturity (3) The analysis of stock structure by means of mitochondrial DNA, specifically the comparison of the Atlantic and Mediterranean populations; (4) The acquisition of biological data by monitoring juveniles and adults in captivity, originated from Atlantic and Mediterranean stocks.

The wreckfish fishery in the Cretan and Ionian waters was found to be localised at specific fishing sites. These sites are characterised by seamounts, steep continental slopes and hard bottom. The depths of fishing ranged from 300 m to 1000 m, while the main fishing depths were between 500 and 850 m.

The use of three polymorphic enzymes in the analysis of mitochondrial DNA showed a remarkable similarity between populations from Greece, Italy and the Atlantic coasts of France. Although the examined stocks were genetically homogeneous they differed significantly with regard to morphometry and seemed to consist of different "phenotypic stocks", probably reflecting different environmental conditions. The stomach content analysis, actually, revealed that feeding of wreckfish was more intensive in the Ionian Sea than in Cretan waters.

The histological analysis of wreckfish gonads yielded estimates of length at first maturity, — fecundity and reproductive season. The latter is situated in the winter months (December to March). The pattern of oocyte development in wreckfish is characteristic of group-synchronous species in which annual fecundity is determined prior to the spawning season.

The estimated Von Bertalanffy growth curves for Italy and Greece did not differ at a significant level and a common growth curve was estimated for the eastern Mediterranean. Moreover, total and fishing mortality estimations revealed that the latter was higher in Cretan waters (Greece) than in the Ionian Sea (Italy). Yield per recruit analysis was not successful in estimating an optimum exploitation level for wreckfish. Further data are needed to estimate the status of exploitation of the stocks.

Wreckfish was well adapted in captivity, juvenile fish grew at very fast rates, however, maturation was not attained in the aquaculture conditions. Fish seem to reach the maximum observed size of the pelagic phase in only one year when kept in captivity. Finally, findings of the present study indicate that postlarvae and juveniles of wreckfish are part of the neuston and are found in close associations with floating debris.

PROJECT Nº 99/013: GENETIC CHARACTERIZATION AND STOCK STRUCTURE OF THE TWO SPECIES OF ANGLERFISH (LOPHIUS PISCATORIUS AND L. BUDEGASSA) OF THE NORTHEAST ATLANTIC

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SUMMARY

This study was carried out within the framework of a contract between the European Union, EU, DG XIV- Fisheries and the Instituto Español de Oceanografía (IEO), in conjunction with the Universidad de Oviedo, Instituto Tecnológico Pesquero y Alimentario (AZTI), Instituto de Investigação das Pescas e do Mar (IPIMAR, Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER) and Marine Institute (MI).

Two anglerfish species are found in the Northeast Atlantic and Mediterranean, white anglerfish, *Lophius piscatorius* and black anglerfish *L. budegassa*. In western and southern European waters these species are highly valuable in trawl and gill net fisheries. For assessment purposes, two stocks — Northern and Southern- are currently distinguished for each species. Stocks are subject to an annual TAC implemented by the EU, together with a number of technical measures. The geographic barrier of the Cap Breton Canyon, in the extreme south-eastern corner of the Bay of Biscay, separates the anglerfish stocks. This feature is considered to provide a physical barrier separating the two stocks, although there is no scientific basis to support this theory.

The GESSAN project had two main objectives: to research different aspects (genetic, morphometric, meristic and tagging) to determine whether or not there is any scientific basis to support the separation of the stocks of anglerfish into North and South, and to carry out a more in-depth study of growth and reproduction, which are two critical biological aspects in population assessment.

In order to achieve the first objective, anglerfish samples taken from different areas of western and southern European waters and one sample from the south-western Mediterranean were examined. The results of the genetic studies for each species of

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anglerfish would suggest that genetic variation between the samples from the different areas is relatively small and the stock discrimination under consideration up to the present (North and South) has no genetic basis. A library of genetic markers was compiled so that a sample of an unknown anglerfish species may be assigned to one of the two species, with almost complete accuracy.

The studies based on morphological traits were not conclusive in determining whether or not the populations were differentiated. They only distinguished between individuals in certain areas (Western Ireland, Western France and Northern Spain for *L. piscatorius* and between Western France and Southern Portugal for *L. budegassa*). The meristic traits were similar along the entire geographic distribution range.

An illicia (1st fin ray) exchange and the 4th anglerfish ageing Workshop were held. In both anglerfish species a high consensus level was reached among experienced readers as to age interpretation. An age illicia guide was elaborated, including protocols of illicia age determination, age reading criteria and a reference collection of images. Different methods of validation (including tagging data) were applied, indicating that the growth estimates from illicium age reading may be considered satisfactory.

As regards reproduction, histological studies of the gonads were performed and new maturity ogives were constructed for anglerfishes in Subarea VII and Divisions VIIIa,b,d. Although not many differences exist related to previous ones, the new ogives were used in the assessment of anglerfish during the ICES Working Group on Assessment of Southern Shelf Stocks of Hake, Monk and Megrin (2002).

Finally, a review of the mark-recapture experiments on anglerfish was described. Rates of recapture of 4.7 % in *L. piscatorius* and 1.7 % in *L. budegassa* were obtained. The location of the recaptures would suggest that *L. budegassa* moves short distances to shallower waters in order to spawn. Similarly, *L. piscatorius* was seen to move greater distances back and forth along the upper slope of Northern Spain and Western France, which is probably related to the reproductive cycle. Some of the recaptures corroborate the growth rates based on the interpretation of illicia, although a greater number would be needed to have conclusive results.

Domain 7: Integration of Environmental Requirements into the CFP



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Sub-domain 7.1:

Incidental By-catches and Strandlings

**PROJECT N° 97/050: BY-CATCHES AND DISCARDS OF SHARKS
IN LARGE PELAGIC FISHERIES IN THE MEDITERRANEAN SEA**

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SUMMARY

Among marine fauna, sharks are one of the less well known groups both in terms of their biology and stock assessment. This fact seems to result from their low economical value and consequently low research priority in most fisheries institutes. However, this situation changed recently due to increase both of the public interest on the conservation of the elasmobranchs and the industry and management concern. Sharks are slow-growing species with long reproductive cycles and there is concern that depleted populations cannot sustain heavy fishing mortality over many years. Moreover, as the status of shark stocks worldwide is generally unknown, there is concern that excessive removals of the top predators could have negative effects on predator-prey relationship in the marine ecosystem.

Long lines as well as other surface gears in large pelagic fisheries can result high by-catches rates and discards of many species of sharks for which no viable market exists.

This project aims at acquiring information concerning the shark by-catch and discards in the pelagic fisheries for tunas and swordfish through investigations in different areas of the Mediterranean providing data for the purpose of biological analysis and stock evaluation. For some fish stock assessments, discard mortalities are such a large fraction of the catch that they Cannot be ignored without seriously compromising the assessment. A particular attention will be paid to quantify the by-catches of non commercial species of sharks of fisheries that have not so far been studied as the swordfish and tunas longline fisheries. In addition, the disposition of the by-catches and the various factors associated with the composition and the magnitude of discarding will be evaluated. Biological and stock state studies will be conducted for the most important species.

The above information, besides being required for sharks stock assessment may well be important for the global management of marine resources because improve the knowledge concerning the environment impact of the fisheries.

The objectives of the study are:

1. to identify the extent of the incidence of the commercial large pelagic fisheries on the sharks and estimate the amount of shark species taken as by-catch in the Mediterranean Sea,
2. to examine the disposition of the by-catch and analyze the causes of discarding,
3. to quantify the discarded sharks and to estimate the mortality rates caused,
4. to improve the knowledge on biology and stock state of the most important shark species

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The study will be performed by means of collaboration among the following Institutions:

University of Athens (Greece) University of Bari (Italy)

Instituto Español de Oceanografía de Malaga (Spain)

The investigation will be mainly carried out through an observer program on board professional vessels fishing large pelagic fishes in different areas of the eastern, central and western Mediterranean sea. Moreover, observers will control the catches during the landings at pilot fishing ports.

PROJECT N° 97/089: IMPACTS OF FISHERIES ON SMALL CETACEANS IN COASTAL WATERS OF NORTHWEST SPAIN AND SCOTLAND

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SUMMARY

Objective 1: Quantification of mortality due to fishing off Galicia

Information in by-catches in Galicia was gathered in two ways: placing observer on-board fishing vessels covering 67 fishing trips and obtaining information of interactions between marine mammals and fisheries from interviews of fishermen. No by-catches took place while observers were on-board fishing vessels. Using information provided by the interviews, and making some assumptions to deal with semi-quantitative data, estimates of total numbers of cetaceans killed annually were derived, stratified by fishing gear and fishing area (inshore and offshore waters), with information also being derived for Grand Sole (SW Ireland) fisheries. Confidence limits were estimated using bootstrap procedures. Most fishermen reported catching relatively few cetaceans annually, but two estimates of >100 animals strongly influenced the results. Even without these outliers, confidence limits are as expected rather wide. In Galician waters, the best estimate of total annual cetacean by-catch is 1728 (95 % CL 588 — 3794) animals or 917 (520 — 1447) animals if the outliers are excluded. Gillnets and trawls appear to cause most cetacean mortality although some by-catch was recorded for most gears. The majority of by-caught animals are probably common dolphins although as many as 114 bottlenose dolphins may also be caught. Previously published information consistently shows common dolphins to suffer mortality in trawls (particularly pair trawling at night) and harbour porpoises to be by-caught in gill nets. In Galicia harbour porpoises are relatively rare and it appears that common dolphins are taken in substantial numbers in gillnets although, since fishermen do not reliably distinguish between the two species, some by-catches of harbour porpoises cannot be ruled out.

Two aerial surveys in Galicia during the first year of the project yielded no sightings and, latterly, surveys were based on opportunistic use of fishing trips (also used for observation of by-catch). The major types of fishery were sampled during this exercise (with the exception of gillnets, due to lack of co-operation from skippers). Retrospective stratification of the data was carried out to yield unbiased estimates of cetacean numbers. Confidence limits were estimated using bootstrap procedures. The common dolphin population size in Galician waters was estimated to be around 9500 (95 % CL 3500 — 18500).

The wide confidence limits reflect the big variation in school size, with a mode of 10-11 but one group of 1000-1500 animals also being seen. The population density (0.346 — 0.440 dolphins/km²) is in good agreement with previous surveys in the Bay of Biscay. The population of bottlenose dolphins, concentrated mainly in inshore waters in the south of the Galician study area was estimated to number around 320 animals (102 — 667) but this may be an underestimate due to concentration of animals in the coastal inlet (Has). Very few harbour porpoises were seen and no satisfactory population estimate could be derived.

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Putting together the by-catch data derived from interviews and the population estimates, it is seen that annual by-catches of common dolphins may exceed 2 % of population size (the upper safe limit suggested by ASCOBANS) and by-catches of bottlenose dolphins almost certainly exceed the 2 % limit. Although no equivalent results are available for harbour porpoise, and relatively few were seen or recorded stranded, the fact that more than 50 % of strandings were diagnosed as by-catches suggests that interactions with fisheries could be a problem for this species too.

In Scotland, a static life table constructed for stranded harbour porpoises leads to a provisional estimate of the by-catch rate of around 3 % of the population. This is higher than previous estimates based on studies of single fisheries. All of the above estimates require assumptions about the data available that may not be justified. However, areas of concern have been identified. It is recommended that further observer programmes should be undertaken, in Galician waters, targeting the gillnet and trawl fisheries. Useful information can be derived from interviews but sample sizes of around 50 boats per sector of the industry are desirable. Good interview procedures, involving experienced personnel known to the fishermen (as utilised in this study) are essential.

Objective 2: Description of patterns of by-catch mortality

Analysis of seasonal and geographical patterns in Scotland and Galicia was carried out using strandings data. In Scotland, the majority of cetacean strandings are of harbour porpoises. Although by-caught harbour porpoises were seen among strandings all around the Scottish coast, constituting around 20 % of all diagnosed mortalities, the proportion of by-caught animals was higher on the West Coast. This is consistent with recently published studies on by-catches in gillnets. By-catches were recorded all year round. In Galicia both strandings and by-catches were concentrated in the first quarter of the year and in the south of the study area. These trends probably reflect prevailing currents rather than real seasonal changes in by-catch mortality. A range of species was seen among by-catches, with common dolphins being most frequent, and bottlenose dolphin, harbour porpoise and long-finned pilot whale also recorded. Considering those animals in sufficiently good state of preservation to allow by-catch diagnosis, in bottlenose dolphin, around 28 % of strandings were by-catch mortalities, while in the other three species over 50 % were by-caught.

Objective 3: Population components vulnerable to by-catch

By-caught harbour porpoises in Scotland were mainly mature, older individuals, including more males than females. The diet of by-caught harbour porpoises included more and bigger whiting than the overall sample of porpoises. These results are consistent with young and immature animals, and females with calves, remaining in the relative protection of coastal waters while males, foraging further offshore are more likely to interact with fishing gear. This result is consistent with previous results on harbour porpoise by-catches. By-catches of common dolphins in Galicia also included more males than females. Data on body length indicated that by-caught individuals had been already weaned but the majority were probably immature. This latter result is also consistent with previously published studies.

Objective 4: Maximising biological data collection from stranded and by-caught animals

Teeth, gonads, stomach contents, parasites, samples of skin, blubber, muscle, internal organs, blood and bones have been collected from both by-caught and stranded animals. Much of this material has been analysed during the project to provide ecological information on the marine mammal populations in Galician and Scottish waters. In addition, samples collected during the project have been kept in sample banks and/or made available to other scientists (e.g. skin samples for genetic studies).

PROJECT N° 98/008: ASSESSING MARINE TURTLE BYCATCH IN EUROPEAN DRIFTING LONGLINES AND TRAWL FISHERIES FOR IDENTIFYING FISHING REGULATIONS

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SUMMARY

The objectives of this two-year project were:

- a. to estimate catch rates, total catch, total direct mortality, and condition when released, of marine turtles in European Mediterranean drifting longline and trawl fisheries in 1999 and 2000 within the framework of a stratified random sampling design using onboard observers as data source, and
- b. to measure relevant marine turtle and fishery interaction parameters on the basis of standardized methodologies and a comparative approach to identify potential mitigation measures.

Approach and methodology

The two endangered marine turtle species that nest in the Mediterranean, the loggerhead *Caretta caretta*, marked as priority species in Annexe II of the Habitats Directive 92/43/EU, and the green turtle *Chelonia mydas*, together with the leatherback turtle *Dermochelys coriacea*, interact with fishing activities operating in this sea. Reliable assessment of the resulting impact requires an integrated approach involving stock identification, estimates of total catch and mortality, and population modeling development. Based on a conservation biology approach, including stock composition assessment and life history stage distribution analysis, "Project 98/008" was designed to investigate turtle bycatch in European fisheries that appear to have the greatest impact on population dynamics. These fisheries are drifting longline activities in Spain, Italy (Ionian sea) and Greece together with trawling activities in Italy (North Adriatic) and Greece. The project was organized in collaboration with fishery and turtle researchers as well as with fishermen to ensure that the methods were acceptable by fishery managers, and that biological data collected from turtles were useful to the turtle researchers.

Main findings and conclusions

Drifting longline fisheries

In European drifting longline fishery a total of 23 turtle catch were observed in the Greek monitoring program (22 loggerhead *Caretta caretta* and one leatherback *Dermochelys*

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coriacea), 220 turtle catch in the Italian program (218 loggerheads and two green turtle *Chelonia mydas*) and 2127 turtle catch in the Spanish one (2125 loggerheads and two leatherbacks). In 2000, in swordfish fishery, turtle catch rates (number of turtle catch per 1,000 hooks) were estimated at 0.63 ± 0.38 (95 %CI) in Greece, 0.22 ± 0.12 and 0.71 ± 0.14 in the Italian northern and southern tonian sea, and 1.15 ± 0.73 in Spain. In albacore fisheries turtle catch rates varied from 0.50 ± 0.19 and 0.20 ± 0.06 in Italy, and were 3.27 ± 4.03 in Spain for the same fishing areas and year. Turtle catch rates were highly variable depending on the fishing areas and fishing seasons, being higher during quarter 2 and 3 in Spain. Set operations as well as gear characteristics also affected the outcome. Unfortunately, only three capture times were obtained using hook timers: 05h20, 21h56 and 07h28, thus preventing any analysis being made regarding correlation between turtle capture time and set/retrieval operations. Hook position relative to float line, as well as the use of lightsticks, might affect probability of turtle catch. However, further analyses of data collected with Sensor (temperature/depth recorder) are needed to obtain reliable results to identify a correlation between gear configuration and turtle catch rate.

Unfortunately, data on fishing effort was often incomplete or was only approximate thus making an estimate of total turtle catch from catch rates unreliable. When fishing effort was, however, available a high total catch per year was calculated. In Greece, catch was estimated at $6,158 \pm 3,521$ in 2000. In the Italian swordfish and albacore longline fisheries, operating in the North Ionian Sea, catch was 71 ± 35 and 103 ± 29 , respectively. In Spain, fishing effort was only available in the swordfish large boat strata for the year 1999 resulting in a catch of $1,858 \pm 1,232$ during the calendar quarter 3 and 4 of the year in question.

Direct mortality; i.e. proportion of turtles found dead, was estimated at 4.3 % in Greece (N=23 longline-caught turtles), 0 % in Italy (N=214) and 2.6 % in Spain (N=676). Total direct mortality was estimated at 342:195 in the Greek fishery in 2000. Injured but healthy turtles were observed in both Italian and Spanish longline fisheries in the proportion of 3.7 % (N=214) and 6.8 % (N=676), respectively. In contrast with leatherbacks found entangled, loggerheads mainly consumed baited hooks. The proportion of those loggerheads captured that return to the sea with a hook inside them was estimated at 85-100 % depending on the monitoring program. The fate of these turtles (which should also be considered seriously injured) is totally unknown thereby rendering unknown the resulting delayed induced mortality, although it is now generally accepted that a 50 % delayed mortality among these specimens would be a reasonable figure.

The present study showed that interaction of sea turtles with European Mediterranean drifting longline fisheries is a significant marine turtle conservation issue and that development of mitigation measures remains a complex challenge. The analysis of the results of the project however provides orientations, in terms of technical measures to follow (gear modification), and identifies operational measures and management options, that could be implemented by specific regulations. Technical solutions leading to higher gear selectivity is a promising one when considering hook location (proximity of float line, number of branch lines per unit and unit length) correlated with a probable hook depth effect. The data gathered within the project, notably from Sensor (temperature/depth recorder), need however to be further analyzed in order to obtain more insight into this question. As regards operational measures (fishing method modifications), the use of chemical lightsticks was presented as a factor that might attract turtles. Since the use of lightsticks is tending to develop in European Mediterranean drifting longline fisheries, a precautionary approach to non-target species (European Fisheries Council) would be to immediately ban further diffusion of this device. This would be a very appropriate regulation for turtle conservation that would not affect fisheries. However, in complement to the gear selectivity approach, other solutions are fundamentally required to solve the problem. Indeed, because, (1) the drifting longline activities and loggerhead feeding take place in the same pelagic areas, along side (2) the range of hook fishing depth and turtle depth distribution appearing to partially match, and together with (3) the carnivorous feeding behaviour of the loggerhead turtle species being particularly opportunistic, significant turtle

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bycatch is thus, to a certain extent, rendered inevitable. Measures such as spatial and seasonal closures would be more efficient in mitigate the impact of drifting longline fisheries on turtle population dynamics. They should be developed in relation to the target species stock management requirements, as fishery management options, and explained as such to lead to higher regulation compliance. To make progress in the European decision-making process to develop and implement these conservation regulations, a sound assessment of the impact of these fisheries on marine turtle populations is needed. This requires the precise estimation of delayed mortality to be carried out beforehand and this is the next step to attain.

Trawl fisheries

In bottom trawl fisheries a total of 62 turtle catch were observed in Italy and four in Greece, representing almost exclusively loggerheads except one green turtle in Greece. Turtle catch rates (number of turtle catch per 30.5 m headrope trawl net and hour) were highly variable, depending on the monitored port fleets. In 2000, the year to which the greater observed effort was allocated, turtle catch rates ranged in Greece from 0.00336 ± 0.00062 (95 % CI) (Alexandroupoli) in the Northern Aegean Sea to 0.00092 ± 0.00182 (Patra) in the Ionian Sea, and varied in Italy (North Adriatic) from 0.06600 ± 0.02337 (Fano) to 0.00411 ± 0.00464 (Ancona). In assuming that the observed range of depth trawled was similar among monitored fleets, such a result indicated the occurrence of areas where density of turtles is higher. This was particularly striking in Italy when comparing western and eastern North Adriatic areas exploited by non Fano and Fano fleets, respectively. Capture depths ranged from 14.9 to 74.5 m in the North Adriatic and 9 to 49 m in Greece, suggesting that such areas may extend in inshore waters. Turtle catch rates varied also with the season in the North Adriatic, being higher during the fourth and the first calendar quarter and indicating a difference in spatial distribution, or in depth distribution relative to the bottom, throughout the year. No turtle was caught during the monitoring of the midwater trawl fishery that operates in the North Adriatic.

Total turtle catch per year in the Italian bottom trawl fishery working in the North Adriatic during 1999 and 2000 was estimated at $3,588 \pm 2,975$, on the basis of a conservative approach, using the fishing effort of the entire fishery in working days (the only fishing effort available) and the lower turtle catch rate of non-Fano port (0.03955 ± 0.032798 turtles/day), instead of the turtle catch rate of the overall ports (0.23664 ± 0.091592 turtles/day). However, the solution would be to estimate separately the total catch for that part of the Italian fleet fishing in the eastern Adriatic (where the sampled boats from Fano operated), in which the turtle catch rate was found to be particularly higher (0.64706 ± 0.25347 turtles/day), but the fishing effort carried out in the eastern Adriatic is not available, making the estimation of total catch in the Italian North Adriatic bottom fishery unsatisfactory. In Greece, 95 % confidence intervals for the total catch per year in 2000, the year to which the greater observed effort — was allocated, were calculated at 0-418 in the northern Aegean Sea, on the basis of two monitored.. fleets (Alexandroupoli and Kavala), and at 0-448 in the Ionian Sea (Patra). Such confidence intervals should however be considered as approximate owing to the very small number of turtles caught in each fishing area (one turtle).

Direct mortality, i.e. proportion of turtle found dead due to drowning or severe trauma, was estimated in the North Adriatic at 14.3-0 % for non-Fano (N=7 trawl-caught turtles) and Fano (N=55) ports, respectively, and 0 % in Greece (N=4). Turtles in a comatose state and injured were only found within the Italian program. The proportion of comatose specimen groups represented 57.1 % of the total in non-Fano port (N=7) and 0 % in Fano port (N=55), while the injured specimen group varied from 14.3 % (N=7) to 5.5 % (N=55), in non-Fano and Fano ports, respectively. Based on the conservative estimate of the total catch, total turtle direct mortality per year in the Italian trawl fisheries working in the North Adriatic was estimated at 513 ± 425 , while total number of turtles in a comatose state was estimated at $2,050 \pm 1,700$. Specimens in a comatose state and other non-healthy

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specimens (dead and injured) resulted from longer haul duration. Without the use of turtle recovery procedures by fishermen, weak and comatose states should be considered as potential mortality.

The present study shows that interaction of sea turtles with trawl activities in European Mediterranean fisheries is also a significant marine turtle conservation issue. The project clearly identified on two different scales in European trawl fisheries a group of solutions to mitigate turtle bycatch and related mortality with variable efficiency (and degree of compliance), considering that no one solution can totally solve the problem alone. Implementation would be through new regulations, enforcement of previous regulation or awareness program. On the European Mediterranean scale the first solution would be an operational measure based on the implementation onboard trawlers of Turtle recovery procedure to reduce potential mortality through fishermen awareness campaigns. The second one is the implementation and enforcement of rules of articles 3(1) and 3(3) of the EC Regulation 1626/94 concerning regulation of trawling within the three nautical miles and above Posidonia beds. Such an enforcement would be appropriate, although far from being sufficient, for reducing turtle bycatch per unit effort at the Mediterranean level with probably little effect in Italian North Adriatic where particularly high turtle catch rate and annual total catch were measured outside the three nautical miles. On the local scale, in these localized zones where turtles concentrate, implementation of (1) spatial and time closures to reduce turtle bycatch per unit effort, in conjunction or alternatively with, (2) bottom haul duration reduction and use of Turtle Excluder Device (if operational for the Mediterranean situation) to reduce direct and potential mortality, would be very efficient in mitigating the impact of trawl fisheries on turtle population dynamics. These regulations should be developed in relation to target species stock management requirements (benthic ecosystem conservation management) as fishery management options, and explained as such, leading to higher level of compliance. Identification of these zones in European Mediterranean waters is therefore urgently needed and the present project has significantly contributed towards achieving this objective. In effect, the eastern north Adriatic area exploited by the Italian fleet has been identified as an area where high turtle catch rate occur, comparable with fishing areas in the USA which hosts the second largest nesting area in the world, where it was decided to regulate trawl activities precisely for this reason.

PROJECT N° 00/027: PELAGIC FISHERIES IN SCOTLAND (UK) AND GALICIA (SPAIN):OBSERVER STUDIES TO COLLECT FISHERY DATA AND MONITOR BY-CATCHES OF SMALL CETACEANS

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SUMMARY

The Standing Committee for Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT) assesses the eastern stock of bluefin tuna by means of the model ADAPT VPA. This model uses Catch Per Unit Effort (CPUE) series from different bluefin tuna fisheries as relative abundance indices for its calibration. In the last assessment in 1998, 5 CPUE series were used, of which the Spanish baitboat index, used as a recruitment index of the eastern stock (i.e. as an index of incorporation to the fishery of age 2) was the only non-standardised series (nominal CPUE). The SCRS-ICCAT working group made a strong recommendation to standardise the CPUE series for the Spanish baitboat bluefin tuna fishery of the Bay of Biscay.

Nominal CPUE employs nominal effort, which is the measurement of the set of elements which fishermen use to catch fish in a given time. Nevertheless, it is the effective effort proportional to fish mortality due to fishing activity which is of relevance to assessments. Through the standardisation of nominal CPUE, this effective effort is obtained and catch rates are used to take changes in efficiency of the fleet into account. Additionally, this process provides a measure of error in the estimate of abundance indices at age (coefficients of variation) which means that they will have a greater or lesser effect on the tuning of the assessment model according to whether they are low or high, i.e. an inverse relationship.

The aim of this project was to standardise the abundance index of age two, and at the same time those of the remaining ages caught by this fishery. To this end it was necessary to use new information, additional and different to that which has been used to date in order to obtain the nominal index of age two.

New catch and effort data on bluefin tuna from two sources were used in this study: catches by trip and catches from logbooks. The processing of these two relational databases together with the revision of fleet characteristics and the creation of a new database with oceanographic data permitted changes in fishing power and the influence of the environment to be taken into account in the abundance indices.

Relative indices of abundance for bluefin tuna of all well represented age classes in the fishery were estimated. The coefficients of variation of these indices for ages 2 to 4 are small, whereas those of ages 1 and 5 onwards are high. In the case of age 1 this is due to the irregularity of the annual presence of this class, which mainly appears at the end of the fishing season, making it the last to disappear. The changes in migratory behavior of the

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ages over 4-5 years, related to spawning in individuals reaching sexual maturity, may explain their scarce appearance in the area. The different migratory behavior of different ages determines their temporary appearance in the Bay of Biscay.

Analysis was performed on the catch rate data in order to get a better understanding of which factors significantly explained the observed variability. Abundance at age throughout the fishing season are reflected in the explanatory factors of the selected final model used in standardisation: Year, Age, Year*Age, Month and Year*Month interaction. The other two significant factors, crew number and number of bait tanks, also reflect their importance on catches due to the fishing system itself. Regarding the crew number, the use of rods which may be handled by one or three men depending on the size of the tuna, gives this factor great importance. On the other hand, the number of bait tanks determines the quantity of bait available, both to attract fish and to bait hooks, which enables longer periods with the possibility of fishing without having to break off and go in search of bait.

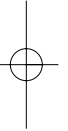
The models selected for the standardisation of the two databases, trips and logbooks include the same explanatory factors. Overall, both year trends and coefficients of variation were similar from both datasets by age-class.

The baitboat fleet targeting bluefin tuna in the Bay of Biscay from 1975 to the present is described. The total number of vessels has remained constant at around 25, all based in the port of Hondarribia except from 1996 to 1998, when boats from the port of Guetaria were incorporated. A total of 78 boats participated in the bluefin fishery throughout the study period, which were divided in 3 groups. The use of black and white sonar became generalised at the end of the 70's and other technological advances have increased throughout the study period at a more or less similar rate throughout the fleet.

In general, the standardisation procedure showed that vessel characteristics and fishing related instrumentation have a relatively minor explanatory effect on the observed catch rates for bluefin tuna in this fishery. Geographical distribution had no explanatory effect on the observed catch rates. The concentration of catches in such a reduced area (90 % in 2 to 4 W and 43.5 to 45.5 N) does not permit the discrimination of this variable.

No statistical differences were found between historical nominal CPUE (currently used as a recruitment index of the eastern stock) and the nominal CPUE of age 2 obtained in the present study. Nevertheless, when this historical index for age 2 was replaced by the new standardised indices for ages 1 to 4 (and their corresponding coefficients of variation) in the calibration of the Virtual Population Analysis, a large influence on recent perceptions of the stock was observed, showing a more optimistic view in particular for the younger ages.

Relationships between bluefin tuna daily catch rates in the Bay of Biscay and remote sensed environmental variables, onboard recorded temperature and spatial variables (latitude and longitude) were tested for the period 1997-2000. Some environmental variables were selected and added to the final model selected to standardise the bluefin catch rates. The model explained 50 % of the variability of catch rates, and 4 % was due to environmental factors.



Sub-domain 7.2:

Impact of Fishing on Marine Ecosystems

PROJECT N° 97/020: ENVIRONMENTAL IMPACT OF TRAWLING ON THE BENTHIC SYSTEM ON TWO DIFFERENT SEA BED OF THE NW MEDITERRANEAN

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SUMMARY

The aim of this project was to investigate the effects of demersal otter-trawling on the seabed substratum and on its associated benthic communities. The study examined the immediate effects of trawling on the environment followed by an assessment of the short-term effects in two contrasting habitat-types. The study had two main aims. The first aim was to quantify the role of demersal otter trawling in modifying the bottom sediments of the continental shelf and to evaluate its role as an erosional process. Its importance as an environmental impact was compared with natural sedimentological processes. The second aim was to analyse the immediate and short-term disturbance effects imposed on the benthic ecosystem by quantifying changes in benthic communities in response to intensive trawling.

The tasks undertaken to achieve these objectives were carried out on two different seabed types in the NW Mediterranean Sea situated in the Catalan Sea (Spain) and in the Tyrrhenian Sea (Italy). A preliminary survey, one in the Catalan sea and one in the Tyrrhenian Sea, was devoted to the characterisation of both the benthic communities and bottom sediments.

In the Catalan Sea experimental trawling was performed along one wayline located at a depth of 32 m on a sandy seabed. This wayline was fished 10 times with a commercial fishing gear. Along this fished line 5 stations (1–5) were located, and 5 additional stations (1c–5c) used as control sites were located outside the fishing line, at a distance of 500 m, in an adjacent area. All samples mentioned in the study were collected at time intervals 24 h

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before and, 24 h, 48 h, 1 month and 6 months after trawling. During and before the experimental fishing disturbance, a towed video survey was carried out. This was repeated after the fishing disturbance. On each occasion, one transect ran in a diagonal across the trawl marks, two transects ran in parallel to the door marks and other, ran over the area disturbed by the net. These transects were filmed immediately, 24, 48 hours, 1 and 6 months after trawling.

In the Tyrrhenian Sea, a fishing disturbance was simulated by making 15 repeated hauls with a commercial fishing gear. Each tow lasted about one hour. These hauls were carried out in a muddy area of seabed at a mean depth of about 32 m. The number, position of the sampling stations and time intervals of sample collection were the same as in Catalan Sea. Bottom video images were recorded along 3 transects orthogonal or diagonal to the experimental area. Three days, one month and six months after fishing disturbance bottom video images were recorded inside the experimental area.

Prior to and after experimental trawling in both study areas (Catalan and Tyrrhenian Seas) side-scan sonar sonographs were taken in order to observe any trawl tracks on the seabed that had been made by the trawl gear. The side-scan sonograms taken over the muddy seabed of the Tyrrhenian Sea showed evidence of considerable disturbance in the experimental area immediately after experimental trawling. One month later these trawl marks were barely visible. In the sandy area of the Catalan Sea immediately after trawling the penetration depth of the otter doors in the seabed varied along the studied wayline. There were no short-term (< 48 hours) changes in the characteristics of the trawl marks along this wayline. One month after trawling, the tracks were identifiable along all the study wayline although they had begun to fade. Six months after the trawling disturbance had occurred, the trawl tracks were still visible at the northern end of the study wayline where the seabed was composed mostly of gravel. However, in the southern sector where sand was dominant, the trawl tracks were no longer visible.

A grid of 16 CTD (temperature, salinity, turbidity and fluorescence) stations was sampled, in order to record the changes of suspended particulate matter (SPM) produced by trawling activity. In the sandy area (Catalan Sea) increases of water turbidity associated with trawling were identified up to 48 hours after fishing had occurred. The variability of the water turbidity depended on resuspension associated with trawling activity and changes in current direction.

The effects of bottom trawling on the benthic community composition were studied using a van Veen grab. Both univariate and multivariate analyses were used to compare the fished and adjacent unfished areas, and to estimate changes in the benthic communities with time. Bottom trawling did not produce large changes in the benthic infauna in either study area. Those changes that occurred were subtle.

The video images recorded showed the most obvious effects of trawling 24 and 48 hours after disturbance had occurred in both the sandy and muddy areas. In the sandy area the maximum depth of trawl tracks was 4.5 cm and occurred up to 48 h after the trawling disturbance. Six months later these trawl marks had infilled by 40 % and were still visible.

PROJECT N° 98/006: ETUDE DE LA MORTALITÉ DES CÉTACÉS ÉCHOUÉS SUR LES CÔTES DES ILES CANARIES: IMPACT DE LA PÊCHE ARTISANALE

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SUMMARY

The Canary Islands represent an interesting region of the North Atlantic where human maritime activities, like fisheries, are coincident with one of the major diversity of cetacean species in the world, since 27 species have been identified in the area. Every year a consequent number of cetaceans die from natural or anthropogenic causes but in the past those deaths were systematically attributed to fishery interactions.

The project objective was to conduct an exhaustive post-mortem analysis of all the stranded cetaceans in the Canary Islands, in order to objectively establish the relationship between those strandings and fishery interactions. In addition, a parallel study with local fisheries aimed at defining the degree of those interactions by interviewing the fishermen.

The cetaceans are usually observed mainly in spring and at the beginning of the summer by all the interviewed Associations. The species which we have more reference of is the tonina, that is to say, the delphinid species. When identifying the cetaceans, the local fishermen use their own terminology. To try to homogenize the terms, we conducted a survey of all the local Associations and introduced them to the project purposes in addition to give them an identification form with the features of the most common species encountered in the Archipelago. According to the information obtained from fishermen's Associations, no cetaceans were caught nor meshed in the fishing gears and the most frequent interactions are derived from the cetaceans which are afraid of fish. According to the fishermen, during some years, there has been a progressive approach from the cetaceans to the boats. They told us that in the past, the dolphins did not come close to the boats but, may be due to the rise of tourism, the animals started to come closer in search of food. For the deep-sea fishing, we have had many difficulties to get in touch with the fishermen because of the problems they have: For a long time, the lack of fishing agreement with Morocco has made the fleet (deep-sea and craft) to be moored in the harbour, so the interactions with the cetaceans have stopped existing around the islands due to these fisheries.

Between 1999 and 2002 stranded cetaceans on the coasts of the Canary Islands were subjected to a detailed postmortem examination as part of a research study which main objective focused on the causes of death of cetaceans and their relationship with fishing interaction in the canary islands waters. A deep study, based on the pathological lesions as a procedure to establish a diagnosis of fishing interaction was carried out. Therefore, a detailed macroscopical and microscopical analysis were performed on every stranded animal. In addition, bacteriological, virological and parasitological as well as toxicological studies were also done on most of the stranded animals in order to precise the causes of disease or death. A total of 123 stranded cetaceans were totally or partly analyzed depending on conservation condition. The final causes of death were divided into four groups: 49 of them, due to severe autolysis or the impossibility to get sufficient information, could not be diagnosed; 45 died due to natural causes, 13 died by ship-collision and 16 were diagnosed as fishing interaction. The ratio of 16 out of 123 stranded cetaceans (13 %)

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or 16 out of 74, if we take only the animals with definitive pathological diagnosis (21.6 %) represent a very similar fishing interaction rate compared to those found in other parts of Europe, with the particularity that more species are involved (*Balaenoptera edeni*, *Balaenoptera physalus*, *Delphinus delphis*, *Kogia breviceps*, *Kogia simus*, *Stenella frontalis*, *Steno bredanensis*) because of the diversity of cetacean species of the Canary Islands waters. This is the first complete study on this matter carried out in the Canary Islands. It has highly contributed to a better knowledge of the pathology of these species, and their causes of death, being an excellent biomarker of the local environment, especially through the analyzed resident species.

In conclusion, although the present results (fishing-interaction part) increase the current scientific data in this field, we are convinced that the stranded animals are not representative of offshore by-catches to any meaningful extent and other additional methods, such as observers on fishing vessels, are needed to provide realistic numbers of by-catches to the government and the public.

PROJECT N° 98/017: COMPARISON OF RAPID METHODOLOGIES FOR QUANTIFYING ENVIRONMENTAL IMPACTS OF OTTER TRAWLS

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SUMMARY

The research reported here evaluates and compares a suite of rapid methodologies for quantifying the environmental impacts of otter trawls. These represent an alternative to traditional methods, which are notoriously slow and costly, and cover a range of readily accessible technologies, from basic biological sampling to advanced remote sensing. Rapid methodologies will be of benefit to the real-time, ecosystem-based approach to fisheries management.

Investigations were carried out on Scottish Nephrops (Norway lobster) grounds and on Aegean grounds that support a multi species fishery. Sites were selected to reflect a range of trawl impacts, based on detailed information on fleet activities. Scottish sites (Clyde Sea area; muddy substrata) covered three nominal levels of fishing intensity (heavy, moderate and light). Aegean sites (off northern Crete) covered a continuum of trawling intensity, sampling across a narrow commercial trawling lane on muddy substrata during open and closed seasons. For comparison off Crete, trawl impact was experimentally manipulated on an adjacent, but previously unfished, sandy site.

The methodologies evaluated divided into four broad categories: acoustic, visual, biological and sedimentological. Acoustic methods comprised the use of bottom-discriminating sonar (RoxAnnTM) and sidescan sonar. Effects attributable to trawling were not detected by the former method, but sidescan sonar enabled trawl marks to be detected and enumerated. Sidescan survey strategies and analytical approaches are discussed. Visual methods used underwater television, deployed either on a towed-sledge (best for transect-type surveys) or mounted on a remote operated vehicle (ROV) (best for 'spot' surveys). A semi-quantitative method for assessing biogenic and anthropogenic impact was applied to the analysis of the video record. Visual methods were limited in their area of coverage, but had high resolution, being the only methods to give some indication of the age or longevity of trawl marks. They also provided a better rapid assessment of the ecological significance of impacts than other methods.

Biological sampling was specifically directed at the benthic megafauna (mostly epifauna). Trials of sampling gear showed that a 2-metre beam trawl was more appropriate for the Clyde Sea area ("100 m deep, high epifaunal density) and a 2-metre Agassiz trawl for the Aegean (>100 m deep, low epifaunal density). Benthic megafauna collected from sites subject to different degrees of trawling impact enabled several investigative approaches, comparing tissue damage in selected species and analysing the structure, population density and functional group composition of the sampled communities. All of these approaches detected effects attributable to trawling impact, and these are discussed. Sedimentological methods comprised granulometry, a suite of geotechnical tests and sediment profile imagery (SPI). Although granulometry and load resistance penetrometry

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showed some potential in assessing trawl impact to sediments, only SPI provided relatively rapid information on sedimentary differences between trawled and untrawled areas that appeared to be attributable to trawling.

The operational constraints affecting the various methodologies utilised are compared and discussed, and their cost-effectiveness examined. Finally, a list of recommendations is given on techniques suitable for the rapid assessment of otter trawl impacts on soft substrata. The importance of using two or more complementary methods for rapid assessment is emphasised. Ultimately, the choice of methods will be largely determined by the specific goals of an investigation and the financial and material resources available.

PROJECT N° 98/018: IMPACT CAUSED BY TOOTHED DREDGES REQUANTIFIED ON A PAN EUROPEAN SCALE

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SUMMARY

The research reported in this 18-month study involved an investigation of the three main types of toothed dredge gear used to catch scallops in Europe. Experimental fishing and detailed ecological investigations were carried out on scallop grounds in the northern Adriatic (Italy), the Bay of Brest (NW France) and in the Clyde Sea area (Scotland). These field experiments established that the major impacts of such dredges are concerned with the disruption to surface physical features (via smoothing topographic irregularities), resuspension of silt fractions and removal of (sometimes sparsely distributed) sessile epifauna, large dead shells and other structural features of the habitat that can form colonisation nuclei. In the immediate aftermath of the passage of such gear, the tracks are littered with damaged and dead organisms, and become foci for mobile scavengers (brittlestars, crabs, hermit crabs, certain fish). These consume fragmented organisms in a matter of hours or days, leaving the track as a visible physical feature for periods varying from months to years, depending upon the dynamism of the sea bed. Highly mobile bottoms, like sands, generally erase the evidence of dredging quicker than sheltered muds or maerl grounds.

The depth of penetration of dredge teeth into the sediment depends on gear design, sediment grade and compaction. The rapido trawls penetrated 2 cm whereas the French and UK dredges penetrated 10 cm. The spring-toothed UK dredges caused the most damage per unit area, as they were the heaviest gear-type. Data derived both from grab sampling and suction sampling revealed more numerous and diverse invertebrate fauna in the top 10 cm of the sediments studied, than in the underlying strata. However, on some grounds the bulk of the biomass is represented in these deeper layers. Small surficial infaunal animals that are numerically dense (probably annuals, rapid growing and r-selected) may be resilient to towed dredge disturbance, as many pass undamaged between the teeth of the dredges. Deep-burrowing organisms (e.g. bivalves, sipunculids, thalassinidean crustaceans) are also largely invulnerable to the passage of dredges (however heavy and damaging) overhead. However, the fact that in those deep-burrowing species encountered, very few juveniles were detected, suggests that successful recruitment of such large, long-lived K-selected species may only be sporadic. Their invulnerability may thus not be absolute. Maerl grounds suffer direct damage from burial and smothering by settling silt (inhibiting light access to living thalli for photosynthesis). The best examples of these, and other biogenic reefs, should be priority habitats for conservation and protection from towed gear impacts.

PROJECT N° 98/019: ACOUSTIC DETERRENTS TO ELIMINATE PREDATION IN TRAMMEL — NETS (ADEPTS)

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SUMMARY

This project addresses problems caused by opportunistic foraging behaviour by dolphins around artisanal gillnet and trammel net fisheries in the Mediterranean where damaging interactions are frequently reported. The area of the study has focussed on the Sicilian trammel and gillnet fishery within the Isole Egadi Marine Reserve where a solution is needed to permit a traditional fishery to co-exist with protected mammals. However, these results should be applicable in other areas.

The objective of the project was to study opportunistic foraging of dolphins around fishing nets and test new acoustic methods of reducing predation on fishing gear by the integration of the following tasks:

1. Record and analyse the foraging behaviour of dolphins in a model artisanal trammel net fishery
2. Develop improved study tools with which to investigate underwater foraging behaviour around fishing nets
3. Record and analyse the behaviour of marine mammals in semi-controlled conditions in the wild, in terms of their reaction to acoustic stimuli and potential deterrent devices
4. Progress technical improvements to: deterrent devices, signal processing and analysis methods and current research (link to Project EPIC).
5. Investigate gear technology and net rigging methods to optimise attachment methods for deterrent devices
6. Investigate operating conditions within a similar fishery where dolphin predation is not reported.
7. Construct a results database with acoustic analysis examples and a bibliography of publications for dissemination via the internet or CD-ROM.

This study has confirmed that the number of dolphin 'interference' events in the set gillnet fishery within the Egadi Island Marine Reserve around Favignana is significant although relatively few dolphins may be involved;

Only one species, the bottlenose dolphin, *Tursiops truncatus*, is implicated when nets are damaged.

In the primary study area around Favignana fishing nets equipped with a low power, AQUAmarkIOTM wideband acoustic deterrent avoided dolphin interactions in all seasons although unprotected nets in the same area were frequently attacked.

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Dolphin interactions with nets peak during the spring and are lowest during the summer months.

Dolphins avoided the localised area around a deterrent device. However, they return to predate on nets as soon as the acoustic stimulus is removed;

In the Favignana fishery the only recorded interference between a dolphin and a net equipped with a single AQUAmark100 deterrent happened after this device had been retrieved and was onboard the fishing vessel together with the first portion of the net. This illustrates that the displacement effect on dolphins is localised.

In Favignana the average 'Catch per Unit Effort' (CPUE) values were higher in nets equipped with AQUAmark100 acoustic deterrent devices than in those nets without an attached acoustic deterrent;

The beneficial effect of reducing the damage and increasing the CPUE applied to all types of set nets when these were equipped with the AQUAmark100 acoustic deterrent;

In Catania, the secondary study area, the marine environment is degraded by anthropogenic activity throughout the year, e.g., marine traffic entering or leaving the Port of Catania, pollution and additional "abnormal" acoustic activities such as underwater explosions from small fire-crackers used by some fishermen. However, fishing nets equipped with an AQUAmark100 demonstrated reduced net damage from dolphins although these results should be considered provisional;

The positive results of these trials were well accepted by the Sicilian artisanal fishermen involved and a larger availability of AQUAmark100 was requested several times during the latter part of the study;

The deterrent equipped gillnets in Favignana and in Catania had higher average yields (catch) and clearly demonstrate that these sounds have no adverse effect on fishes, molluscs and crustacea;

Without acoustic devices the lower average CPUE in set gillnets shows that dolphins close to nets do alter the catch rates and, in addition, may remove economic quantities of fish already caught in the nets;

Damage caused by dolphins demands extensive repair time in port. This 'down-time' is an important economic factor as severe cases can require several days of work to restore the nets;

In sensitive protected marine areas, the use of electronic deterrent devices like the AQUAmark100 can now be considered as a benign management method which can help gillnet/trammel net fisheries and cetaceans to co-exist without serious conflict.

This small scale study has shown rather better results than expected and should encourage an extended study involving additional artisanal fisheries where conditions may be different.

PROJECT N° 99/036: A NEW METHOD FOR THE QUANTITATIVE MEASUREMENT OF THE EFFECTS OF OTTER TRAWLING ON BENTHIC NUTRIENT FLUXES AND SEDIMENT BIOGEOCHEMISTRY

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SUMMARY

The impacts of seabed disturbance by otter trawling and other fishing gear on the rate of regeneration of nutrients from sea bed sediments to the overlying water column, and on the biogeochemical zonation within the near surface sediments have never previously been studied. These impacts can have very important implications for nutrient supply, and hence on primary production on the continental shelf where most trawling activity is concentrated, and consequently on demersal and pelagic fish production and fishing management. Additionally, resuspension of sediment by bottom trawling may decrease light transmission in the short term and consequently influence benthic primary production rates as well as increase concentration and transport of pollutants through the desorption of adsorbed chemical compounds to the sediment particles.

The study of the effects of trawling on nutrient supply and on the resulting biological response requires new field methodologies and sampling techniques, which was the main aim of this project. The labile fractions of sedimentary organic matter responsible for most of the sedimentary metabolism are usually concentrated on or near the sediment water interface. Consequently the impact of trawling on sediment biogeochemistry could be studied by measuring inorganic nutrient releases as well as resuspension of other particulate and biologically active substances derived from the artificial disturbance of the sediment surface layer. The part of a trawling rig contributing mainly to this process is the groundrope (more than 90 % of the total conduct surface) that was finally chosen for the carrying out of the trawling simulation experiments.

The site chosen for the experiments was the continental shelf and upper slope of Heraklion Bay (Eastern Mediterranean, Cretan Sea). Experimentally generated nutrient fluxes derived from sediment resuspension were measured by applying a new method simulating trawl groundrope conduct with the seabed. The initial hypotheses for the development of the method were verified and validated with results derived from a thorough seasonal study of the sediment biogeochemistry and the estimation of the natural benthic fluxes of nutrients to the water column. In conclusion, the combined use of underwater video, acoustic release systems and water sampling bottles in experimental fishing gears simulating otter trawls enabled direct measurements of the amount of sediment biogenic compounds, and nutrient concentrations put into suspension per track length or seabed surface unit, to be carried out.

The new methodology allows the quantification of the rate at which bottom trawls resuspend sediment and supply nutrients and it is proposed that further investigation of this, unstudied and very interesting aspect of fishing gear effects on the marine environment, be undertaken.

PROJECT N° 99/051: STUDY ON THE MIXED-SPECIES CATCHES OF THE RAPIDO TRAWL FISHERY ALONG THE ITALIAN COASTS

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SUMMARY

Rapido trawl is a bottom trawl gear planned and used in Italy mainly to exploit soles (*Solea vulgaris*) and scallops (*Aequipecten opercularis*, *Chlamys glabra* and *Pecten jacobaeus*). It resembles a toothed beam-trawl and is made of an iron frame provided with 4 skids and a toothed bar on its lower side. These gears are usually towed at a greater speed in comparison to the otter trawl nets.

This fishing activity at present largely spreads along the Italian coast of the northern Adriatic Sea, while only a few number of vessels are fishing with this gear along the western Italian coasts.

Due to the lacking information on the rapido trawl activity exploiting the common sole on the soft, sand-muddy bottoms along eastern and western Italian coasts, the present project has been conceived, in order to collect the basic information for a possible future management of this fishery. The aim of this study was to collect data on fishing areas, landings, fishing effort, fishing yields and composition of the retained and discarded catch, as well as the size composition of the target (*S. vulgaris*) and the most relevant commercial species.

Investigation was carried out in three Mediterranean areas: the northern Adriatic Sea, the eastern Ligurian Sea and the central Tyrrhenian Sea. Data were collected from July '00 to March '02, both through a sampling activity on landings and fishing effort and by observations onboard of commercial vessels. The former was performed by monthly data collection at the landing sites of the rapido trawl vessels of Rimini and Ancona (northern Adriatic Sea) as well as of the vessels of Viareggio (eastern Ligurian Sea) and Fiumicino (central Tyrrhenian Sea). The latter was carried out at 20-day intervals adopting the same sampling protocol at all the investigated areas: observations were carried out aboard of commercial vessels belonging to Ancona, Viareggio and Fiumicino rapido trawl fleets. A total of 179 hauls were sampled in the first harbour, 177 and 87 in the other two, respectively.

The catch obtained in each haul was studied according to the commercial categories adopted by the fishermen of each area: target species, "kept" by-catch and discarded by-catch; subdividing this last fraction in "commercial" and "not commercial" species. In addition, occurrence and composition (dead shells, wood, stones, waste, ecc.) of debris was registered. In each area, number and total weight were recorded for each species as well as the size of each individual of *S. vulgaris* and the most important commercial species.

Abundance and biomass were standardised as number of individuals/km² and kg/km², in order to have comparable estimations among the three areas. Analysis of variance was used to perform statistical comparisons of the total catches in weight, for each area. This analysis was also applied to evaluate differences in the weight catches of the different

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categories as well as of *S. vulgaris* and the most relevant commercial species, with the season as the main factor. Only in the northern Adriatic this analysis was also performed in function of the depth stratum. When data deviated strongly from being normally distributed, a non-parametric method (Kruskal-Wallis test) was used.

Ecological Use Efficiency, Stock Use Efficiency indices and the discard (kg) produced for one kg of retained biomass were computed as different approaches to evaluate the ecological impact produced by rapido trawling.

The non parametric statistic test of Kolmogorov-Smirnov was utilised for the statistical comparisons among the seasonal frequency distributions of *S. vulgaris* and the other relevant commercial species.

The study carried out inside this project, although temporarily limited, allowed to partially fill the gap of information on the rapido trawling, drawing a first global picture of this type of fishing activity and represented a starting point for any further investigation, especially concerning landings and fishing effort, as well as the composition of the catch.

PROJECT N° 99/062: ASSESSING THE IMPACT OF BIVALVE FISHERIES ON THE BENTHIC ECOSYSTEMS OF THE RIA FORMOSA LAGOON (PORTUGAL), VENICE LAGOON (ITALY), AEGEAN SEA (KAVALA-GREECE) AND ON THE JUVENILE FLATFISH IN THE SOUTH COAST OF PORTUGAL (IMPACTO)

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SUMMARY

The impact of bivalve fisheries on the benthic ecosystem was assessed in areas under different impact stress: the Ria Formosa lagoon (Portugal), the Venice lagoon (Italy) and the North Aegean sea (Greece). Ecosystem changes attributable to the fishing impact was assessed in the short-term (hours to days) with RNA/DNA condition index, medium-term (days to weeks) with ecophysiological indices (filtration and excretion rates) and immunological indices (haemocyte parameters: haematocrit, phagocytosis, Neutral Red retention, lysozyme and SOD activities), and in the long-term (months to years) by changes in the Shannon-Wiener diversity index (H') and in sediment characteristics (changes in Nitrogen and Phosphorus balance between water and sediment, and changes in Organic content, Particulate Organic Carbon and chlorophyll content in the superficial sediment layers). Results indicated that lower RNA/DNA ratios occurred in fished areas of Ria Formosa suggesting a decrease in the ecophysiological condition of the target species caused by cumulative fishing impact, but this was not evident in the Venice lagoon.

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However, regarding the physiological indices, similar trends of metabolism decrease in fished areas were observed both in Venice lagoon and Ria Formosa. Also in the fished areas a decrease in macrofauna diversity and an increase in sediment grain size, was observed. Comparison of the impacts within the studied areas evidenced that mechanical gears (Italian hydraulic dredge) cause more impact in the benthic ecosystem than manual fishing (Portuguese clam hack) or Greek towed dredges, on the short and medium-term. However, procedures involved in Portuguese fishing (macroalgae cleaning, artificial changes in sediment grain size, juveniles seeding) may, in the long-term, cause more definitive changes to the ecosystem productivity.

PROJECT N° 99/078: ASSESSMENTS OF THE IMPACT AND EFFICIENCY OF HYDRAULIC DREDGING IN SCOTTISH AND ITALIAN WATERS

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SUMMARY

The use of hydraulic dredging as a fishing technique has a long history in the Adriatic Sea (for vongole clams; *Chamelea gallina*) and is emerging in Scotland for razor clams (*Ensis* spp.). Concerns raised about the environmental impacts of such gear prompted the present investigation. Dredge designs are site-specific and based on practical experiences of fishers. Dredge efficiencies are high (>42 %) but vary with sea state, depth of clam burial, dredge performance and seabed type. Co-existing fauna both in the Adriatic and in the Clyde Sea were burrowing sea urchins. These fragile organisms were unaffected by dredge operations until dredges were hauled on deck.

Dislodged bivalves in situ rapidly reburied but the speed of reburial was dependent on sediment cohesiveness. Sea urchins that had experienced aerial exposure failed to rebury. A high diversity of by-catch was recorded in the Clyde Sea area. Scavengers and predators exploited resources disturbed by the passage of the gear, their activity decreasing with time after fishing. Some dredge hauls remained visible for 98 days. Dredging altered the sediment compaction, destroying vertical stratification and changing sorting characteristics. Production estimates for razor clams were comparable with expectations but recruitment emerged as a key issue. Razor clams exhibit K-selected life-history traits and as such their populations are vulnerable to overexploitation. "Boom and bust" fisheries would result from unregulated fishing with such efficient gear.

Disentangling the effects of hydraulic dredging from natural environmental variability, especially in shallow-water sandy environments with mobile sediments and a high degree of environmental patchiness, has proved to be difficult. Since numerous variables impact on both fisheries (including gear design, sea bed type) and target species concerned, great difficulty would be experienced in attempting to develop an international protocol for the management of hydraulic dredge fisheries. It is clear from the results of this investigation that, in order to achieve sustainability, individual fisheries and/or areas need to be considered on a case-by-case basis. This necessity lends itself to local area management of fishery resources which, in itself, is a desirable outcome.

**PROJECT N° 00/031: MITIGATION OF SMALL CETACEAN BYCATCH;
DEVELOPMENT OF NEW FISHING TECHNOLOGY AND EVALUATION
OF ACOUSTIC ALARMS**

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SUMMARY

The MISNET project (Mitigation of small cetacean bycatch; evaluation of acoustic alarms) addressed B.3:1 Fisheries impact on marine mammals, seabirds elasmobranchs and reptiles of the Common Fisheries Policy's (CFP) 2000 call for proposals. The objectives of the project were:

- 1) To investigate the extent of the habitat degradation caused by pingers by determining both the shift in position of closest surfacing and underwater echolocation activity and the maximum distance at which encounter rate and echolocation activity is affected by pingers.
- 2) To determine if porpoises attempt to swim through nets where malfunctioning pingers create an acoustic gap (the failure tolerance of pingers).

The field experiment was conducted in Bloody Bay, Isle of Mull, West Scotland, UK between 3 April and 13 June 2001. Acoustic and visual monitoring of harbour porpoises was conducted around a simulated gillnet set in water around 40 m deep and equipped with acoustic alarms (pingers). The experimental set-up consisted of eight Dukane NetMark 1000™ pingers evenly distributed along a 700 m lead line. The two central pingers were always quiet while the three pingers on each side were programmed to be simultaneously either on or off during two 4-hour observation periods every tidal cycle. Porpoise click detectors (PODs) were deployed on the lead line between the silent pingers and among the active pingers. Single PODs were also deployed perpendicular to the active pingers at distances of 250, 500 and 750 m. The experiment area was surveyed from a land site with an 80 m elevation using naked eye, binoculars and a theodolite to determine porpoise distribution and surface movements. Observers were not aware of whether the pingers were active or silent.

Porpoise clicks and click trains logged on the PODs were identified and counted for each observation period. When pingers were on, there was a significant reduction in the number of observation periods with porpoise clicks up to a distance of 500 m from the simulated net. Further, the echolocation activity (number of clicks and click trains per unit time) was significantly reduced up to a distance of 500 m.

The visual data supported the acoustic results with a lower encounter rate recorded within 375 m of the active pingers. Theodolite tracks of porpoises showed a shift in mean closest surfacing point to the simulated net from 431 m when pingers were off to 752 m when they were on. Further, the average distance from the simulated net during tracks increased from 653 m to 961 m when pingers were on. Apart from one track, there was no indication that porpoises would choose to cross a net equipped with active pingers where malfunctioning pingers create an acoustic gap of 300 m.

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In conclusion the results showed that pingers significantly reduced the number of porpoises within 500 m from the simulated net. The results further indicate that this deterrence method is not sensitive to a few malfunctioning devices, although this will depend on the distance between pingers. This supports the view that pingers as a mitigation measure are effective in preventing bycatch in certain fisheries by displacing porpoises from the vicinity of the net. However, the difficulty of achieving effective monitoring and enforcement of pinger use is well known and pingers should therefore not be seen as a satisfactory method of reducing porpoise bycatch in gill nets.

Finally, the area of reduced porpoise activity was larger than observed in previous studies, implying greater possible impact through exclusion of porpoises from critical habitat or effects on their movement patterns.

Sub-domain 7.3:

***Effect of Environmental Variables
on Fisheries Resources***

PROJECT Nº 97/083: COLLECTION OF BIOLOGICAL DATA OF 5 FLATFISH SPECIES FROM IBERIAN WATERS (PORTUGUESE COAST AND GULF OF CADIZ)

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SUMMARY

The objective of this project was the collection of biological data on five flatfish species caught along the South, Southwest and West coast of the Iberian Peninsula. The data collected allowed the estimation of several biological parameters. During the first year five species of flatfish (*Solea senegalensis* — senegalese sole, *S. lascaris* — sand sole, *S. vulgaris* — common sole, *Microchirus azevia* — bastard sole and *Dicologlossa cuneata* — wedge sole) were sampled in different fishing harbours along the study area. All participants agreed to adjust the sample collection according to the occurrence of each species in the landings.

Age-length keys are presented by species and by geographic area. Growth models were fitted to the length-at-age data, and growth parameters are presented by species, by sex and in some cases by locality. Further improvement is required, regarding age readings on whole otoliths. The outcome of age reading on these structures was far from satisfactory. Due to the reduction of the study period from three to two years, different ageing methods could not be used. Other studies were also affected by the reduction of the study period, namely fecundity estimates. The numbers of developing females by species were very small, in the first sampling year, to produce a credible length fecundity relationship, as well as to compare fecundity estimates between geographic areas.

During the second year, some attempts were made to obtain more maturing females for fecundity studies. However, this exercise proved to be expensive, very time consuming and the outcome results did not pay the effort. The different aspects of the reproductive cycle of the target species were successfully studied. The spawning season was established by species and by geographic area; the studied species have a wide spawning season, but are mainly winter spawners. The mean length and age-at-first maturity were estimated for each sex, by locality. A macroscopic scale was made and calibrated. In general, the biometric tests performed showed, depending on the species and variable studied, a significant geographic and sex effect at 95 % level of confidence, as shown in the following table.

Summary of the project at hand, including the objective, and the main outcomes of the study. L_{00} , K , and t_0 are the von Bertalanffy growth parameters; L_t range is the total length range and L_{50} % is the length-at-first maturity for females.

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| Growth | | | | | |
|----------------------------------------|----------------|-------------------|------------------|-----------|-------------|
| Species | Locality | L_{∞} (cm) | K (y^{-1}) | t_0 (y) | Lrange (cm) |
| <i>S. senegalensis</i> | UAig | 71.12 | 0.740 | -2.006 | 16.30-42.40 |
| | UAig | 37.41 | 0.106 | 0.664 | 16.30-51.30 |
| Combined sexes | | | | | |
| <i>S. lescaris</i> | UAig | 46.11 | 0.072 | -7.072 | 11.60-37.40 |
| <i>S. vulgaris</i> | UAig | 76.60 | 0.155 | -0.371 | 22.50-56.10 |
| <i>M. azevia</i> | UAig | 40.99 | 0.212 | -0.858 | 12.60-37.60 |
| <i>D. cuneata</i> | FCUP | 23.0 | 0.523 | -0.878 | 16.70-25.20 |
| | UAig | 24.0 | 0.220 | -4.254 | 13.10-23.90 |
| | IEO | 22.0 | 0.209 | -3.337 | 11.20-21.50 |
| | FCUP | 27.0 | 0.215 | -3.787 | 15.80-26.50 |
| | UAig | 25.0 | 0.284 | -3.007 | 13.00-24.80 |
| | IEO | 35.0 | 0.182 | -3.240 | 12.40-24.20 |
| Length at first maturity L_{50} (cm) | | | | | |
| Species/Locality | FCUP | UAig | IEO | | |
| <i>S. senegalensis</i> | — ¹ | 34.7 | — | | |
| <i>S. lescaris</i> | 19.4 | 21.8 | 21.1 | | |
| <i>M. azevia</i> | — | 23.4 | — | | |
| <i>D. cuneata</i> | 13.48 | 12.53 | 13.96 | | |
| <i>S. vulgaris</i> | — | 37.4 | — | | |

¹ The L_{50} was not possible to estimate due to few observations.

PROJECT Nº 97/084: ENVIRONMENT AND BIOLOGY OF DEEP-WATER SPECIES APHANOPUS CARBO IN NE ATLANTIC: BASIS FOR ITS MANAGEMENT (BASBLACK)

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SUMMARY

Until recently, the fishing grounds of the continental shelf zones in the North Atlantic have provided adequate fish stocks for the needs of commercial fishermen. Today most of these stocks are described as fully exploited and on which no further fishing effort increase should be permitted. Consequently, during the next decades world is likely to turn more and more to explore deep resources. Deep-water ecosystems are very fragile and it is necessary try to understand them before (fully) exploitation of these resources began.

Black scabbardfish (*Aphanopus carbo* Lowe, 1839) is a species inhabiting the continental shelf and slope between 180 and 1600 m depth. It is widely distributed in the northeastern Atlantic along the European continental shelf and also around isolated island groups and seamounts.

Several countries already exploit black scabbardfish, namely Portugal, France and United Kingdom. While the long established Madeira's fishery (since the early 19th century) and the more recent fishery off mainland Portugal (since 1983) are longline fisheries targeting for this species, the increasing landings in northern areas result from the bycatch of deep-water trawl fisheries.

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The objective of the Project "Environment and biology of deep-water species *Aphanopus carbo* in the NE Atlantic: basis for its management (BASBLACK)" EC DG XIV Study Project 97/0084 was to provide the basis for the development and implementation of a programme for the routine study and management of the black scabbardfish (*Aphanopus carbo* Lowe, 1839). Owing to the lack of biological and environmental information critical for the assessment and management of the species a special effort will be put into investigations of its biology, stock discrimination and habitat characterisation.

To achieve these objectives the main activities were directed to:

TASK1: Review of the available information on black scabbardfish

TASK 2: Establishment of a Landing Sampling Programme

TASK 3: Population discrimination

TASK 4: Biological data on growth, feeding and reproduction parameters

TASK 5: Habitat environment

TASK 6: Bioaccumulation studies

TASK 7: Data management

Sampling at sea was carried out using observers on fishing vessels. In Portugal sampling of the landings was carried out twice a month while in the UK this was done at monthly intervals. This sampling strategy allowed the construction of a comprehensive database on this species. Under the project a total of 21,884 fish were measured for length structure studies, more than 5300 fish were sampled for biological and other studies under several tasks, and about 3950 otoliths were available for growth studies.

All the historical data from research surveys and biological sampling programme held in the Portuguese EEZ (ICES IX and Madeira) from 1979 to 1989, were compiled and included in BASBLACK database. Additional historical information was obtained from surveys carried out on ICES areas Va, VI, VII, X and XII.

An annotated bibliography containing about 166 references was prepared, and the content of each paper or report included in it was briefly summarised.

A BASBLACK database was constructed and a CD-ROM containing the ACCESS database file was produced.

A World Wide Web (WWW) BASBLACK home page was designed. Its main topics include a general description of different aspects relating to black scabbardfish and a more detailed explanation of BASBLACK objectives and lines of activity.

PROJECT N° 98/070: THE SICILIAN CHANNEL ANCHOVY AND THE UNDERLYING OCEANOGRAPHIC AND BIOLOGICAL PROCESSES CONDITIONING THEIR INTER-ANNUAL FLUCTUATIONS

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SUMMARY

This final report illustrates the results of the work carried out under the project MED98-072. The general objective of this project was to investigate on the oceanographic and biological processes conditioning the inter-annual fluctuations of the European Anchovy *Engraulis encrasicolus* in the Sicilian Channel. In order to study of environmental conditions able to affect distribution of adults stages, their reproductive potential and ultimately the recruitment success, an interdisciplinary approach was adopted, which involved: 1) the collection and analysis of oceanographic, meteorological and satellite data to depict the main hydrological features of the study area, 2) the accomplishment of ichthyoplanktonic and hydro-acoustic surveys for the evaluation of the fish stock size, and 3) the analysis of retrospective Catch Per Unit Effort (heretofore CPUE) data in the main port (Sicacca) of the study area. Data analysis included information previously collected by the same research team within the former EU-funded project MED96-052.

The spawning biomass of the anchovy population off the southern coast of Sicily is mainly composed by year class 1, so current stock size of this resource mainly depends on the recruitment success. Stock biomass evaluations and CPUE estimates indicated consistent and remarkable interannual fluctuations in the last 5 years (1997-2001) which were related to hydrological variability.

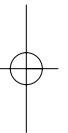
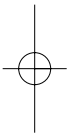
The main hydrographic feature off the southern Sicilian coasts is the Atlantic Ionian Stream (heretofore AIS), a meandering surface current inflowing towards the Ionian Sea. Its path and its year to year variability has consequences on the other predominant hydrological phenomena occurring in the region, such as, on the extension of upwelling and on the formation of frontal structures. All these hydrological features have shown their influence on the anchovy spawning strategy and the survival of the early life stages.

On one hand, the AIS acts as a transport mechanism for displacing eggs and larvae from the more important northern spawning grounds towards the southern limit of the region. If the AIS path is distant offshore, the northern coasts can show a greater upwelling extension, thereby, producing drastic changes in the temperature regime of the surface waters. If upwelling is intense, anchovy which has preference for warm waters, may refrain from spawning during the peak spawning season. On the other hand, by means of the AIS transport, larvae tend to aggregate in the southernmost region of the island's tip, off Cape Passero. In this region, the AIS forms a cyclonic gyre which helps maintain the relative position of larvae in the area, thus retaining the larval population and reducing larval mortality linked to offshore advection. In addition, when the AIS trajectory meets water masses from the northern part of the Ionian Sea, a density front is formed that

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concentrates plankton, thus providing the feeding requirements for an adequate growth of larval stages.

Data analysis indicates larval survival in the region off Cape Passero might have an important role on the recruitment success and consequently on the stock size of the Sicilian Channel population. The highest anchovy spawning biomass corresponded to year 1998. This stock suffered a sharp drop during 1999. Contrarily, the lowest anchovy spawning biomass estimated occurred during the year 2000. However, the CPUE of the year 2001 revealed the highest recuperation of the series. The intensity of the Cape Passero front was in these cases highly contrasting. During 1998, the frontal intensity was quite mild, while during the year 2000 it was the most pronounced of all the series.



Domain 8: Monitoring and Control



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Sub-domain 8.1: Application of modern techniques

PROJECT N° 98/023: ALTERNATIVE USES OF DATA FROM SATELLITE MONITORING OF FISHING VESSEL ACTIVITY IN FISHERIES MANAGEMENT

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SUMMARY

The research project was carried out between mid 1998 and mid 2001 in order to provide insight into the alternate uses of satellite monitoring data in fisheries assessment.

In 1997 the Commission Regulation (EC) No 1489/97 laid down rules for the application as regards satellite — based vessel monitoring systems. The satellite-tracking devices installed on board of fishing vessels had to ensure the automatic transmission during each fishing trip to their fisheries monitoring centre at all times (at least every two hours) of the date and time of the fishing of the position of the vessel. Although these schemes were aimed primarily at monitoring the activity of the vessels, they provide a unique opportunity to use also these data in fisheries assessments and subsequent fisheries management.

One of the most vital parameter in the models used for the assessment of exploited fish stocks consists in the determination of the fishing effort. The information obtained so far on the fishing effort was derived from the fishermen's logbooks. These data are unfortunately sometimes liable to errors and might therefore in most of the cases underestimate the effective effort and subsequently the effective fishing mortality. Underestimating fishing mortality means automatically overestimating stock sizes and TAC's.

This project is directly linked into project 99/002 enabling the three main beam trawl fleets (Belgium, the Netherlands and UK) to be fully covered.

The original proposal contained a long list of possible uses for the scientific community. Therefore the wide range of project objectives were distributed amongst both projects and all aims of the project were fulfilled over the two reports.

First of all the most important information needed for scientific purposes and for management purposes was the geographical description of the fishing activities. This project provided for the first time a clear and unbiased coverage of the spatial distribution and activity of the major beam trawl activities in the North Sea and surrounding areas. This picture became thus available by season and by country and enables managers to determine — if needed — areas or seasons to be closed for this type of fishing. It may also be used as a guide for the other fishing methods used in the area.

In addition this project demonstrated a number of secondary applications from this research. These other applications may be grouped in areas as unbiased cpue-data, environmental sensors, and research vessel data.

The project thus provided an extensive review of future applications of the "satellite based vessel monitoring system" (VMS) in the biological stock assessment procedures.

Domain 9: Social and Economic dimensions of fisheries activity



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Sub-domain 9.1: Social and Economic Implications of Policy and Technical measures

**PROJECT N° 97/051: COASTAL FISHERIES PRATICED BY VESSELS
BELLOW 20 HP IN GREECE: BIOLOGICAL, ECONOMIC AND SOCIAL
FRAMEWORK**

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SUMMARY

The 'under 20HP' segment of the 'coastal fishery' fleet, is an important one for the rural coastal and island communities of Greece. Not just because of its traditional nature, but mainly due to the number of people directly or indirectly professionally involved in this segment, has it been considered an important one, in sociological, demographic and regional economic terms. The fleet accounts for the largest share in the number of vessels and employment offered, over the total of the national fishery sector. In addition, the ecological importance of the areas within which such vessels operate, renders the sector — through its volume of landings and diversity of the species caught — a rough but reliable potential indicator for the state of the national fishery resources.

However, despite these characteristics, the 'under 20HP' segment of the fleet has been largely overlooked by the national statistical recording systems, which inadequately monitor only several structural and operational aspects of it. Acknowledging this information deficit, the present study aimed at the gathering and presentation of information on a number of critical issues, in order to provide — through an integral and largely holistic approach — a reliable basis upon which research can be directed towards the drawing of potentially efficient management plans, taking into account the biological, economic and social framework of this particular segment of the fisheries.

National inventory and registry data were compiled and comparatively evaluated, while low-cost sampling techniques were devised and implemented for the collection and evaluation of information. A representative sample of fishermen and their vessels was established in ten areas, and detailed information was regularly monitored and recorded, for the duration of one year, aiming at the 'quantification' of several issues of importance. Moreover, meetings and interviews with fishermen and their representatives, from a number of places around the country, were arranged, in order for more 'qualitative' information to be compiled. It is noteworthy, that the results of these two complementing approaches largely support one-another, providing valuable insights into socio-economic, biological, technical and operational aspects of the sector.

In brief, conflicts were identified with other types of fisheries, professional and amateur, while widespread was the notion of overexploitation of the fishery resources. Additionally, the increasing operational costs and shrinking income from the reducing catches, the largely ineffective management measures and the low rate of success in the enforcement of the law, if coupled by a number of operational issues (ie: damages incurred by marine animals, abandoned non-degradable gear), and various socio-demographic aspects, such as the age of fishermen, the number of youngsters entering the profession, the social security schemes etc, provide a clear depiction of a rapidly shrinking segment of the national fleet.

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The time is considered critical for significant and bold reforms to take place, through an integral and largely holistic approach, towards the sustainable conservation of the marine resources as well as the people making a living out of it.

PROJECT N° 97/063: TRAWLING BAN IN THE GULF OF CASTELLAMMARE: EFFECTS ON THE SMALL SCALE FISHERY ECONOMICS AND ON THE ABUNDANCE OF FISH

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SUMMARY

The present study intends to update a previous study (EC MED92/011) in order to (i) assess the effect of an eight-year trawl ban on the demersal resources (over trawlable and non-trawlable bottoms) in the Gulf of Castellammare, and (ii) investigate how these resources are now being exploited by the small-scale fishery, as well as the extent of any social or economic gain arising as a result of the trawl ban. The study is made of two parts: A) biological section, and B) socio-economic section.

A — Biological section

Four seasonal trawl surveys were carried out from June 1998 to March 1999 on the continental shelf. The stratum that yielded the highest CPUE was stratum A (10-50 m: 61248 gr/haul), followed by str. B (51-100 m: 47914 gr/haul) and str. C (101-200 m: 26356 gr/haul). Considering the seasons, CPUEs were 34663 gr/haul in spring, 52234 in summer, 53079 in autumn and 27578 in winter. *Mullus barbatus* was the most abundant species overall. Highly commercial species were the dominant category in almost all the seasons and strata, with a peak in str. A in summer.

Twelve trammel-gillnet surveys were carried out on a monthly basis in shallow waters on sandy bottoms (SB), rocky bottoms (RB) and an artificial reef area (ARA), from June 1998 to May 1999. The area that yielded the highest CPUE was SB (4000 gr/trip), followed by RB (3646 gr/trip) and ARA (3322 gr/trip). Considering the seasons, CPUEs were 2709 gr/trip in spring, 3569 in summer, 3168 in autumn and 4006 in winter. The most abundant species overall was *Boops boops*. Moderately commercial species dominated the trammel-gillnet catches; highly commercial species reached a peak in abundance in RB in summer.

The CPUEs of the total catch in the trawl surveys was larger in 1998-99 than in 1993-94, especially in str. A. Considering the single strata and seasons, CPUEs were larger in 1993-94 only in winter (str. B, C and total area) and in spring (stratum B). The CPUEs of the following target species (mean over the total area) decreased in 1998-99: *M. barbatus* (which increased in str. A), *Lithognathus mormyrus*, *Sepia officinalis*, *Eledone moschata*. The proportion of highly- and non-commercial species decreased in 1998-99, while that of moderately commercial species increased.

The CPUEs of the trammel-gillnet surveys were larger in 1998-99 than in 1993-94, especially in SB. Considering the single areas and seasons, there was a decrease in 1998-99 in spring (in ARA and RB). The CPUEs of following species decreased in 1998-99: *Octopus vulgaris* in RB, *Scorpaena porcus* in RB, *S. officinalis* in ARA and RB. The proportion of highly commercial species decreased in 1998-99, while that of moderately commercial species increased.

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A landings survey of the small-scale fishery catches was carried out on a fortnightly basis from July 1998 to June 1999. The highest catches of the set net fishery were made in winter and spring, the lowest in summer. Fishermen in Castellammare and Balestrate obtained the largest CPUEs. Considering the Balestrate FAD fishery, dolphin fish (which is the target species) was the most abundant fish, followed by amberjack and juvenile bluefin tuna.

B — Socio-economic section

In 1998-99 there were 147 fishing vessels registered to fish in the Gulf of Castellammare. Of these, 96 were registered artisanal fishing boats. The main gear used by fishermen was a set net (trammel or gillnet). The economic assessment of the small-scale fishery required primary data, which were collected through a landings survey, a fishing characteristics survey and a motivations survey. The assessment of the financial performance of artisanal fishermen also data on fish price and capital costs were collected.

Net financial profit (boat income) of trammel netters in 1998-99 averaged 8.7 million lira (= 4493 Euro). Just fewer than 7 % of operators incurred losses, while some 13 % earned profits in excess of 25 million lira (= 12911 Euro). The fishery has the potential to be economically sustainable, since the capital necessary for its long-term continuation would be expected to earn a competitive return.

Biological data based on experimental trawl surveys and trammel net surveys showed a large increase in demersal stocks since the ban was imposed. However, over the period species composition has changed, with most of the biomass increase being for varieties classed as only 'moderately commercial'. This may therefore have attenuated the financial gains for artisanal fishermen.

Recreational fishing was identified as the single most important problem facing professional artisanal fishermen. As far as the ban is concerned, most fishermen felt that fishing was "better" or "much better" since the ban, 14 % "worse" or "much worse". This contrasts with their view of prospects, where 24 % believed fishing would be "better" or "much better" while 55 % stated it would be "worse" or "much worse". Despite their apparent pessimism, the overwhelming majority (86 %) signalled their intention of carrying on fishing in the Gulf in the future.

PROJECT N° 98/016: EVALUATION OF THE EFFECTIVENESS AND APPLICABILITY OF TECHNICAL MEASURES IN FISHERIES MANAGEMENT (TECMES)

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SUMMARY

Technical measures such as gear and area restrictions play an important role in the fisheries policy in many parts of the world. This is reflected in large number of national and international regulations and initiatives where the importance of various technical measures as a tool for improved fisheries management are stressed. The intended effects of these measures, however, have often not been assessed and documented.

The major objectives of this study were to (a) assess and evaluate the structure and effectiveness of current technical measures in the EU waters and in some selected areas outside EU, and to indicate biological, technical and socio-economic problems associated with these measures, (b) describe requirements and conditions where particular combinations of technical measures are appropriate, acceptable and efficient (alone or in connection to other measures), and (c) indicate required future actions to improve the effectiveness of technical management instruments.

The report summarizes major technical management measures applied on some selected fisheries in the EU waters and in other parts of the world, in particular in the USA. This overview shows that although various technical measures are common, very little scientific analysis exists about their real efficiency in attaining fisheries management and broader ecosystem objectives. In most fisheries there is a lack of suitable data and information to conduct relevant quantitative evaluations of the efficiency of measures applied. Usually, technical management measures are used in conjunction with other management measures. This greatly complicates the analysis.

To achieve more information of the efficiency of technical measures, some fisheries where technical management plays a potentially important role and where there is appropriate data available, were analyzed and evaluated in more details as special case studies. For example, an extensive analysis was made of potential short- and long-term effects of a mesh size increase in the Baltic cod demersal trawl fishery. Also some other trawl fisheries were analysed. Other case studies assessed the efficiency of technical measures in fisheries that are conducted with passive fishing gears. In addition to these special case studies, two extensive reviews were made of the general applicability of fishery closures and gear modifications in achieving fisheries management and ecosystem objectives.

Our study demonstrates that technical measures, if properly planned and implemented, have great potential for resource conservation and improvements in the status of many stocks and fisheries. Measures that involve modifications to fishing gears or practices, offer effective means of reducing bycatch of non-wanted organisms. Fisheries closures may contribute to the protection for marine resources and habitats. However, many regulations, particularly technical measures applied to fishing gears, are often enforced and monitored inconsistently. There is an acute need to enforce the technical management controls in a more consistent way. The successful use of technical measures also depends on the willingness of fishing industry to accept them. Generally, technical measures are long-term

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management measures. Substantial short-term economic losses are often associated with their use. Successful management actions address these problems.

It is obvious that lessons could be learned from many parts of the world how to manage fisheries and fisheries bycatch, and this experience could be applied in the EU context. For instance, the use of real-time-closures, bycatch quotas, discard bans and controlled access rights should be explored in full details when developing the Common Fishery Policy of EU.

PROJECT N° 98/037: COMPARATIVE STUDIES ON THE CURRENT STATE OF FISHERY OF THE NATIVE *PENAEUS KERATHURUS* SHRIMP POPULATIONS OF NORTH MEDITERRANEAN

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SUMMARY

The project aims to the study of the current status of the fishery of the population of *Penaeus kerathurus* shrimp in the North Mediterranean countries where it is produced. These countries are Greece and Italy. The initial idea was to provide information concerning the state of these populations based on the fact that they have never been studied scientifically before regarding the shrimp fishery. The lack of time series and previous information from these populations in the area of North Mediterranean made the comparison of the information obtained extremely difficult and this is described in the text where applicable. However, this species is a primary commercial product with very high market value; higher than most other species (fish, shellfish or other fish). The initial news coming from the target areas informed the scientists participating in the project about the rapid decline of the production which led to significant decrease of the local income in Greece and the classification of the species are by catch in Italy (without a structured target fishery).

The groups of scientists in the project included the National Centre for Marine Research from Greece, the Shrimp culture Research Unit of the University of Lecce in Italy and the NAVIGATOR Ltd from Greece. The first 2 partners undertook the difficult tasks of field studies, experimental fishery and data collection while the third partner undertook the analysis of the data from the social and economic point of view. The teams identified a target area for the research: this was Amvrakikos Gulf in Greece where the species is native and there exists one of the best developed populations of the species in Greece and the lagoons Lesina and Acquatina as well as the open sea area North of Lesina lagoon which were selected by the Italian team due to the existence of the species there. The main axes of the study were:

Fisheries research: conduct a full scale experimental fishery was organised in order to collect samples of shrimps on a monthly basis and with the application of standard techniques, to describe the status of the population in terms of mortality, growth, distribution and yields.

Social and economic analysis of current status: a full scale study was undertaken in order to describe the current status of income, costs, households, taxes, marketing and sales, product distribution, structure of landings and economic pressure on the commercial fishermen and their families.

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Co-analysis of the findings: with the analysis of the above categories of information, the scientific data were linked directly to social and economic effects while, the effects of various management and protection measures were then evaluated. This is the first time in Greece and Italy where from a strictly fisheries project, the information were linked to social and economic aspects and the use of standard socio-economics and macro-economic methodology was used to evaluate existing and current management proposals.

Involvement of the Public: a campaign was organised for the dissemination of information to the locals and the target-group of fishermen and public fisheries administrators. Material was created for the dissemination of information and feedback workshops (both in Italy and Greece) were organised in order to receive and recording of the local opinions and proposals. In addition, members of the local target-groups were involved in the project from the start.

PROJECT N° 99/024: CARACTÉRISTIQUES DES PETITES PÊCHES CÔTIÈRES ET ESTUARIENNES DE LA CÔTE ATLANTIQUE DU SUD DE L'EUROPE

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SUMMARY

The European contract PECOSUDE (Small inshore fisheries of the south of Europe) accepted in 2000 (n 99/024) for 2 years involves French partners (IFREMER, GEOLITTOMER and CEMAGREF), Spanish (AZTI, UPV and IEO) and Portuguese (IPIMAR). The aim is to assess the inshore and estuarian fisheries from Loire estuary to Portugal in view of the negotiations of the PCP in 2002. Three main aspects are considered in the study: fisheries monitoring (data 1999), socio-economy and marketing (data 1999 or 2000). Three main criteria have been established to define the limits of the fishing fleet considered in the study: fishing grounds within the 12 miles zone for the French fleet and the continental shelf and slope (down to 1000 m depth) for northern Spanish and Portuguese fleets, as well as fishing trips lower than 96 hours.

The halieutic part analyses the activity of fishing vessels taking into account gears used, landed species, areas and fishing seasons. A total of 15 582 coastal or estuarians vessels with 35 256 crewmembers are located over the 311 harbours of the 3 000 km PECOSUDE

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coasts. Mean PECOSUDE vessel characteristics are: 6.4 m long, 30 kW power engine, 4 GRT capacity and 25 years old. Mean values are influenced by Galicians and Portuguese boats (84 % of the overall fleet studied). Static gears are predominant in the fishing activity, and more than half of the vessels are polyvalents (using several gears sequentially during different fishing seasons). The main gears used are nets (gillnet, trammel, ...) but lines, longlines and pots are also commonly used. Trawls are only used by French and Portuguese fleets, and near 50 % of the French vessels use glass-eel nets². In most of the fishing typologies the activity is carried out all year. Nevertheless as most of the boats are small size, they usually work close to their home ports. In 1999, total landings were estimated at 71 935 t for a value of 195 M€. Among the 200 identified species or species groups along coastal and estuarine area, 7 species represent about 53 % of total value: octopus, common sole, glass-eel (young eel), hake, monks, sea bass, mackerels. Several interactions (conflicts) between fishermen have been identified. The main are related to the static vs mobile gear, the large fishing boats working inside coastal area, and an increase of the coastal area use by others users (yatching, reserves, seashell farming, ...)

The fishing activity of these boats was also analysed using multivariate analysis techniques to obtain fleet activity typologies, based on fishing gears and/or species landed. From country to country, between 5 to 10 ships components were found. These characterisations allowed the application of a stratified sampling scheme for socio-economic studies (on 586 boats) carried out by French, Basque and Portuguese teams.

The information received from fishermen permits to describe the production factors, to estimate their costs, as well as, turnover, the wealth creation and efficiency of the production factors. The analysis carried out, by country for the total population and by fleet component, covers 1999 or 2000. Thus fishermen, from 41 to 46 years old on average from country to country, are in 80 % of the cases born in the coastal department where they work. The capital value of the "ship" is estimated in 94 K€ for France and Basque country, and 23 k€ for Portugal. The average turnover amount, for France, Basque country, and Portugal (83 k€, 65 k€ and 19 k€, respectively) and the average rate of added value (70 %, 79 % and 50 %, respectively) show an important variation among countries. Products commercialisation vary from component to component. Although many vessels sell in auction place, some valuable species are sold to particulars. About induced employment, an estimation indicate that for one coastal or estuarine French Bay of Biscay fisherman, 9 persons work.

To complete PECOSUDE study, 5 peculiar areas enclosed in French sector were analysed (Loire estuary, Yeu island, Gironde, bassin d'Arcachon and Adour) taking into account halieutic as well as socio-economic aspects. The analysis carried out in those areas permit to detail specific fishing behaviour.

PROJECT N° 00/022: A PILOT STUDY FOR ESTIMATION OF DATA FROM LOCAL FISHERIES IN THE CANARY ISLANDS

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SUMMARY

This report presents the results of a pilot study conducted at the island of Tenerife (Canary Islands, Spain) to evaluate the possibilities of establishing a statistical system adapted to the characteristics of the Canary Islands fisheries permitting a maximum reliability of the information obtained or estimated on catches and fishing effort with a minimum financial cost.

Interviews were made in all the detected fishing sites around the island of Tenerife in order to update information on the sites infrastructures and boats characteristics collected at the beginning of the 80's. This revised information indicates that the infrastructure of most fishing sites has improved substantially although some deficiencies have been observed specially in the northern coast of the island. The evolution of the fleet has been generally regressive in numeric terms but technical characteristics of individual boats seem to have ameliorated in many of the sites. Professional boats have been found in 22 of the 41 potential fishing sites visited. There has also been identified a huge amount of theoretical recreational and game fishing boats with similar characteristics to the professionals which impact on the resources is thought to be very significant. More than 10 different fishing gears used and around 80 species caught by the professional fleet have been recognized from the interviews.

Multivariate and statistical analyses carried out using updated information gathered in the interviews indicate the existence of 8 homogenous groups of ports and boats in relation to the species caught and the characteristics of the boats. This basic structure was adopted to design a sampling scheme consisting in a proportional sampling by ports covering 1/4 or 1/6 of the total fleet for precisions in the estimates of 0.10 and 0.125 respectively. Simulations suggest that the proposed sampling scheme could provide rather accurate estimates reducing the sampling effort to about 1/5 of the work needed to sample the entire fleet and consequently the economic costs involved in monitoring the fishing activity in the island of Tenerife.

Sub-domain 9.2:

Recreational Fisheries

PROJECT N° 00/003: “SPORT FISHERIES” IN EASTERN AND CENTRAL MEDITERRANEAN: DESIGN, IMPLEMENTATION AND ECONOMIC EVALUATION OF AN INTEGRATED MONITORING SYSTEM

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SUMMARY

The present study forms the initial basis for the application of an integrated data collection system for recreational fisheries in Eastern and Central Mediterranean. This proposed system has been initially designed to apply in Greece and Italy and is based on EU funded research projects (96/018) titled “Sport Fisheries in Eastern Mediterranean (Greece and Italy)” as well as on (94/036) titled “Sampling System for the Collection of Fisheries Statistics”.

Firstly, the current study begins by determining the data — biological, economic, social and demographic — that portray the state of “sport fisheries” in Greece and Italy and by defining levels of priority for the future monitoring needs for this type of fishing activity. On top priority, or better, for a so-called “minimum program” there are data absolutely needed for scientific methods of analysis (current methods of analyses as well as possible future development of analyses and statistical procedures). Thus, the analysis of such data can provide us with crucial information about the state and dynamics of recreational fisheries. On second priority, or better for a so-called “extended program” there are data that if used in scientific analyses can refine and strongly enhance the quality of results obtained.

Secondly, two data forms were constructed inquiring parameter quantification in accordance with the two priorities set. According to these two groups of parameters two databases were designed: the database (a) for data collected on annual basis and the database (b) for the data collected on monthly basis. Regarding the needs of the current project for testing the data forms, i.e., data forms A and B we proceeded to face-to-face interviews as well as in telephone interviews in the case of Italy, with recreational fishermen. In Italy interviews were carried out during April to August 2001 and in Greece during September and October 2001. A statistical methodology for determining an optimum sample of fishermen was constructed in order to carry out our proposed data collection system for recreational fisheries in the future. The data collected by testing the data forms were input in the database and the results were assessed and discussed. Furthermore, proposals were made for their future application of the system regarding the data to be collected and the response of the database. To manage database, software package named STARFISH-RF (STATistics Reliable for FISHerY-Recreational Fisheries), has been developed according to requirements of the present project, taking into account know-how coming from the previous EU projects 96/018 and 94/036.

Finally, our proposed data collection system and its aims were presented to Italian and Greek Authorities that are responsible for fisheries data collection. Proposals were made for the future application of this system and an initial economic evaluation was performed

Domain 10: Dissemination of Information



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Sub-domain 10.1:

***Dissemination of Scientific Data
and Techniques and Methodological
Studies to Optimise and to Standardise
the Collection of Data and Communication***

PROJECT N° 97/021: SENSIBILISATION DES PROFESSIONNELS AU PROBLÈME DES REJETS DE PÊCHE

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SUMMARY

The assessment of exploited living resources is based on observations on catches and often on landings for facility and ease of access to data and with the advantage that these are classified into commercial size categories. However, landings are not always equal to catches because a part of the catch is discarded at sea by fishermen. Data on discards are mainly required when they are dead or do not survive in great numbers. This is the case for most of the fisheries targeting on finfishes. Discards are a waste of resources and must be avoided if possible by appropriate management. This requires a good knowledge of the reasons for discarding, which can be due to ecological, technical, legislative or economical reasons. Studies of discards have been carried out on commercial boats only every five or ten years because they are expensive.

This study is the first one in the Western Channel. It concerns several French métiers: **fixed netting, inshore trawling and offshore trawling**. Fixed netting has developed during recent years and has produced conflicts with trawling for space and resource: each métier has blamed the other for the decreases in yield. The French métiers in the Western Channel are in competition for resources with several European fleets, mainly from the UK.

This study was done over a full year to take into account the seasonal variations of resource availability and strategy of the fleets. It uses the at sea observation method (the less biased one). However for long trips (time at sea > 1 week), the method of using samples taken by fishermen over the year was applied to only one boat (always the same boat. This boat was selected for its motivation to collaborate with scientists. Most of the species caught were counted or measured. The gears studied, the sampling design, the location of observations and the data treatment are described in the report. The results were not expressed in relation to the total fleets in this report, which has the objectives are 1) collecting information on demographic structure of the catches for the main exploited species, 2) identifying factors explaining discards, in order to find remedies.

Fixed netting

The discards occurring in this métier differ according to equipment and tactics. Small mesh nets must be separated from large mesh ones. These two kinds of equipment are sometimes used by the same boat. During one trip, one boat can haul during one trip several types of equipment (trammel or gill net; several mesh sizes in use) fixed during different immersion times. The nets are used only on tides with a coefficient < 70, which limits their monthly activity to 10-12 days a month.

The small mesh nets (<200 mm stretched mesh size) are fixed in the inshore areas; these nets are short in length (<500 m) and are 3-5 meters high off the bottom. They target pollack, ling, cod and, according to the area, crawfish, anglerfish, sole or hake. Their short immersion time does not produce damaged fish which have to be discarded. The discards are non-targeted species of low value which are sometimes not landed like red gurnard, spotted dogfish, pout whiting (bib). The equipment sometimes catches juvenile pollacks which are landed. Crustaceans (spider crab and edible crab) are the species of most concern as discards (80-90 % of discards), for reasons of small size or of low value during the molting periods.

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The large mesh nets (270 to 360 mm) are fixed in more offshore areas inside 12 miles during winter and sometimes outside 12 miles in summer. They have an immersion time of between two and six days according to tactics, technical reasons and weather. The immersion time is the principal factor explaining discards of fish. An immersion duration of three days induces some discards but only gadoids. A five day immersion time affects all the species of fish. Discards are damaged fish and species like brill and anglerfish are partly discarded, all the gadoids are discarded. It appears that immersion time of 3-4 days maximum may limit fish discards and increase fish landings from the studied area. Crustaceans are also discarded by this metier; the immersion time has no influence on the discard rate but has an influence on the quantity discarded. Seasonal factors explain a part of discards of shellfish. No difference in the discard rate appears between gill net and trammel net; the latter was previously supposed to have higher discards because of presumed lack of time in clearing the net.

The optimum immersion duration of four days produces low discards. The average duration of the samples collected is very close to the optimal value. The principal species of fish discarded after such an immersion duration are gadoids which are, however, caught in small numbers. Fishing operations may be different according to the area: at the edge of the continental shelf (an area not concerned by this study), shorter immersion time is sometimes requested to avoid damaged anglerfish.

No marine mammals were recorded in the catch of the 410 km of nets examined for this work.

Inshore trawling

The discard rate is greater than 50 % for some species. The discards are due to regulation (minimum landing size) or economical reasons (small sizes in catches). Species like rays, pouts and spider crab have the same discard rate between fishing grounds. Others species are discarded differently between areas (near ports). Sole has a low discard rate in the West side compared to the East side. It is the same for red mullet and black bream. In the bays of Saint-Malo and Saint-Brieuc, small individuals of several species were found in great quantities in discards. These juveniles were probably concentrated in nursery areas. A better knowledge of their distribution in space and time will be useful for management. Red gurnard is, however, discarded more in the West than in the East of the concerned area. The difference is due to bait requirements for potting activities, which are more concentrated in the East side than in the West. Some species were mainly caught by trawlers of one harbour: anglerfish (10 % of discards), john doris and pollack (low discards), horse mackerel (all discarded), whiting (50 %) were found in Camaret; plaice (low discards) was recorded from Morlaix.

This metier was found to have a great spatial heterogeneity in the catches and discard practices. However, sampling in inshore trawling does not offer a good spatiotemporal representation: all the seasons are not represented in each port. Saint-Brieuc was the most important port for inshore trawling and could not be well investigated because of reticence from fishermen.

Offshore trawling

The concerned boats are from Saint-halo (12-15 day trip) and from Saint-Quay (7-10 day trip). The fishing grounds of this offshore metier are widespread outside the West Channel (7E area) towards the Bristol Channel (7F) and the Smalls (7G). The main factor explaining the variability of discards is the fishing area. A difference in the species composition was found between the West English Channel & North Bishop and the Bristol Channel & Smalls. More data would probably give rise to more detailed discrimination inside these two fishing areas. Another important factor is the fishing equipment. The offshore trawlers can use several types of equipment during the same trip. A difference was found between 2-sided trawls and 4-sided trawls (great vertical aperture). The discards with the second trawl were

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found to be greater in numbers and in species. However, the corresponding landings were not included in that comparison because of the methodology used.

The species most concerned as discards are the gurnards, whiting, pouts and horse mackerel. These species have a discard rate approaching 100 % and are caught in great numbers. Landings of whiting and pout have a low value so that quantities are unsold and then converted to fish meal.

The results obtained in this study indicate that logbooks need to be filled carefully. The fishing equipment (gear, codification in the logbook is insufficient to take into account the difference in the vertical aperture between bottom trawls. An appropriate modification is required to make a good estimate of the discards of that fleet. All the gear used by the fleet was probably not represented in the sample (five boats).

The main interaction between métiers concerns the anglerfish. This species is caught by the offshore trawling at "la pointe de Bretagne" and targeted by large mesh netting. Improving selectivity of trawls is needed when looking at the size composition of the catches. Other strong interactions exist as for edible crab between netting and potting, for spider crab between inshore trawling and spider crab netting or potting, for pelagic species between bottom trawling and pelagic trawling. Quantifications of such interactions can only be assessed by modelling of fisheries in that area.

Conclusion

This study was a first approach for assessing French discards in the Western Channel. It identifies the main species discarded and produces a rough estimate of discard rates and size compositions in each métier targeting fish. The major reasons for variability were explained; Size compositions of catches and discards were provided in order to permit better estimates of the mortality induced by fishing operations. Netting was found to be more selective than trawling in species diversity and in size composition (inter and intraspecies selectivity).

PROJECT N° 97/022: LES ÉQUIVOQUES ENTRE SCIENTIFIQUES ET PROFESSIONNELS DE LA PÊCHE: NATURE ET MOYENS DE LES RÉSOUDRE

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SUMMARY

1. L'objectif de cette étude est d'examiner les équivoques qui pourraient exister entre les scientifiques et les professionnels de la pêche. Une enquête a été menée à cet effet, au cours de laquelle un nombre important de pêcheurs, représentants professionnels et scientifiques de France et du Royaume Uni ont été interviewés. Cette stratégie a permis de dégager les principaux points portant à équivoque, en faisant la part des réactions émotionnelles.
2. Si en France le suivi des pêcheries est la mission officielle d'un seul institut, il en existe trois aux Royaume Uni (Angleterre & Pays de Galles, Irlande du Nord et Ecosse). Chacun de ces instituts a sa propre stratégie de communication. En face des instituts de recherche, on trouve une organisation professionnelle relativement structurée au Royaume Uni avec un nombre limité de syndicats. En France, on observe un niveau d'organisation plus faible avec des formes de représentations des professionnels variables suivant qu'il s'agisse des organisations professionnelles ou du Comité National des Pêches. En conséquence, le discours de chacun varie suivant les objectifs recherchés, ce qui nuit au dialogue.
3. Les moyens existants de communication entre les deux parties sont limités. Il existe quelques structures formelles qui réunissent les représentants des professionnels et les scientifiques que ce soit pour les besoins de programmation de la recherche ou l'explication des résultats. La constatation des représentants des scientifiques et des professionnels est que les messages délivrés au cours de ces réunions ont du mal à toucher les pêcheurs de base (par opposition aux représentants). À côté de cela, les scientifiques, surtout au Royaume Uni tentent de faire un travail d'explication à travers les journaux professionnels. L'impression qui se dégage est que les articles sont souvent peu abordables par le public cible et qu'ils ne contribuent pas à faciliter le dialogue.
4. Les principales équivoques sous la perspective des professionnels proviennent d'une incompréhension des méthodes utilisées pour l'estimation de l'état des stocks à l'origine des propositions de TAC. Les professionnels reprochent notamment aux scientifiques de ne pas intégrer les informations qualitatives qu'ils fournissent et d'aboutir à des résultats erronés. Ils reprochent par ailleurs aux scientifiques d'être trop éloignés des réalités du terrain, et d'ignorer les réalités socio-économiques des entreprises de pêche. Concernant les mesures techniques, les travaux scientifiques sont beaucoup plus consensuels dans la mesure où ils associent pratiquement toujours les pêcheurs dans leur élaboration.
5. Les scientifiques sont en général conscients des reproches faits par la profession. Ils soulignent que leur science est difficile à expliquer simplement d'une part, et que

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d'autre part ils ne sont pas recrutés pour leurs talents de communicateurs. Ils regrettent de leur côté l'attitude des professionnels (surtout leurs représentants) qui tiennent un double langage suivant qu'ils soient en public ou en privé. Les scientifiques soulignent également que les professionnels font peu d'effort pour comprendre les méthodes et résultats, principalement parce que cela permet aux syndicats professionnels de rester sur une position défensive plutôt que constructive.

6. La résolution des équivoques sera probablement difficile. Un moyen de les atténuer serait d'impliquer davantage en amont les professionnels dans les travaux scientifiques, et de les faire participer aux travaux de programmation, conduites de campagnes scientifiques et d'analyses afin de mettre la profession dans une situation où elle serait coresponsable des recommandations finales. On peut également suggérer le développement des méthodes de communication avec l'utilisation de professionnels de ces techniques.

**PROJECT N° 97/028: PÊCHERIES BIGOUDENE:
BILAN DES CONNAISSANCES**

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SUMMARY

Located at the far south-west of Brittany, the Pays Bigouden is the first of the French maritime regions in terms of landed value and the second one in weights. The Bigouden fishing practices are characterised by a large diversity of target species and métiers.

Studying the fishing practises leads to a description of the various métiers and fishing strategies together with their trends over the last ten years. Identification of métiers is based on multifactors analysis. Using a classification method based on thresholds of species landings then allows a more objective analysis and leads to a more quantitative characterisation of the trawl métiers, which represent more than 80 % of the total fishing activity of this region. Two métiers are based on Nephrops (alive or iced), one relies on benthic species (anglerfish, cuckoo ray), and another one on gadoids (cod, whiting, haddock). The relative proportion of each species in the landings of these métiers is relatively stable over the studied period (1987-1997).

Most of the trawlers only make one métier during a quarter. Nephrops in the Bay of Biscay, benthic species and also Nephrops in the Celtic Sea are the main métiers. Their relative importance depends on the level of the biomass of their main target species (Nephrops and anglerfish). Mixed métiers (alive Nephrops and benthic species, or iced Nephrops and gadoids) are increasing.

Most of the stocks exploited by the fleets from this region are either harvested outside safe biological limits (anglerfish, megrim, cod, hake, and probably Nephrops), or overexploited (hake), or growth overfished (Nephrops, hake, megrim...).

Rules set to achieve the fisheries policy aim to conservation of fish stocks in order to allow their sustainable exploitation.

The concept of TAC is a key element to the management of fishing exploitation rates, but does not fully succeed because they are set on a monospecies basis whereas most of the fisheries are mixed and multi-species. Furthermore, TAC are set by the Council of Ministers for whom conservation of fish stocks may not be the only aim.

Since most of the rules are not always complied (quotas, minimum legal sizes, mesh sizes...), the CFP cannot be considered as a total success. The task of policing and enforcing the rules is the responsibility of the Member States' Governments... But usually, control and actual enforcement are so scarce and without any actual penalties for the contravener.

The Pays Bigouden is dependent on its fishing activity, and it is quite obvious that effective regulations (i.e. restrictive) would not be accepted by the fishermen if they lead to economical problems for themselves or for the region as a whole.

A more courageous policy is needed but should propose financial compensation as it is done in agriculture.

Even though contradictory individual interests may confront, the conservation of fish stocks is of general interest and is required to allow a sustainable exploitation.

PROJECT N° 97/037: LAGGON INFORMATION SYSTEM**AUTHORS**

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SUMMARY

Coastal lagoons and estuaries are key fishery ecosystems. Their ecological role is in general well known. They provide, in their natural form, a complete sustainable ecosystem for important fish populations. They function as pathways or waypoints for migrating fish and other aquatic organisms and form nursery areas for euryhaline species. On the other hand, not much is known for their economic importance and potential of supporting local (usually small-scale) fisheries and providing opportunities for the development of coastal aquaculture. These water bodies are usually over-fished and over-polluted by sewage and agricultural run-offs and they are not protected and exploited properly. For this reason, certain management plans were needed to be derived and applied.

Each management plan is based on the collection and compilation of information, the formulation and finally the implementation of management measures and regulations. The management of lagoons initiated long ago in the Mediterranean area, starting in Italy. The derived applied management models were regarded as reference points for the management of other similar areas around the Mediterranean basin. The important point in lagoon management is that the manager should take into consideration a large number of parameters like exploitation of fish stocks, applied management measures, physicochemical characteristics, advances in extensive aquaculture technology etc. The integration of this information in a certain geographic area is very important for the design of a successful management plan that avoids side effects on the local socio-economical status.

The Greek coastline exhibits numerous geological formations — lagoons and gulfs — that are exploited for fisheries production, using both modern and traditional methods. It is commonly accepted that scientific knowledge of these ecosystems is still limited. Although several data sets are available, they are distributed in several organisations and there is not a simple way to access those data. Additionally, there is no compatibility between the various data forms. Both reliability and compatibility among different forms of recorded data files are key issues for the establishment of good lagoon management. The present project aimed directly to resolve this inefficiency of the lagoon management system in Greece.

The objectives of the current project were:

- The creation of an information system consisting of a database and the necessary information dissemination tool.
- The collection and elaboration of an initial group of data that could be serve as input to the system.

As target areas for the initiation of the system created in this project were selected:

- The Messolongi — Etolikon lagoon (Etolokarnania Prefecture, Fig.2, area 1)
- The North Amvrakikos Gulf lagoons (Arta and Preveza Prefectures, Fig.2, area 2)
- The Porto Lagos lagoon (Rodopi and Xanthi Prefectures, Fig.2, area 3)

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The operation of such an information system is hoping to facilitate and support the administration, district authorities, producers, researchers and policy makers involved in lagoon management in Greece.

The system is operational now and provides information to any stakeholder either through direct access to the database or through the Internet. Several initiatives have been launched by the hosting organization of IMBC towards continuation of the program with the support of national sources while collaboration with the Fishery Research Institute of Kavala is established for the completion of missing data and enrichment of the database.

PROJECT N° 97/059: PROVIDING A FRAMEWORK TO IMPROVE THE ASSESSMENT OF THE MAIN DEMERSAL AND PELAGIC FISHERIES IN WESTERN EUROPEAN WATERS

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SUMMARY

Basic scientific data on the economic, biological and technical aspects of exploited fisheries are required for the provision of fisheries management advice to national bodies, international organisations and the EU. The EU recognised that any reduction in the provision of these data for stock assessment would have serious implications for the quality of the scientific and management advice needed to conduct the Common Fisheries Policy. In order to address this problem, the EU DGXIV prepared several “calls for proposals” (Study Contracts) in this area and a number of projects were funded with the objective of achieving improvements in data collection for stock assessment in ICES Sub Areas VI, VII, VIII, IX and X.

The FIEFA project (Providing a Framework to Improve the Assessment of the main Demersal and Pelagic Fisheries in Western European Waters — EU Study Contract 97-0059) was funded by the EU in 1998 and built on the achievements of Study Contract 94-013. This project was co-ordinated by Ireland and involved 8 partners; MI, IPIMAR, DOP/UA, IEO, AZTI, IFREMER, MARLAB and CEFAS. In 1998, the total landings of the target stocks by each country involved in the project was circa. 1.05 million tonnes with an associated landed value of circa. 1,367 million EUROS. FIEFA comprised 6 main tasks; to

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maintain and consolidate sampling (task 1); document protocols for sampling data analysis and data management (task 2); data base development (task 5) and improved communication between research and industry. (task 6). Task 3 (guidelines for adequate sampling levels) and task 4 (Standard Data Exchange formats) were removed from the project work programme when the project was scaled down from a 3 to a 2 year programme.

The FIEFA project can be regarded as a success in that all the major objectives were achieved and all major tasks were carried out. Sampling levels were maintained and/or improved for many of the major stocks. Protocols in relation to sampling, data management and data analyses were documented for the first time in the FIEFA Report of the Protocols Workshop. In general terms, all partners are undertaking similar analyses. The methods used are generally consistent, as are the quality control measures. The main differences detected are in the stratification of the national sampling programmes (e.g. sampling schemes, strata). Data confidentiality is given a high priority and for all partners no disaggregated data are provided to outside bodies. The main destination for results are national administrations, international fisheries organisations, EU projects and the fishing industry. The techniques developed during the FIEFA project in relation to sampling protocols were used in January 2000 by the ICES Study Group on Market Sampling Methodology.

Institutes continued their work on national data base development. The International Sampling Level Data Base (ISLDB) is a powerful tool that has been further developed under FIEFA. The database contains information on national sampling levels by all the partners for the major stocks in western European waters. ISLDB will facilitate the analysis of sampling coverage on a stock basis and will be a very important tool in the examination of 'adequate sampling levels'.

All institutes reported an improved dialogue with their industries and there was an increased flow of scientific information to fishermen on the state of the resource. FIEFA has brought together scientists from the major fisheries laboratories of the north east Atlantic. A close working relationships has been established between the partners and this has facilitated co-operation in relation to the international sampling of stocks.

The results from the FIEFA project were of great benefit to the STECF Fisheries Data 2000 Atlantic Fishery Sub-Group and were used to prepare the report that will establish a 6 year plan on the sampling of EU fisheries. This report will have major implications for the project partners in terms of the future funding for fisheries sampling in western European waters.

**PROJECT N° 97/067: COMMUNICATION AND DISSEMINATION
OF SCIENTIFIC PAPERS IN THE CENTRAL MEDITERRANEAN**

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SUMMARY

Objectives: to improve communication and dissemination because of a gap between scientific data and publications, from one side, and fishermen and managers, on the other side, as clearly outlined during the 2nd Workshop on dissemination of information on the scientific basis of the fisheries management — Rhodos (Greece), 23-27/10/1996. During this meeting, difficulties in communication and dissemination in the Mediterranean region were analyzed and considered in relation with peculiarities of Mediterranean fisheries. In particular, it was noted that the Mediterranean has a high level of biodiversity with well over 100 species of fish being taken in commercial catches. However, the bulk of the commercial landings comes from only 10-15 of these species. Few of the Mediterranean fisheries are directed permanently on one species (the exception is the fishery for large pelagic fish, such as tuna). The substantial range from small to large fish taken in the main fisheries, means that control of the fishery through mesh size regulation is very difficult. A general point, which applies to many fisheries not only in the Mediterranean, is that fishermen and scientists frequently disagree about the assessment of stocks and fishing prospects. There is no problem when the news is good, because everyone is pleased by forecasts which show that catches can be maintained or improved. However, when scientists believe the stocks are declining and restrictions on fishing are necessary, the fishermen tend to be less optimistic and they are likely to disbelieve the scientific findings. In these circumstances the communication problem is particularly difficult.

So a better knowledge of the actual state of stocks on the basis of data gathered by researchers, can help the collaboration with fishermen and managers.

The main aim of the present project was to prepare three scientific volumes SYNDEM (bottom resources), DEMERSAL (demersal resources), mainly fished by otter trawl, TUNA (large pelagic resources), accessible also by non-scientific people, to improve the cooperation and the discussion between scientists and fishery operators.



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