Quality of Life and Management of Living Resources

MANAGING FISHERIES TO CONSERVE GROUNDFISH AND BENTHIC INVERTEBRATE SPECIES DIVERSITY

MAFCONS

5.1.2 Sustainable fisheries and aquaculture

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1. OBJECTIVES AND EXPECTED ACHIEVEMENTS

This project has six main objectives, each objective linked to its own specific work package. The linkage between work packages, and hence between objectives, is described explicitly in section 2.

The primary objective of the project is:

1. ***To provide the scientific advisors to fisheries managers with the mathematical tools that would allow them to quantify the consequences to groundfish and benthic invertebrate species diversity of achieving particular fisheries objectives.***

Species diversity is affected by fishing, but the relationship is unclear [a,b,c]. The Rio Convention on Biological Diversity requires that ecosystems be exploited in such a way that biological diversity is conserved. Fisheries managers may be required to balance fisheries objectives against species diversity consequences. To do this, the relationship between fishing and species diversity needs to be clearly defined to allow managers to predict the consequences of fisheries management policy on species diversity in much the same way as they currently predict the effects of particular levels of fishing mortality on future stock size.

The ultimate achievement of this project would be to provide stock assessment scientists with a "mathematical tool" that would allow them to explore the effect of various fisheries catch targets on groundfish and benthic invertebrate species diversity. Such a "tool" should operate in much the same way that Virtual Population Analysis or Extended Survivors Analysis currently enables the estimation of the impact of catch targets on residual fish stock size. It is intended that this mathematical tool be developed to the point where it could be used in the current routine ICES stock assessment Working Groups. This would present ICES with the opportunity of providing the EC and fisheries ministers with advice regarding the impact of fisheries policy on the wider marine ecosystem, as well as on the fish stocks themselves. For such a mathematical tool to have any chance of success it must be based soundly in ecological theory. So our second main objective is:

2. ***To develop the ecological theory, including rigorous hypothesis testing, necessary to underpin any mathematical tool designed to enable the impact of various fisheries strategies on groundfish and benthic species diversity to be explored.***

As an initial start point the project would carry out a full evaluation of Huston's[d] Dynamic Equilibrium Model, which suggests that the response of species diversity to disturbance is dependent upon local productivity. The first stage in addressing this objective would be the rigorous testing of hypotheses derived from this model, and a thorough evaluation of the model's usefulness as the basis for the mathematical diversity assessment tool described above. While this theoretical model appears to hold considerable promise, it may not be the only candidate. A secondary requirement in addressing this objective therefore is to carry out a major review of the theoretical ecology literature so that if necessary, alternative theoretical approaches could be investigated. This review would include an international workshop convened over five days to which selected ecologists with a strong reputation in theoretical community ecology would be invited. The production of a major literature review document detailing the theoretical structuring processes providing the foundations to benthic invertebrate and demersal fish communities, together with the formulation of alternative hypotheses which could be tested in the field, would constitute the second main achievement of this part of the work. This document

would be produced early on in the project timetable, in time to influence the data collection programme so as to allow newly developed hypotheses to be examined if this should be deemed necessary. Including fisheries scientists with a strong theoretical ecology background, and also including internationally renowned theoretical ecologists within the MAFCONS consortium, and as invitees to the workshop, should ensure the success of this part of the project. The scientists involved in this project remain absolutely convinced that this is the approach that has to be adopted if fisheries are ever to be successfully managed within an ecosystem context.

Any theoretical model attempting to predict the effects of fishing on marine species diversity requires a detailed knowledge of the disturbance to the ecosystem caused by fishing. Our third main objective is therefore:

3. *To derive a detailed understanding of the spatial and temporal patterns of disruption, or disturbance, to the ecosystem caused by fishing.*

Previous EC funded projects have initiated the compilation of international fishing effort databases. This process will be continued and expanded during this project to develop indices of ecological disturbance caused by fishing. Although such databases provide the best indication of variation in fishing practice in both time and space[e], they still do not provide a true indication of ecological disturbance. In theoretical ecology terms, disturbance is the mortality caused by perturbations to the ecosystem. Thus the ecological impact of one hour of beam trawling differs to that of an hour of otter-trawling. More powerful fishing vessels, towing heavier gears faster, cause greater disturbance to the ecosystem than less powerful vessels. The disturbance caused by directing all the effort attributed to a particular ICES statistical rectangle to one or a few small locations, or distributing it evenly across the entire rectangle will differ markedly. Miss-reporting or erroneous recording will result in effort being assigned to the wrong rectangles. These interactions need to be unravelled if true indices of ecological disturbance due to fishing, based on the effort statistics, are to be developed. There is now a considerable body of literature available that should enable the differential effects of various gears and differing vessel power to be quantified[f,g]. The inclusion of fisheries protection data should help quantify the extent of miss-reporting and miss-recording, as well as contribute to investigations into the distribution of effort with statistical rectangles[h].

Understanding the relationship between fishing effort statistics and actual impact to the marine ecosystem will be a major achievement of the project. The intention being, to provide maps showing variation in indices of ecological disturbance across the North Sea, at the spatial resolution of the ICES statistical rectangle, for each year that international fishing effort data are available. This would again be achieved through convening a second five-day international work-shop to which experts in the fields of gear technology and impact, benthic bycatch studies, fish discard studies, ecosystem disturbance, effects of fishing gear on habitats, etc. would be invited. This workshop would review all the relevant literature. The specific problems associated with each index, particularly with respect to their application in the sort of theoretical models discussed above would also be carefully documented in the resulting review publication.

Huston's Dynamic Equilibrium Model suggests that the response of species diversity to ecological disturbance is dependent upon local productivity. To test Huston's model with respect to, for example, groundfish species diversity, we therefore require information concerning secondary production within the benthic invertebrate fauna, ie. productivity within the trophic level below the groundfish. So the fourth main objective is:

4. *To determine spatial variation in benthic invertebrate productivity across the study area in each of two years.*

Previous EC funded projects have developed the methodology to sample benthic epifauna during the ICES 3rd quarter International Bottom Trawl Survey using two-meter beam trawls. This project would continue this practice, but in addition, samples of benthic infauna would also be collected using a box-corer and/or grab at each of the epi-benthos 2m beam trawl/ GOV Groundfish survey stations. Estimates of benthic invertebrate productivity, across the entire benthic invertebrate community, including the meiofauna, will be derived using a method based on size-spectra[i]. Analysing the benthic sample data to determine size-spectra, and the resultant productivity estimates is the principle requirement in addressing this objective. The production of maps indicating variation in benthic productivity across the North Sea, at the spatial resolution of the ICES statistical rectangle, for each of the two years of data collection would be the work package's primary achievement.

Given the increasing concern over the impact of fishing on benthic invertebrate communities, a secondary objective for this part of the work concerns the classification of benthic invertebrate communities.

4b. *To determine spatial variation in species composition and species diversity across the study area in each of three years.*

The benthic samples will be analysed to determine species abundance in each sample. The intention would be to determine point estimates of benthic species composition and diversity, for both the epi-benthos and the infauna. Maps of benthic species composition and diversity across the North Sea, at the spatial resolution of the ICES statistical rectangle, would be produced for the two years of planned data collection. Given the fine scale size-spectra analysis of the benthic samples, together with knowledge of their trophic interactions, the general approach adopted in this project could be extended to provide managers with a mechanism to take account of the effects of fisheries policy on benthic invertebrate communities.

The final requirement for testing Huston's model with respect to predicting groundfish species diversity, is actually determining current and past levels of groundfish diversity. So the fifth main objective of the project is:

5. *To determine spatial variation in groundfish species diversity across the study area.*

Groundfish survey data collected during the ICES International Bottom Trawl Surveys will be analysed to determine species abundance and species diversity in each sample. The main achievement will be the production of maps of groundfish species composition and diversity across the North Sea at the spatial resolution of the ICES statistical rectangle, for each of the three years of the project duration. If possible maps will also be produced based on groundfish species data collected in surveys carried out prior to the start of this project.

The final aspect of the project concerns the application of the mathematical species diversity assessment tool within a fisheries management context. The ecological theory currently available requires ecological disturbance as the "input parameter". Consequently, the project will focus primarily on the development of measures of ecological disturbance based on estimates of fishing effort (see above). However, current fisheries management within the Common Fisheries Policy region is not based on the direct control of fishing effort, rather it is instigated through the

setting annually of Total Allowable Catches. Thus, the relationship between annual fish landings and the pattern of fishing effort required for these to be achieved needs to be established. This is the sixth main objective of the project.

6. ***To determine the relationship between landings and the pattern of fishing effort needed to attain these catches.***

Considerable information regarding the relationship between fishing effort and landings is already available from the annual ICES stock assessment processes. But these data are generally aggregated over whole assessment regions. There is a need to examine the data at a much finer spatial resolution if we are to be able to determine the actual pattern of fishing effort, in time and space, and by gear and vessel type, required to land specific quantities of fish. These landings and effort data are collected routinely by countries with a stake in fisheries operating under the CFP of the EU. The main achievement of this package would be the collation and analysis of these data to produce detailed maps of predicted fishing effort, given the setting of particular TACs, across the North Sea, by ICES statistical rectangle, gear and vessel power, etc.

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2. PROJECT WORKPLAN

2.1 Introduction

Seven separate work packages are envisaged for this project. The first six work packages cover the main scientific work to be carried out, and each of these is organised to address one of the six main objectives presented in section 1. The principal objective of the project is to develop a management protocol to enable fisheries scientists to provide managers with advice regarding the consequences of particular management actions on other aspects of the marine ecosystem, in particular demersal fish and benthic invertebrate species diversity. WP1 will achieve this goal. Such a protocol needs to be soundly based in established ecological theory. Establishing this theoretical basis is the purpose of WP2. Collecting the data to test hypotheses derived from the ecological theory, and to enable application of the management protocol, in the future, are the main goals of WP3, WP4 and WP5. Sampling to fulfil the needs of these work packages will be carried out in the areas indicated in chart 1 below by each partner. Initially MAFCONS will examine the Dynamic Equilibrium model to see whether this can provide the required theory to underpin the management protocol. This model suggests that the response of species diversity to disturbance at one trophic level is dependent on the productivity of the next trophic level down the foodweb. So WP3 will concentrate on determining patterns of disturbance, WP4 will focus on patterns of benthic diversity and productivity, and WP5 will examine the effects of these on groundfish species diversity. Most ecological theory deals with the effects of disturbance. Fisheries management currently deals in catch limitation. For the protocol to be put into practice therefore, future catch limitations have to be converted to consequent disturbance. This is the role of WP6. WP6 is a necessary to allow the management protocol to be used under current management regimes. Work package seven simply covers project co-ordination, management and dissemination. The work packages are listed in Table 1. The linkage between the six primary work packages is illustrated in Flow-chart 1. The role of WP7 is to ensure that this linkage operates effectively.

The project makes use of the ICES International Bottom Trawl Surveys for the provision of the required field data. The timings of these surveys are fixed and cannot be altered. Given the proposal submission deadline of 18 October 2001, previous experience suggests that, if successful, the contract negotiation process is unlikely to be completed before September 2002. The 2002 third quarter IBTS should already have been completed by this time. Two years of data collection are envisaged, the first survey data collected for the project will be obtained therefore in autumn 2003, the second in autumn 2004. Several key actions have to take place prior to the collection of the first set of field data necessitating a reasonable period of time prior to the first surveys. Consequently, the timing of the start of the project is critical. We propose that, if successful, the project should start on 6 January 2003 to allow sufficient time for this preparatory work. Analysis of the benthic invertebrate samples, particularly the infaunal samples, will require one year of laboratory time for each of the years of survey data. This work should be completed, and the data required to test the theoretical models (WP2) available by October 2005. Evaluation of the ecological models will be an ongoing process, started when the first survey data are available and completed by March 2006, five months following the last set of survey data coming on stream. Similarly, applying the models to develop a management approach (WP1), will also be an ongoing process started following the initial testing of the ecological models. A further three months will be required once final model testing is completed, giving a project completion date of end of June 2006. Total project duration is therefore 42 months. The actual timetable of project tasks and events is indicated in the timetable chart.

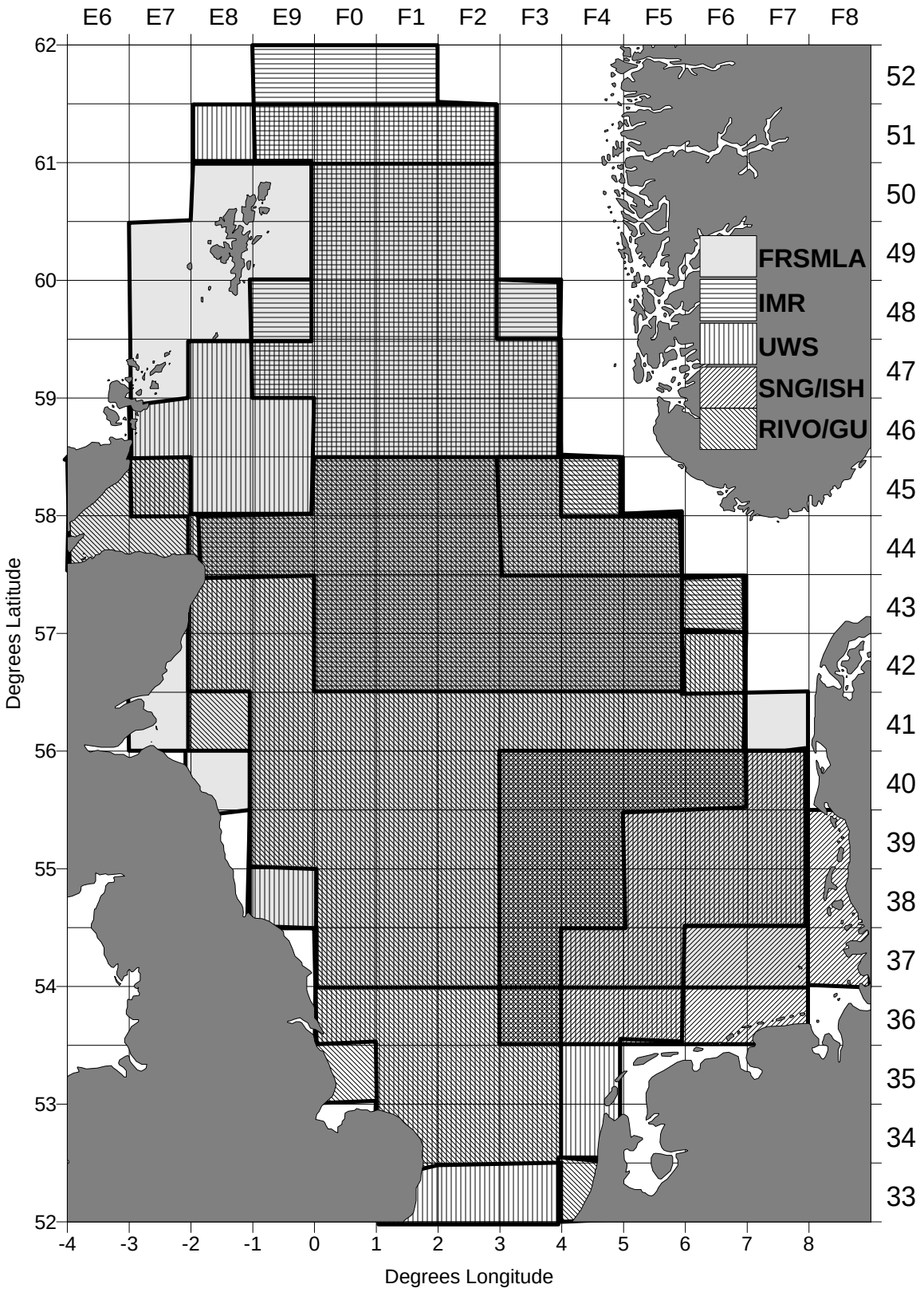
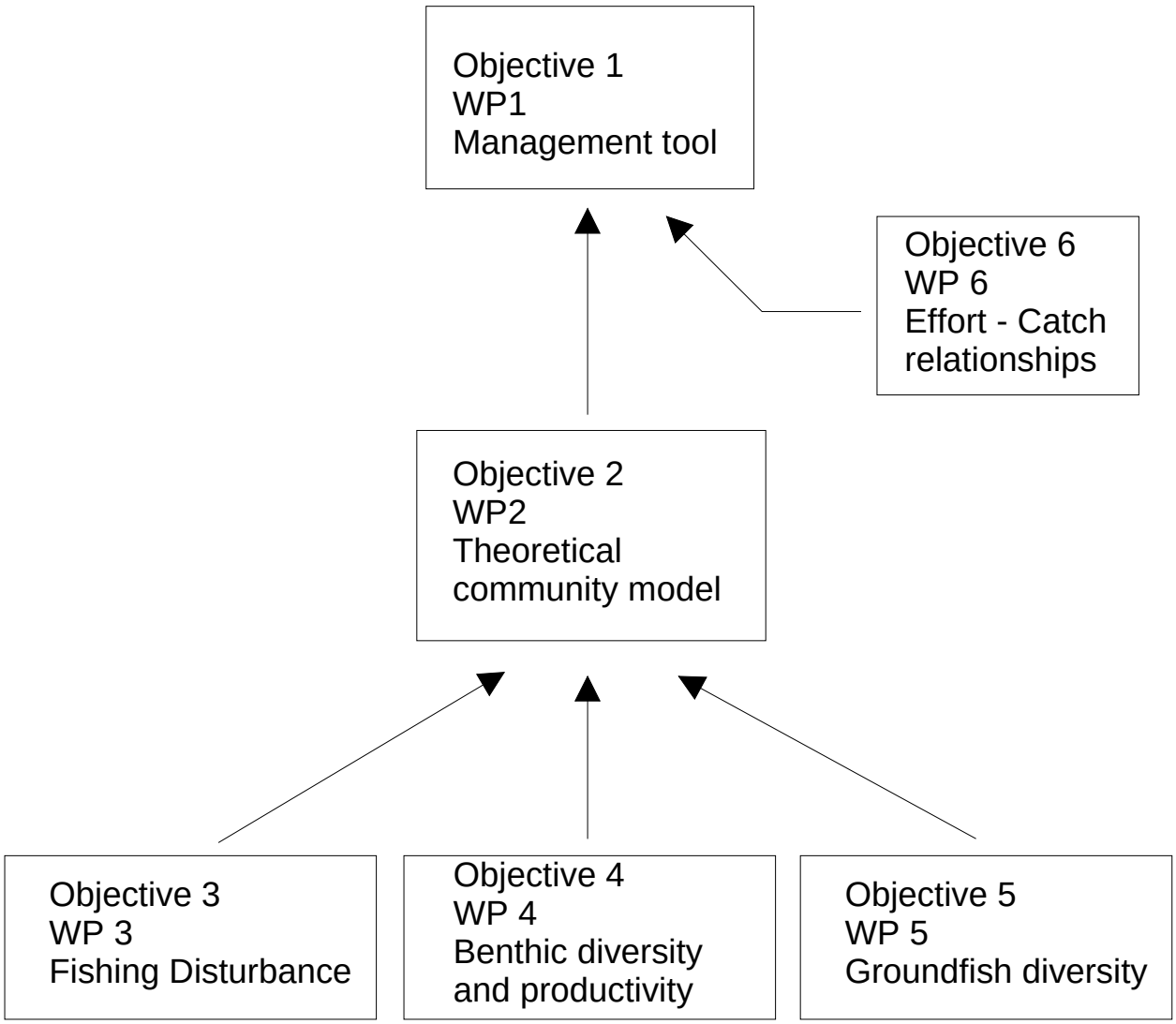


Chart 1. Areas from which GOV and benthic samples will be collected by each partner in each year.



Flow-chart 1. Linkage between six main work packages. Work package 7 covers project coordination.

2.2 Project structure, planning and timetable

The MAFCONS consortium consists of six collaborating institutes that are main partners, and a seventh institute sub-contracted to partner 4.

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Table 1 provides a list of workpackages. The major project milestones are listed in table 2 and a list of deliverables is provided in table 3.

Table 1. List of work packages.

WP No.	Work Package Title	Contributing Participant numbers	Person-months	Start month	End month	Deliverable Numbers
1	Development of a management protocol enabling single species fisheries objectives to be balanced against ecosystem species diversity targets.	2,3,4,5	15.5	26	42	23,30
2	Testing of ecological models, such as Huston's Dynamic Equilibrium Model. Development of an ecological model based algorithm that will allow the effect of fishing on the ecosystem to be predicted. In the case of Huston's model, the mathematical relationship between disturbance, production and diversity.	2,3,4,6	20	1	39	2,15,29
3	Determination of quantitative relationships between fishing effort statistics and actual ecological impact: development of index of "Ecological Disturbance Due to Fishing".	1,2,3,4,5,6	27	1	35	3,12,25
4	Benthic infauna sampling: estimation of standing stock biomass, species diversity, size spectra, and secondary production in time and space.	1,2,3,4,5,6	190.4	6	39	1,5,7,8,10, 11,13,16,18, 19,21,22,24, 26,27,28
5	Analysis of groundfish survey data: estimation of fish species diversity in time and space.	1,2,3,4,5,6	37	6	31	1,4,6,14,17, 20
6	Determination of quantitative relationships between fishing effort and catches.	1,2,3,4,5	23	11	19	9
7	Project co-ordination and management.	1,2,3,4,5,6	25.5	1	42	

Timetable Chart: A timetable for the project is presented here in graphical form. The work is divided into particular tasks. The months when work on each task will be taking place are indicated by X. Numbers indicate when deliverables (listed in Table 3, Table of Deliverables) should become available. Some, but not all, of these deliverables constitute project milestones (every milestone is associated with a deliverable, see Table 2, List of Milestones) and such deliverables are indicated by grey shading. Milestone numbers are not shown in this table. Instead the deliverable number associated with particular milestones can be found here, and cross-referenced with the associated deliverable number column

Year		03												04											05											06					
Month		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Project Month Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
TASKS	WORK																																									
	PACKAGE																																									
Project Management and Co-ordination Meeting	7	X			X	X	X							X													X												X			
Working Doc. for theory/models workshop	2	X	X	X	X																																					
WP2 5 day workshop on Ecological Models	2				X																																					
Ecological theory and models review	2				X	X	X	X	X	X	X	2																															
Working Doc. for disturbance workshop	3	X	X	X	X	X																																				
WP2 5 day workshop on Ecological Disturbance	3					X																																				
Ecological Disturbance review	3					X	X	X	X	X	X	X	3																														
Calculation of fishing disturbance indices	3																		X	X	X	X	12								X	X	X	X	25							
Sampling methodology and analysis workshop	4,5						X	1																																		
Groundfish and Benthic Surveys	4,5								X	X	X	X									X	X	X	X																			
Analysis of Fish Trawl survey data	5									X	X	X	X	4								X	X	X	X	14																
Annual Reports/maps of fish diversity and comp.	5														X	X	6										X	X	17													
Final Report Fish Community Analyses	5																													X	X	20									
Analysis of epibenthos beam trawl survey data	4										X	X	X	X	X	5							X	X	X	X	X	16													
Ann.Rep/Maps. epibenthic diversity, comp., productivity	4																X	X	7										X	X	18										
Final Report Epibenthic Community Analyses	4																															X	X	X	24						
Analysis of benthic infauna grab/core survey data	4										X	X	X	X	X	X	X	8	X	X	11	X	X	X	X	X	X	X	X	19	X	X	22								
Annual Report/Maps benthic infauna productivity.	4																		X	X	10										X	X	21								
Final Report benthic infauna productivity	4																																	X	X	27						
Ann.Rep/Maps. benthic infauna sp comp and diversity	4																						X	X	13									X	X	26						
Final Report benthic infauna sp comp and diversity	4																																				X	X	28			
Testing Ecological Models	2																						X	X	X	X	15	X	X	X	X	X	X	X	X	X	X	X	29			
WP1 Workshops Eco/fisheries management protocol	1																										X												X			
Discussions Eco/fisheries management protocol	1	X			X	X	X																				X												X			
Eco/fisheries management protocol development	1																										X	X	X	X	X	X	X	X	23	X	X	X	X	X	X	X	30
Working Doc. for Catch/effort/activity workshop	6											X	X	X	X																											
WP6 Workshop relating catch to fishing activity	6														X																											
Catch/fishing effort/fishing activity review	6														X	X	X	X	X	9																						

Milestones are indicated by grey shading (reports from critical workshops or on critical analyses of the data) and deliverables by bold numeral.

(col.4) in Table 2. This project has to fit around the ICES third quarter groundfish surveys, the timings of which are fixed. In order for the project to work the timetable below has to be followed closely. The start date is therefore critical. **The project must start in January 2003.** It is a 42 month project. Consequently it will finish on 30 June 2006.

Table 2. List of Milestones					
Milestone No	Title	Delivery Month	Associated Deliverable No.	Participants contributing (responsible)	Role in project
1	Sampling/Analysis methods manual	7	1	(1),2,3,4,5,6	Establishes sampling consistency and data quality control
2	Review of ecological theory	11	2	(2),3,4,5,6	Establish theory to underpin management protocol; set hypotheses
3	Review of ecological disturbance by fishing	12	3	1,(2),3,4,5,6	To convert fishing effort to ecological disturbance (how does fishing perturb ecosystem?
4	1st annual report on groundfish assemblage species composition and diversity	16	6	1,(2),3,4,5,6	Diversity – model output test data; management goals
5	1st annual report on epibenthic assemblage species composition, diversity and productivity	18	7	1,(2),3,4,5,6	Productivity – model input Diversity – model output test data; management goals
6	Review of catch/effort relationships	19	9	1,(2),3,4,5	Required for management protocol – converts catch setting to effort requirement
7	1st annual report on benthic infauna productivity	21	10	1,(2),3,4,5,6	Productivity – model input
8	Calculation of spatially and temporally resolved indices of ecological disturbance caused by fishing	22	12	1,(2),3,4,5,6	Disturbance – model input
9	1st annual report on benthic infauna species composition and diversity	24	13	1,(2),3,4,5,6	Diversity – model output test data; management goals
10	2nd annual report on groundfish assemblage species composition and diversity	28	17	1,(2),3,4,5,6	Diversity – model output
11	2nd annual report on epibenthic assemblage species composition, diversity and productivity	30	18	1,(2),3,4,5,6	Productivity – model input Diversity – model output test data; management goals
12	Final report on groundfish assemblage species composition and diversity	30	20	1,(2),3,4,5,6	Diversity – model output test data; management goals

13	2nd annual report on benthic infauna productivity	33	21	1,(2),3,4,5,6	Productivity – model input
14	Final report on epibenthic community analyses	34	24	1,(2),3,4,5,6	Productivity – model input Diversity – model output test data; management goals
15	Update ecological disturbance indices	35	25	1,(2),3,4,5,6	Disturbance – model input
16	2nd annual report on benthic infauna species composition and diversity	36	26	1,(2),3,4,5,6	Diversity – model output test data; management goals
17	Final report on benthic infauna productivity	36	27	1,(2),3,4,5,6	Productivity – model input
18	Final report on benthic infauna species composition and diversity	39	28	1,(2),3,4,5,6	Diversity – model output test data; management goals
19	Final report on testing ecological models	39	29	(2),3,4,6	Test ecological model to underpin management protocol
20	Report on development and application of management protocol.	42	30	(2),3,4,5	Test protocol under management conditions

Each milestone is associated with a specific deliverable, indicated here in column 4 for cross-referencing with the List of Deliverables (see next table, Table 3). The Timetable Chart above indicates when each deliverable will become available. Deliverables associated with milestones are shown in grey shaded cells in the Timetable Chart.

Table 3. List of Deliverables					
Deliver-able Number	**Deliverable Title**	**Delivery Date**	**Nature**	**Dissemi-nation Level**	**Dissemin-ation Target**
D1	Sampling Protocols Manual.	7	R	CO	Consortium
D2	Review of ecological models underpinning the structure of demersal fish and benthic invertebrate communities.	11	R	PU	
D3	Review of the ecological impact of fishing; actual disturbance caused to the ecosystem by fishing activity.	12	R	PU	
D4	Fish trawl data exchange files – first cruises.	13	O	CO	Consortium
D5	Epibenthos data exchange files – first cruises.	15	O	CO	Consortium
D6	Annual Report: Fish species composition and diversity – first cruises.	16	R	CO	
D7	Annual Report: Epibenthos species composition, diversity and production – first cruises.	18	R	CO	
D8	Benthic infauna productivity data exchange files – first cruises.	18	O	CO	Consortium
D9	Review on relationships between catch and effort.	19	R	PU	
D10	Annual Report: Benthic infauna productivity – first cruises.	21	R	CO	
D11	Benthic infauna species composition and diversity data exchange files – first cruises.	21	O	CO	Consortium
D12	Update international effort database and calculate disturbance indices resolved in time and space	22	R	CO	
D13	Annual Report: Benthic infauna species composition and diversity - first cruises.	24	R	CO	
D14	Fish trawl data exchange files – second cruises.	25	O	CO	Consortium
D15	Preliminary report on testing of ecological models – using first cruises' data.	26	R	CO	
D16	Epibenthos data exchange files – second cruises.	27	O	CO	Consortium
D17	Annual Report: Fish species composition and diversity – second cruises.	28	R	CO	
D18	Annual Report: Epibenthos species composition, diversity and production – second cruises.	30	R	CO	
D19	Benthic infauna productivity data exchange files – second cruises.	30	O	CO	Consortium
D20	Final Report: Demersal fish community analyses.	31	R	PU	
D21	Annual Report: Benthic infauna productivity – second cruises.	33	R	CO	
D22	Benthic infauna species composition and diversity data exchange files second cruises.	33	O	CO	Consortium
D23	Preliminary report on development of ecosystem based fisheries management protocol.	34	R	RE	

D24	Final Report: Epibenthic community analyses.	34	R	PU	
D25	Update international effort database and calculate spatially and temporally resolved disturbance indices.	35	R	CO	
D26	Annual Report: Benthic infauna species composition and diversity – second cruises.	36	R	CO	
D27	Final Report: Benthic infauna community productivity.	36	R	PU	
D28	Final Report: all benthic infauna community analyses.	39	R	PU	
D29	Final Report on testing of ecological models.	39	R	PU	
D30	Final Report on development of ecosystem based fisheries management protocol.	42	R	RE	

These deliverable numbers are indicated in the Timetable Chart above.

2.3 Description of the workpackages

Work package number:	**1**	
Start date or starting event:	**Month 26**	
Completion date or event:	**Month 42**	
No of the partner responsible:	**Partner 2**	
No's of other partners involved:	**Partners 3, 4 and 5**	
Person-months per partner:	**P2-6; P3-6.5; P4-2; P5-1.**	**Total = 15.5**

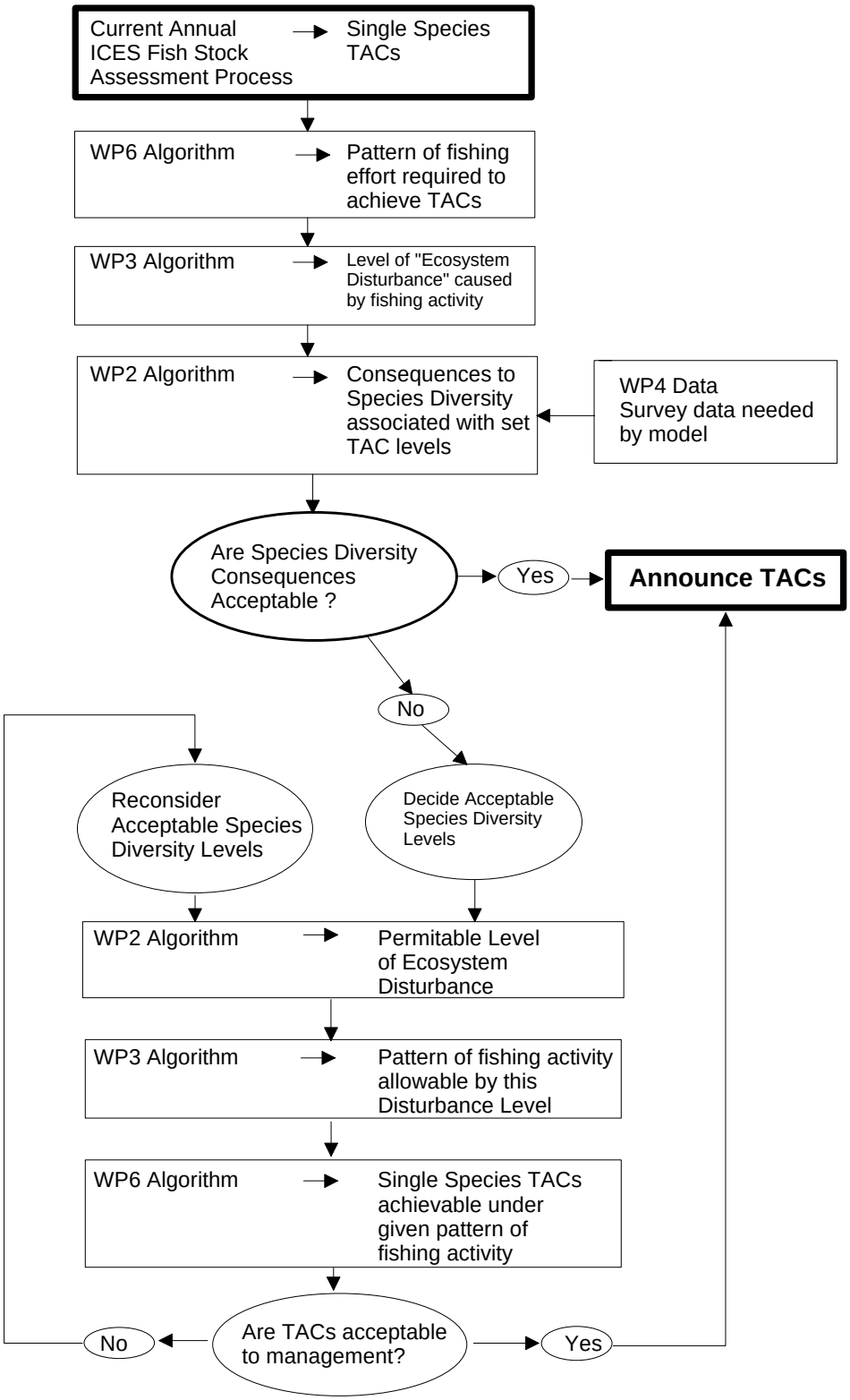
Objectives:
The object of this work package is to place the ecological model relating fishing activity to effects on fish and benthos species diversity within a workable management framework so that fisheries managers can take account of ecosystem consequences when setting fisheries targets.

Description of work:
The management protocol is illustrated in the accompanying schematic. Thus fish stocks would be assessed and TACs set following current practice. The TACs would then be input into the WP6 algorithm to estimate the level and distribution of fishing effort required to achieve these. The generated pattern of fishing activity then feeds into the WP3 algorithm to determine spatially resolved indices of ecosystem disturbance. Inputting these into WP2's ecological model, along with the other input parameters required, generated by WP4 (eg. spatially resolved estimates of benthic invertebrate secondary production if Huston's Dynamic Equilibrium Model is used), produces the predicted effect of achieving these TACs on species diversity. Managers then have to decide whether these species diversity consequences were acceptable or not. If so, then the TACs recommended would be in line with both, fisheries management objectives and ecosystem conservation goals. If unacceptable, then "acceptable levels" of species diversity would have to be decided. Having done this, the diversity – ecosystem disturbance, ecosystem disturbance – fishing activity, and fishing activity – catch algorithms of WPs 2, 3, and 6 can all be used in reverse to determine the tolerable pattern of ecosystem disturbance consistent these acceptable levels of species diversity. From this, tolerable levels and distributions of fishing effort can be established, and these can be used to estimate the likely resultant catch. Managers would then have to decide whether these TACs were acceptable from an industry or political perspective. If so, then the TACs could be announced. If however, the TACs were deemed too stringent, then the "acceptable levels" of diversity would have to be reconsidered. In effect, the latter part of the process could be cycled through repeatedly to find the best compromise between TACs and species diversity consequences.

Deliverables:
Two workshop reports, constituting deliverables 23 and 30, will be delivered in months 34 and 42. The first will detail progress in applying the ecological model within the management protocol based on one year's data. Any changes in the protocol structure, or in the underlying philosophy will be documented in this first report. The second report will describe the final protocol developments, based on all the available data. It will also provide details of its application within a management scenario.

Expected results and relevant corresponding milestones:
Real progress on this work package will not occur until the necessary data sets are compiled, on or around month 22. Once the data from the first set of cruises are available, a workshop will be convened, in month 26, to review progress and stimulate further developments. Scientists involved in ICES stock assessment and the provision of advice to managers will be invited to

this workshop in order to take account of their views. A preliminary management protocol document summarising the conclusions of this workshop will be produced as deliverable 23 in month 34. A second longer workshop will be convened in month 39 when the second year's data are available. At this workshop the final management protocol will be decided and its applicability tested using data from previous years ICES fisheries assessments and advice documents. The results of the management simulation will be written up as the final project deliverable, number 30, available in the last month, month 42, of the project.



Work package number:	**2**	
Start date or starting event:	**Month 1**	
Completion date or event:	**Month 39**	
No of the partner responsible:	**Partner 2**	
No's of other partners involved:	**Partners 3, 4, and 6**	
Person-months per partner:	**P2-12; P3-3; P4-2; P6-3.**	**Total = 20**

Objectives:
The purpose of this work package is to develop and test an appropriate ecological model which will enable the consequences of attaining specific fisheries management targets on species diversity (of fish and benthos) to be predicted. Huston's Dynamic Equilibrium Model could, for example, provide the basis for such a model, although the possibility that alternative models may be more appropriate will be thoroughly investigated. This model will underpin the management protocol of WP1

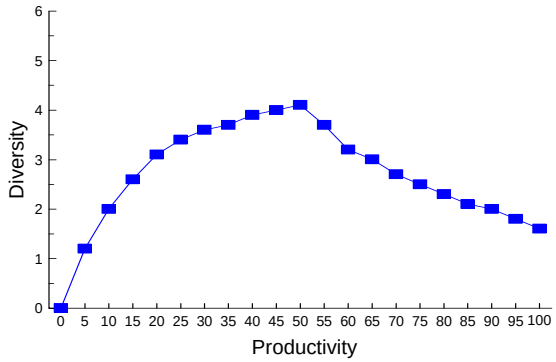
Description of work:
Huston's model is based on two commonly noted unimodal relationships: between species diversity and productivity and between species diversity and disturbance. Each can be explained on the theoretical basis that competitive forces impose structure on communities. With increasing productivity, resources are more abundant allowing greater specialisation, reducing niche width and allowing closer niche packing. More species can co-exist; diversity increases. With continued increase in resource abundance, the scope for growth in dominant competitor populations becomes more or less unlimited. Their populations expand, limiting resources for nearest competitors, whose populations start to decline, with a resultant decrease in species diversity (figure 1). At low levels of disturbance, population growth of dominant competitors is unchecked and these out-compete close competitors, resulting in low species diversity. As disturbance intensity and/or frequency increases, the population growth of dominant competitors is checked, allowing sub-ordinate species access to part of the resource spectrum. Sub-ordinate species are able to co-exist and diversity increases. At higher disturbance levels, populations of susceptible species, unable to tolerate the high mortality, decline and diversity decreases (figure 2). Combining these two relationships, Huston produced a three dimensional model of species diversity, relating diversity simultaneously to productivity and disturbance (figure 3). The implication of this model is that the response of species diversity to ecosystem disturbance is entirely dependent upon local productivity (figure 4). Thus, considering the region on the disturbance scale between 25 and 75, in rich areas diversity increases with increasing disturbance, while the reverse occurs in areas of poor productivity. Thus this model therefore predicts the apparently contradictory results noted in the literature. Huston's model provides a start point for the project, generating hypotheses that can be tested using field data. Productivity and disturbance can be determined at points in space and their effect on local diversity established to attempt to create the three-way relationship depicted in figure 3. Alternatively, long-term trends in species diversity can be related to trends in disturbance in areas varying in their productivity to look for the relationships shown in figure 4. If interested in the diversity of the groundfish assemblage, limited by productivity in the trophic levels beneath them, ie small groundfish and benthos, we therefore need estimates of productivity in these components of the marine food web.

Huston's model may not provide the whole solution to the problem. Fish species diversity may, for example, be related to habitat variability. Fishing disturbance may result in reduced habitat heterogeneity, and therefore cause a knock on reduction in groundfish diversity. There is

certainly some evidence for this on the northeastern seaboard of the North America and Canada[i,ii]. It is important that alternative theoretical processes governing species diversity be taken into account early in the project so that the data required to test alternative hypotheses may be collected. To this end it is intended that a workshop be convened to which theoretical community ecologists of international repute from outside the project consortium would be invited, thereby widening the breadth of expertise. This workshop would review the theoretical ecology literature to identify and assess processes controlling the composition and structure of the groundfish and benthic invertebrate communities.

Deliverables:
Three deliverables are planned for this work package. The first is the major review of the theoretical ecology literature examining the processes structuring fish and benthos communities. This review will detail the conclusion reached at the workshop and provide the basis for the ecological model underpinning the management protocol. This review would be deliverable 2 of the project, available in month 11. An initial report detailing progress in the model testing (deliverable 15) will be provided in month 26,in time for the first workshop on development of the management protocol. A final report on the ecological models underpinning the structure of benthic invertebrate and demersal fish communities, deliverable 29, will be provided by month 39, in time for consideration at the second management protocol workshop.

Expected results and relevant corresponding milestones:
A workshop will be convened in Month 4 to review the theoretical ecology literature with the purpose of defining the processes structuring fish and benthic invertebrate communities. A working document, developed through Email correspondence over two months prior to the workshop, will form the initial basis for workshop discussion. During the workshop this document will be developed to form a major review, for publication in the scientific literature, identifying possible theoretical ecological models underpinning the structure of benthic invertebrate and groundfish communities. The necessary data on ecological disturbance from fishing activities, benthic invertebrate community secondary production, and groundfish species diversity required to test the Dynamic Equilibrium Model, and any other data required to test alternative models identified during the workshop, would be provided by work packages three, four and five. These data should be fully available approximately one year after the cruises that generated them. Testing of the models would therefore commence in Month 22 with final testing of the model, using all the data, taking place by Month 39. By this stage a suitable model for application in the management protocol will have been identified and fully tested.



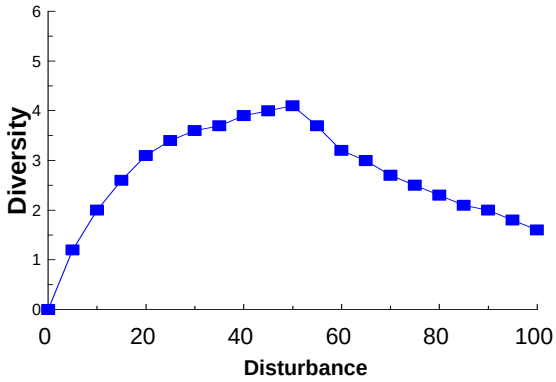


Figure 1: Diversity on Productivity.

Figure 2 Diversity on Disturbance

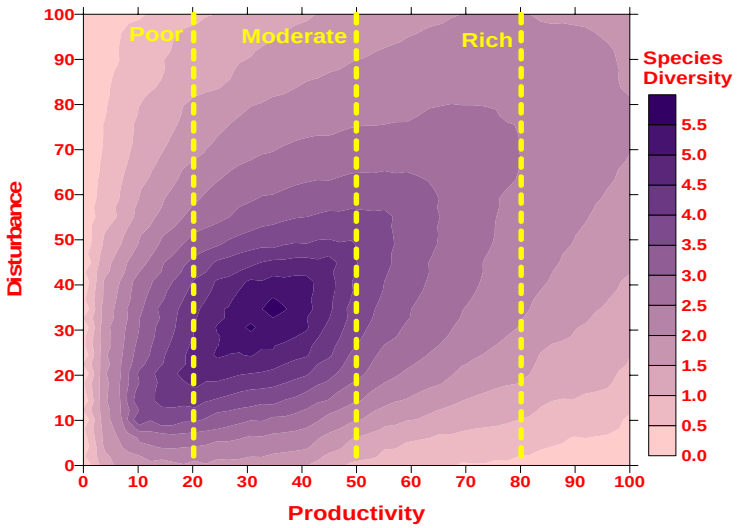


Figure 3: Huston's Dynamic Equilibrium model relating species diversity to productivity and disturbance.

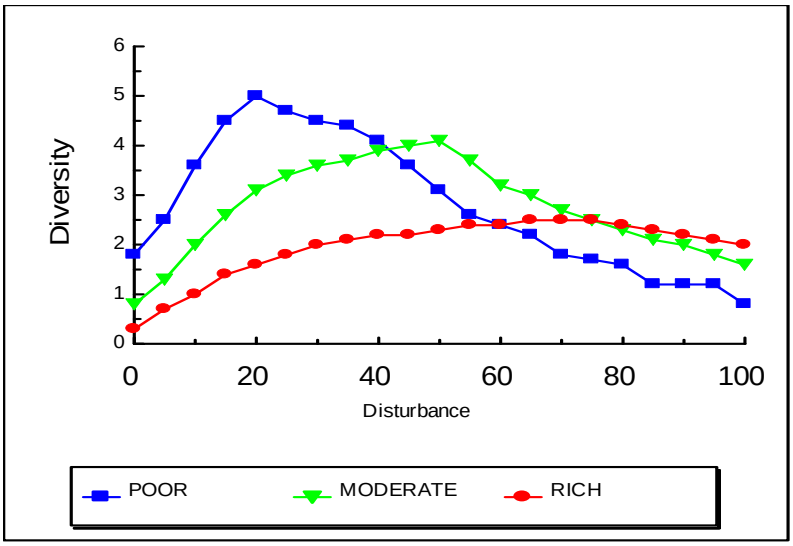


Figure 4: Relationships between diversity and disturbance at three different levels of productivity.

Work package number:	**3**	
Start date or starting event:	**Month 1**	
Completion date or event:	**Month 35**	
No of the partner responsible:	**Partner 1**	
No's of other partners involved:	**Partners 2, 3, 4, 5 and 6**	
Person-months per partner:	**P1-3; P2-16; P3-1; P4-2; P5-1; P6-4.**	**Total = 27**

Objectives:
The objective of this work package is to determine the relationship between patterns of fishing activity that can be described using standard fisheries effort statistics and the actual ecological impact caused by such activity.

Description of work:
Most previously published papers examining the wider impact of fishing on marine ecosystems have used some sort of index of fishing effort as an indicator of variation in the level of fishing disturbance[iii,iv,v]. For the North Sea, one of the most comprehensive of such data-sets was compiled during previous EC funded BIODIVERSITY projects[vi]. This included effort data, in terms of hours fished per ICES statistical rectangle per year for otter and beam trawling by most countries exploiting the North Sea for the period 1990 to 1995 and 1997 to 1998. This data-set will be updated to include the year 1996 as well as more recent years. Whilst effort statistics provide a measure of fishing activity, they are not reliable measures of the ecological disturbance caused by fishing. Different gear categories effect the ecosystem in quite different ways: each hour of beam trawl effort will kill many more benthic invertebrates and flatfish, and rather less pelagic and demersal roundfish, than an equivalent hour of otter trawling. Within each gear category a multitude of different types of fishing gear could be included, varying in their size and weight. Fishing vessels vary markedly in their size, power and fishing capability. As a result, the impact on the ecosystem per unit fishing effort can vary markedly. Furthermore, the distribution of effort within each unit of space can effect the level of impact on the ecosystem. Thus 1000 hours of beam trawl effort concentrated on one small location is likely to have a completely different impact as the same number of hours distributed evenly across a full ICES statistical rectangle.

This WP will develop indices of ecological disturbance derivable from the basic effort statistics, and any other data that are available, that can be used by the ecological model to predict the effects of fishing on the species diversity. The available effort statistics will themselves be thoroughly examined to see whether more could be made of the actual information available, eg. incorporating information on vessel power as well as the hours actually spent fishing by each vessel. Much information is available in the literature which could be utilised in the development of ecological disturbance indices, including the previous EC funded IMPACT studies[vii,viii] and a recently published meta-analysis of published studies[ix]. Several other types of data are routinely collected which could have a bearing on the development of useful disturbance indices. For example, discard monitoring schemes could provide useful information on actual levels of mortality inflicted on the fish and benthic invertebrate communities for given levels of fishing activity. All countries operate fisheries monitoring schemes. The information collected here could be very useful in correcting miss-reporting of the standard fisheries statistics, and in examining between-rectangle variation in the distributions of fishing effort within a rectangle[x].

Deliverables:

The review document produced at the workshop will be deliverable 3 of the project, completed by Month 12. Current and historical disturbance index data, resolved in both time (years) and space (ICES statistical rectangles), will be available for use in model testing as deliverables 12 and 25 in months 22 and 35.

Expected results and corresponding milestones:
A workshop to develop indices of ecological disturbance based on fishing effort statistics will be convened in Month 5 to which experts, such as gear technologists, scientists involved in discards schemes, or in monitoring benthic bycatch, and personnel involved in fisheries protection agencies would be invited. The timing of this workshop is again scheduled for early on in the life of the project, in time to influence future data collection and discussions. A working document will again be produced prior to this workshop through Email correspondence to provide the initial basis for discussion. During the workshop this document would be developed into a major review (deliverable 3 due in month 12) for publication in the scientific literature describing the actual ecological disturbance caused by fishing. The indices of ecological disturbance derived at the workshop would then be calculated from all the fishing effort data available, updated to the most recent years possible, for use in the development and testing of the ecological model produced by work package two. The effort databases will be updated twice during the course of the project, and the relevant disturbance indices calculated.

Work package number:	**4**
Start date or starting event:	**Month 6**
Completion date or event:	**Month 39**
No of the partner responsible:	**Partner 1**
No's of other partners involved:	**Partners 2, 3, 4, 5 and 6**
Person-months per partner:	**P1-37.5; P2-30; P3-14; P4-30; P5-31; P6-47.9. Total = 190.4**

Objectives: This work package will collect the necessary auxiliary data required to run and test the ecological model. Thus for Huston's Dynamic Equilibrium model, data on benthic productivity, at various size and trophic levels, will be required. Examining the effect of fishing on benthic species diversity also requires the collection of benthic invertebrate species abundance data. These data required to be resolved in both space (ICES statistical rectangles) and time (years).

Description of work: Benthic infauna and epifauna will be sampled during the groundfish surveys. At each GOV/ benthic sample station a 0.25m^2 USNEL box core (or equivalent, eg. 0.1m^2 Van Veen or Day grab) will be deployed so as to sample a total area of 0.5m^2 (two deployments for the box core, five deployments for the grabs). A 2m benthic beam trawl (developed during previous BIODIVERSITY projects) will also be deployed at each station and towed in contact with the seabed at a speed of 1-2knots for 5min, sampling an area of approximately 300-650m^2. Approximately 150 to 200 epi-benthic and benthic infaunal samples will be collected in each of the two field-work years from across the whole North Sea.

The material in the two box cores (or five grab samples) will be washed through a 250micron sieve to remove fine material on board the vessels using Gardline Autosievers. All the material retained in 250micron sieve will then be fixed in buffered formal-saline for analysis back at the respective laboratories. Onshore the samples will be passed through a series of sieves to assign the organisms within to various size classes. The fauna retained in each sieve will then be

identified, initially to the low taxonomic resolution (eg. Phylum or Family level) required by the size spectra analysis methods to estimate benthic productivity[xi,xii]. Wet weight to dry weight conversion factors[xiii,xiv] will then be used to determine the size spectra dry weight values required for productivity estimation. Temperature is an important parameter in the estimation of productivity using this method. It will be necessary to record, as a minimum, water temperature at the seabed at every station where benthic samples are collected, although full water column temperature and salinity profiles would be advantageous. For species composition and diversity analyses, the organisms retained in the larger mesh size sieves (eg. >1000:m, for compatibility with previously published studies[xiii]) will be identified to species level, and as far as possible measured and weighed. It is recognised that nearly all the sediment from samples collected in areas of the North Sea where the seabed consists mainly of sand will be retained by the 250micron sieve used on board the vessels. Analysis of such samples may necessitate some level of sub-sampling. Under these circumstances all the material retained in the 250micron sieves at sea will be brought back to the laboratory and passed through the sieve stack. It is likely that any sub-sampling required will only be necessary for material retained in the smaller mesh size sieves in the stack, eg. 250micron, and perhaps 500micron. Under these circumstances sufficient material will be sorted through so as to extract the biomass of organisms belonging to the smaller size classes required for the successful application of the size-spectra benthic productivity estimation methods. The final details regarding the precise benthic sampling and analytical methodology will be determined at the methodology workshop in month 6 and documented in the resulting manual available in month 7.

Box core sampling may not be feasible at every station, being more susceptible to constraint through poor sea conditions, and it is not possible to deploy such equipment on all vessels participating in the groundfish surveys. The use of such equipment is important, however, if the larger, deeper dwelling benthic infauna are to be sampled, and diversity and productivity estimates for the whole benthic community obtained. An alternative infauna sampling strategy would be to use Day or van Veen grabs (a decision on this would be made at the first meeting so that all partners use the same sampling equipment) deployed five times at each station to sample an equivalent area. These samples would then be treated in exactly the same way as described above, ie passed through a 250micron sieve. Where and when it was possible to use a Box Core, this would also be done, in addition to the five grab deployments. The Box Core would be deployed twice at each station and the samples passed through a 4mm sieve, since only the larger, deeper dwelling organisms would need to be retained, and treated as described above. Additional sub-sampling of the Box Core samples will be considered, for example, sub-sampling for information on benthic meiofauna and seabed habitat parameters. Any sub-sampling will be carried out on the whole sample prior to sieving.

The material retained in the 2m beam trawl will be sorted onboard ship and, as far as possible, all the benthic organisms identified, counted (or quantified in some other way with respect to colonial organisms), measured and weighed. Each epibenthic organism will also need to be assigned to a size class so as to estimate epibenthic productivity using the same size-spectra methods. Published relationships will be used to convert wet weights to dry weight, as for the infauna. For some species, these relationships may need to be determined directly. Not all the epibenthic organisms will be identifiable on board ship. These will need to be retained in buffered formal-saline for identification back in the laboratory. Likewise individual organisms that are too small to measure and weigh accurately at sea will also have to be retained for biometric recording back in the laboratory.

Deliverables:

The methodology manual produced at the workshop will constitute deliverable 1 and be available by month 7. Data exchange will be by way of ASCI CSV format files. The precise fields and file format required will be determined at the methodology workshop. It is expected that the epi-benthic data exchanges files should be ready for passing onto the scientific co-ordinator three months following each set of cruises (months 15 and 27, constituting deliverables 5 and 16). Approximately three months following receipt of these data exchange files, the scientific co-ordinator should have prepared annual reports which will include maps of epi-benthic species composition diversity, and productivity (Deliverables 7 and 18 delivered in months 18 and 30 respectively). The infauna data will take longer to fully process. However, the data required to estimate benthic infaunal productivity should be available six months following each set of cruises, and these data should be passed to the scientific co-ordinator at this point (months 18 and 30, constituting deliverables 8 and 19). Three months following receipt of these files, the scientific co-ordinator should have prepared annual reports which will include maps of benthic infauna productivity (Deliverables 10 and 21 delivered in months 21 and 33 respectively). Species level analysis of the benthic infauna samples should be completed within one year of collection and the data exchange files sent to the scientific coordinator (Deliverables 11 and 22 delivered in months 21 and 33). Annual reports providing details on spatial variation in benthic infauna species composition and diversity should be available in months 24 and 36 (Deliverables 13 and 26). The information contained in the individual annual reports will be collated in a series of final reports detailing the results of all the benthic sampling, and any additional data collected as part of this work packages (Deliverables 24, 27 and 28 delivered in months 34, 36 and 39). These final reports will be directed towards a wider audience, and it is intended that much of their content be submitted for publication in the scientific literature.

Expected results and relevant corresponding milestones:
Standardisation of sampling methodologies, taxonomic analysis and data presentation between partners will be critical. Partners 1, 4 and 6 will undertake taxonomic quality control and provide taxonomic advice on hard-to-identify species. All the partners involved in the Groundfish surveys and benthic sampling will meet for a three-day workshop in Month 6, prior to the first surveys taking place. This workshop will produce a sampling and analysis manual detailing the precise methods to be employed by all partners in the project. The purpose of this manual is to ensure harmonisation of fish and benthic sampling methodology and analysis across all the work carried out by all partners throughout the project. The project will produce maps of epibenthic and benthic infauna species diversity and productivity across the North Sea for two years, 2003 and 2004. These will be detailed in final reports available by month 39 and should form the basis of several major publications in main-stream scientific journals.

Work package number:	**5**	
Start date or starting event:	**Month 6**	
Completion date or event:	**Month 31**	
No of the partner responsible:	**Partner 4**	
No's of other partners involved:	**Partners 1, 2, 3, 5 and 6**	
Person-months per partner:	**P1-4; P2-10; P3-5; P4-4; P5-5; P6-9.**	**Total 37**

Objectives:
The objective of this work package is to collect the data required to determine species composition and diversity of the demersal fish community at sampling stations distributed over a wide geographic range covering most of the North Sea. These data will be used for testing the ecological model and setting targets for the management protocol. For example, using Huston's

model we should be able to predict fish species diversity at each station knowing benthic productivity and the level of ecological disturbance prevailing at each location.

Description of work:
Many of the project participants will be involved in the groundfish surveys where the benthic sampling and trawl sampling of demersal fish will be carried out. These surveys will be carried out in quarter three of the two fieldwork years (2003 and 2004) and will cover most of the North Sea. For the most part these individual surveys will be part of the ICES co-ordinated International Bottom Trawl Survey. Thus the fish sampling techniques are already standardised between the countries involved. Set stations are sampled each year using a Grande Overture Vertical (GOV) trawl rigged in a set manner for particular stations, towed for 30mins. Procedures for trawling and handling of the samples are laid down in the IBTS manual. As far as possible, all fish trawl sampling carried out in this project will be undertaken using the same equipment according the procedure in this manual. Fish abundance data from 200 to 300 trawl samples should be available in each of the two years. Following each survey the groundfish survey data will be collated and sent into the scientific co-ordinator. Data exchange will be in the form of two separate files in ASCI CSV format, consisting of the Trawl Chronological data and the trawl fish catch data. Standardisation of trawl sampling and analysis methods will be dealt with at the Methodology workshop in Month 6, prior to the collection of any data. Much of this will be covered by the standard ICES IBTS instructions. However, these surveys are not directed towards species diversity studies so issues, such as how to deal with the sub-sampling of exceptionally large trawl samples, will need to be addressed.

Deliverables:
The data exchange files constitute Deliverables 4 and 14 delivered in months 13 and 25. The annual reports detailing spatial variation in demersal fish species composition and diversity will be Deliverables 6 and 17 delivered in months 16 and 28. The summary report detailing spatial variation in the species composition and diversity of the demersal fish community over the two years of data collection, and relating these to previous work, will be Deliverable 20 delivered in month 31.

Expected results and relevant corresponding milestones:
It is anticipated that the cruises will take place in August and September at the end of years one and two of the project. The data exchange files should be collated and passed on to the scientific co-ordinator within two months of each cruise. The scientific co-ordinator will assemble, develop and maintain an overall database. Appropriate multi-variate analyses will be used to define communities of different species composition and standard diversity indices (Hills N1 and N2) will be applied to the data. The initial meeting of the partners involved in this work package will determine the appropriate multi-variate approaches to use. The PRIMER suite is likely to form the basis for much of the initial analysis. Three months following the receipt of the data, annual reports including maps detailing spatial variation in the groundfish community species composition and species diversity will be available and circulated to all partners. Spatial variation in the species composition and diversity of the groundfish assemblage in the two years of survey work will be documented as a “stand alone” summary report by the scientific co-ordinator. This report will relate the projects’ results to previous work and is intended to form the basis of a paper for publication in the scientific literature.

Work package number:	**6**
Start date or starting event:	**Month 11**
Completion date or event:	**Month 19**

No of the partner responsible:	**Partner 2**	
No's of other partners involved:	**Partners 1; 3; 4 and 5**	
Person-months per partner:	**P1-1; P2-16; P3-4; P4-1; P5-1.**	**Total = 23**

Objectives:
Currently the output data from the annual stock assessment and management advice process is catch based, ie TACs for each species. However, all the ecosystem models are likely to require a "ecosystem disturbance" input parameter, ie an input variable based on fishing effort. So long as the management is based on catch limitation, rather than effort limitation, any predictive ecosystem approach to management is going to require a mechanism to relate the TACs set to the effort required to achieve these TACs. The purpose of this work package is therefore to examine the fisheries catch and effort statistics to determine the relationships between them in order to develop such a mechanism.

Description of work:
Most countries record standard fisheries data, ie the effort expended by a fishing vessels and the catch landed. This work package would examine these data to establish the relationship between these two parameters. It is recognised that the ICES stock assessment working groups already do this to a certain extent. Their approach would be reviewed and extended so as to make the results of this work package as useful as possible to these groups, the intended principal users. This review, as well as the main analyses, will be carried out over the course of a five-day workshop. We are also aware of work on this subject being done by other groups, for example a sub-group of the Scientific, Technical and Economic Committee (STECF) is currently investigating the relationship between fishing effort and mortality. We would hope to co-operate/collaborate with such groups, and would intend to invite key members, as well as other experts in this field, to this workshop.

Deliverables:
Over a period of three to four months prior to the workshop in Month 14, a working document would be developed by Email correspondence between all the project partners and other interested parties. This document will be developed to form a major review article on the subject and will constitute deliverable 9 to be presented in month 19.

Expected results and relevant corresponding milestones:
Following previous patterns, a working document will be developed through Email correspondence prior the workshop, scheduled to take place in Month 14. This document will form the initial basis for discussion at the workshop, and will be developed into a full blown scientific paper for submission to a fisheries science journal. This paper will bring up to date all we know about the relationship between catch and effort for different fishing gears in different parts of the North Sea. This document will form the basis of an algorithm designed to convert individual species TACs to estimates of the distribution of fishing effort required to achieve each TAC.

Work package number:	**7**	
Start date or starting event:	**Month 1**	
Completion date or event:	**Month 42**	
No of the partner responsible:	**Partners 1 and 2**	
No's of other partners involved:	**Partners 3, 4, 5, and 6**	
Person-months per partner:	**P1-13.5; P2-6; P3-3; P4-1; P5-1; P6-1.**	**Total = 25.5**

Objectives:
This project requires considerable co-operation between all partners. All partners are involved in data collection. Considerable exchange of information is therefore going to have to happen. The objective of this work package is to ensure that information exchange, and general management and co-ordination of the scientific work, is made as efficient and as effective as possible.

Description of work*:*
In addition to the project co-ordinator responsible for the general administration of the project, it is our intention that one partner should act as the overall scientific co-ordinator. The role of the scientific co-ordinator will be to oversee the entire scientific programme, acting as a central point through which data exchange will take place, thereby ensuring compatibility of data formats between all partners. The scientific co-ordinator will also ensure that work is done at the correct time, bringing all the information together in a timely fashion so as to ensure that deliverable are produced by the required dates. The scientific co-ordinator will largely be responsible for compiling all the necessary information and actually producing the actual report product, thereby ensuring a consistent reporting format. Managing the scientific work in this way should facilitate the flow of data from the project partners and the return of results and compiled data sets back out to all participants.

Deliverables:
An initial project management meeting is planned for month 1. Thereafter, project management meetings, involving all partners, will be a feature of all the workshops planned over the course of the project. Currently six workshops are planned, in months 4,5,6,14,26 and 39. The first three take place shortly after the initial dedicated management meeting, however, the remainder occur at between 7 and 12 month intervals, and this is thought to be sufficiently frequent. One or two additional meetings may be required to resolve specific issues, and may or may not involve all partners. These management meetings will be "minuted" so that all partners have a record of the proceedings, conclusions and decisions reached. These documents are not listed in the table of deliverable, but would be available on request from the EC or any other authorised party.

Expected results and relevant corresponding milestones
The purpose of this work package is to ensure that the scientific work is carried out, and generally co-ordinated so that it is kept on schedule. In this way all the deliverables, particularly reports required by the commission or needed by project participants, should be delivered on time.

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3. ROLE OF PARTICIPANTS

Partner 1: (UWS) University of Wales Swansea, Singleton Park, Swansea, SA2 8PP, UK. Team Leader: Dr. J. Lancaster Ruth Callaway (nee Zühlke)

- General coordination of project
- Responsibility for over-seeing WPs 3 and 4; joint responsibility for WP 7
- Attend ecological theory workshop (WP2)
- Organise and attend ecological disturbance workshop, contribute to working document and report (WP3, DL 3)
- Update International effort database (WP3, DLs 12 & 25)
- Develop working document to form the basis of sampling/analysis workshop (WP4)
- Organise and attend sampling/analysis workshop, finalise report/methods manual (WP4, DL 1)

- Participate in groundfish surveys (GFSs) to sample epi-benthos and benthic infauna (WP4) and collect fish abundance data (WP5)
- Epibenthos species abundance and size-spectra productivity data exchange files 3-6mths after GFSs (WP4, DLs 5 & 16)
- Benthic infauna size-spectra productivity data exchange files 6-9mths after GFSs (WP4, DLs 8 & 19)
- Benthic infauna species abundance data exchange files 9-12mths after GFSs (WP4, DLs 11 & 22)
- Groundfish species abundance data exchange files 2-3mths after GFSs (WP5, DLs 4 & 14)
- Attend catch/effort workshop, contribute to report/review (WP6, DL 9)
- Attend management protocol workshops (WP1)
- Coordination of project: ensuring workshops are convened on time, project management meetings take place as indicated in timetable, deliverables are delivered as required, and collating project interim and final reports when required by EC (WP7)
- Along with Dr Demestre of RESPONSE project, coordination of informal cluster "INTERACT"
- The funded personnel on the project:
  Coordination: 1 Postdoctoral academic for 9.5 months, 1 Secretary for 4 months
  Research activities: 1 Postdoctoral scientist for 37.5 months, 1 graduate scientist for 8 months

Partner 2: (FRSMLA) Fisheries Research Services, Marine Laboratory, PO Box 101, Victoria Road, Aberdeen, AB9 11DB, UK.
Team Leader: Dr. Simon Greenstreet
Michael Robertson, Helen Fraser, Gayle Holland, Post-Doctoral Scientist

- Scientific coordination of project
- Responsibility for over-seeing WPs 1, 2 and 6; joint responsibility for WP 7
- Develop working document to form the basis of ecological theory workshop (WP2)
- Organise and attend ecological theory workshop, and finalise report/review (WP2, DL 2)
- Develop working document to form the basis of ecological disturbance workshop (WP3)
- Attend ecological disturbance workshop, and finalise report/review (WP3, DL 3)
- Update International effort database (WP3, DLs 12 & 25)
- Analysis of effort database to provide indices of ecological disturbance (WP3, DLs 12 & 25)
- Develop working document to form the basis of sampling/analysis workshop (WP4)
- Attend sampling/analysis workshop, finalise report/methods manual (WP4, DL 1)
- Participate in groundfish surveys (GFSs) to sample epi-benthos and benthic infauna (WP4) and collect fish abundance data (WP5)
- Epibenthos species abundance and size-spectra productivity data exchange files 3-6mths after GFSs (WP4, DLs 5 & 16)
- Annual reports on Epibenthos species composition, species diversity and productivity (WP4, DLs 7 & 18)
- Final report on Epibenthos species composition, species diversity and productivity (WP4, DL 24)
- Benthic infauna size-spectra productivity data exchange files 6-9mths after GFSs (WP4, DLs 8 & 19)
- Annual reports on benthic infaunal productivity (WP4, DLs 10 & 21)

- Final report on benthic infaunal productivity (WP4, DL 27)
- Benthic infauna species abundance data exchange files 9-12mths after GFSs (WP4, DLs 11 & 22)
- Annual reports on benthic infaunal species composition and species diversity (WP4, DLs 13 & 26)
- Final report on benthic infaunal species composition and species diversity (WP4, DL 28)
- Groundfish species abundance data exchange files 2-3mths after GFSs (WP5, DLs 4 & 14)
- Annual reports on groundfish species composition and species diversity (WP5, DLs 6 & 17)
- Final report on groundfish species composition and species diversity (WP5, DL 20)
- Develop working document to form the basis of catch/effort workshop (WP6)
- Organise and attend catch/effort workshop, and finalise report/review (WP6, DL 9)
- Testing of hypotheses derived from ecological theory (WP2, DLs 15 & 29)
- Develop working document to form the basis of management protocol workshops (WP1)
- Organise and attend management protocol workshops, produce preliminary and final reports (WP1, DLs 23 & 30)
- Attend project management meetings associated with all workshop (or when required), prepare material for interim and final reports as requested by coordinator, ensure that data exchange occurs in a timely fashion (WP7)
- Setting up and maintenance of project web-site

Partner 3: (RIVO) The Netherlands Institute for Fisheries research, Ijmuiden, The Netherlands.
Team Leader: Dr J.A. Craeymeersch
Dr. Henk Heessen, Mrs Ingeborg de Boois, Research technician

- Attend ecological theory workshop, contribute to working document and report (WP2, DL 2)
- Attend ecological disturbance workshop, contribute to working document and report (WP3, DL 3)
- Update International effort database (WP3, DLs 12 & 25)
- Attend sampling/analysis workshop, contribute to working document/methods manual (WP4, DL 1)
- Participate in groundfish surveys (GFSs) to sample epi-benthos and benthic infauna (WP4) and collect fish abundance data (WP5)
- Epibenthos species abundance and size-spectra productivity data exchange files 3-6mths after GFSs (WP4, DLs 5 & 16))
- Benthic infauna size-spectra productivity data exchange files 6-9mths after GFSs (WP4, DLs 8 & 19)
- Benthic infauna species abundance data exchange files 9-12mths after GFSs (WP4, DLs 11 & 22)
- Groundfish species abundance data exchange files 2-3mths after GFSs (WP5, DLs 4 & 14)
- Attend catch/effort workshop, contribute to report/review (WP6, DL 9)
- Attend management protocol workshops, contribute to working document and reports (WP1, DLs 23 & 30)
- Attend project management meetings associated with all workshop (or when required), prepare material for interim and final reports as requested by coordinator, ensure that data exchange occurs in a timely fashion (WP7)

Partner 4: (SNG) Forschungsinstitut Senckenberg, Abt. Fur Meeresforschung, Schleusenstr. 39a,

D-26382 Wilhelmshaven, Germany.
Team Leader: Dr. Ingrid Kröncke,
Sub-Contractor (ISH) Federal Research Center for Fisheries, Institute for Sea Fisheries, (Bundesforschungsanstalt für Fischerei (BFA), Institut für Seefischerei (ISH), Palmaille 9, D-22767 Hamburg, Germany.
Dr. Siegfried Ehrich

- Responsibility for over-seeing WP 5
- Attend ecological theory workshop, contribute to working document and report (WP2, DL 2)
- Attend ecological disturbance workshop, contribute to working document and report (WP3, DL 3)
- Update International effort database (WP3, DLs 12 & 25)
- Attend sampling/analysis workshop, contribute to working document/methods manual (WP4, DL 1)
- Participate in groundfish surveys (GFSs) to sample epi-benthos and benthic infauna (WP4) and collect fish abundance data (WP5)
- Epibenthos species abundance and size-spectra productivity data exchange files 3-6mths after GFSs (WP4, DLs 5 & 16))
- Benthic infauna size-spectra productivity data exchange files 6-9mths after GFSs (WP4, DLs 8 & 19)
- Benthic infauna species abundance data exchange files 9-12mths after GFSs (WP4, DLs 11 & 22)
- Groundfish species abundance data exchange files 2-3mths after GFSs (WP5, DLs 4 & 14)
- Attend catch/effort workshop, contribute to report/review (WP6, DL 9)
- Attend management protocol workshops, contribute to working document and reports (WP1, DLs 23 & 30)
- Attend project management meetings associated with all workshop (or when required), prepare material for interim and final reports as requested by coordinator, ensure that data exchange occurs in a timely fashion (WP7)
- The funded personnel on the project will be one graduate or doctoral scientist for 42 months

Partner 5: (IMR) Institute of Marine Research, Nordnesgaten 50, P.b. 1870, Nordnes N-5024, Bergen, Norway.
Team Leader: John Alvsvåg
Research Technician, Research Technician, Research Technician

- Attend ecological theory workshop (WP2)
- Attend ecological disturbance workshop, contribute to working document and report (WP3, DL 3)
- Update International effort database (WP3, DLs 12 & 25)
- Attend sampling/analysis workshop, contribute to working document/methods manual (WP4, DL 1)
- Participate in groundfish surveys (GFSs) to sample epi-benthos and benthic infauna (WP4) and collect fish abundance data (WP5)
- Epibenthos species abundance and size-spectra productivity data exchange files 3-6mths after GFSs (WP4, DLs 5 & 16))
- Benthic infauna size-spectra productivity data exchange files 6-9mths after GFSs (WP4, DLs 8 & 19)

- Benthic infauna species abundance data exchange files 9-12mths after GFSs (WP4, DLs 11 & 22)
- Groundfish species abundance data exchange files 2-3mths after GFSs (WP5, DLs 4 & 14)
- Attend catch/effort workshop, contribute to report/review (WP6, DL 9)
- Attend management protocol workshops, contribute to working document and reports (WP1, DLs 23 & 30)
- Attend project management meetings associated with all workshop (or when required), prepare material for interim and final reports as requested by coordinator, ensure that data exchange occurs in a timely fashion (WP7)

Partner 6: (GU) Ghent University, Department of Biology, Marine Biology Section, K. L. Ledeganckstraat 35, B 9000, Gent, Belgium.
Team Leader: Dr. Steven Degraer
Prof. Dr. Magda Vincx, PhD student, Research Tecnician

- Attend ecological theory workshop, contribute to working document and report (WP2, DL 2)
- Attend ecological disturbance workshop, contribute to working document and report (WP3, DL 3)
- Update International effort database (WP3, DLs 12 & 25)
- Attend sampling/analysis workshop, contribute to working document/methods manual (WP4, DL 1)
- Participate in groundfish surveys (GFSs) to sample epi-benthos and benthic infauna (WP4) and collect fish abundance data (WP5)
- Epibenthos species abundance and size-spectra productivity data exchange files 3-6mths after GFSs (WP4, DLs 5 & 16))
- Benthic infauna size-spectra productivity data exchange files 6-9mths after GFSs (WP4, DLs 8 & 19)
- Benthic infauna species abundance data exchange files 9-12mths after GFSs (WP4, DLs 11 & 22)
- Groundfish species abundance data exchange files 2-3mths after GFSs (WP5, DLs 4 & 14)
- Attend catch/effort workshop (WP6)
- Attend management protocol workshops (WP1)
- Attend project management meetings associated with all workshop (or when required), prepare material for interim and final reports as requested by coordinator, ensure that data exchange occurs in a timely fashion (WP7)
- The funded personnel on the project will be:
  1 recently graduate licentiate for 42 months
  1 technician for 22.9 months

All partners have been indicated as attending all the workshops. This will serve to broaden workshop inputs to the fullest extent. Also, project management meetings will take place at every workshop and the lead-scientist (or appropriate deputy) will be expected to attend these. However, only partners indicated as contributors to particular work packages in Table 1 are shown as contributing to the workshop working documents and reports associated with those work packages. Contributions from other partners will of course be encouraged and welcomed.

This project has been linked with four others as an “informal cluster”. Responsibility for managing the MAFCONS contribution to this cluster will reside with Partners 1 and 2. UWS

will take on the administrative tasks required, while FRSMLA will oversee the more scientific issues involved. However, it is anticipated that the boundaries between the two will be indistinct, and that this will simply be a shared responsibility.

A project website will be developed. This will primarily be the responsibility of partner 2, however, all partners will be expected to contribute to this. All documentation produced during the course of the project will be made available, in the form of "portable document files", downloadable from the website.

4. PROJECT MANAGEMENT AND COORDINATION

The project will be co-ordinated by Dr John Lancaster at the University of Wales, Swansea. The co-ordinator will be responsible for the administrative aspects of the work and be the immediate link between the consortium and the EC. This co-ordination role will include arrangement of seven management meetings scheduled in months 1, 4, 5, 6, 14, 26, and 39, of the project. The nominated lead scientist of each institute in the consortium, or an appropriate deputy, will attend these meetings. The first of these meetings is deemed as critical, when much of the detail regarding the precise running of the project will be determined, for example, data exchange formats, reporting duties and formats, etc. The computer software used by each participant will be discussed at this first meeting to ensure compatibility. Arrangements for all following management meetings and workshops will be discussed at this first management meeting. Responsibility for actually arranging these meeting and workshops will lie with the project co-ordinator and scientific co-ordinator. The project co-ordinator will also ensure that all deliverables, and other required documentation, are delivered to the EC by the specified dates.

Responsibility for overall management and co-ordination of the scientific work will rest with Dr Simon Greenstreet at the Marine Laboratory, Aberdeen (FRSMLA). Giving one partner this overall central responsibility was deemed the most effective way of ensuring steady progress towards the project's goals. Thus FRSMLA will:
co-ordinate the Email correspondence prior to each workshop;
ensure that working documents are prepared and distributed prior to each workshop;
prepare the reports documenting the conclusions reached at each workshop;
co-ordinate the exchange of data files following preliminary analysis of the data collected on the fish/benthos surveys;
collate the individual data sets collected by each participant involved in the surveys into overall databases;
distribute amalgamated databases to all participants;
produce the interim reports and maps for each year and for the two years data combined and issue these to all participants;
co-ordinate work by all partners involved in testing ecological models;
co-ordinate work by all partners involved relating fishing effort to ecological disturbance;
co-ordinate work by all partners involved relating fishing effort to catch;
co-ordinate work by all partners involved in developing and implementing the management protocol;
collate input from all partners in the production of project interim and final reports for submission to the EC.
Where these tasks concern project deliverables, the scientific co-ordinator will ensure the timely completion of the work according to the schedule stipulated in Document B.

Each participant involved in data collection for Work Packages 3, 4 and 5 will be responsible for the initial analysis of their own data, and the subsequent production of data exchange files, at the times indicated in the project timetable, in the formats agreed at the management meetings and workshops. Problems of "quality control" will be addressed at the relevant workshop in month 6. A set of sampling methodology guidelines, covering all aspects of the work carried out, will be produced at this workshop and all participants will be expected to abide by these. Participant 1 (UWS) will be responsible for overseeing quality control issues, for example ensuring the correct identification of benthic species.

Several workshops are planned to address key issues in the project. These involve:
developing and testing the ecological models underpinning the structure and composition of benthic invertebrate and demersal fish assemblages (WP2);
utilising successful ecological models within a management protocol designed to allow managers to take account of the effects on species diversity of specific management policy (WP1);
understanding the precise ecological impact of varying patterns of fishing activity (WP3), necessary for applying ecological models;
defining the relationship between patterns of fishing activity and the catch taken (WP6), necessary for implementing a proactive management protocol.
All participants will be free to attend these workshops. Participants actually contributing to these work packages will be expected to attend. In addition, selected experts in each particular field will be invited to attend so as to increase the "breadth of expertise" available. Working documents will be developed prior to each workshop (see above) by Email correspondence. All participants will be expected to be involved in this process. These documents will provide the basis for discussion at the workshops and will be developed into full-blown reviews on each particular subject. These are expected to have a strong influence on the work of the project. These workshops will, as far as possible, be worked into the programme for the "informal cluster" of projects.

Implementation of the "Informal Cluster"

INTERACT

Interaction between environment and fisheries

The implementation of an informal cluster, involving projects related to the interaction between the environment and fisheries (3 new projects plus 2 on-going projects) will increase the potential for understanding the functioning of marine ecosystems. The marine ecosystem is affected by a number of factors and it, in turn, has an impact on the environment in general. The sustainable management of fisheries can only be achieved by understanding all the effects of such fisheries on the environment.
One of the main objectives of this informal cluster will be to bring together the proposed projects, exchange information and combine the results in the form of a synthesis. The informal cluster will promote interactions between scientists rather than research activities. In order to achieve these aims the work plan of the cluster will be fully devoted to the aspects of organising co-ordination meetings between the projects involved and an open conference or workshop, to which external scientists may be invited.

The proposed timetable of the cluster consists of 3 joint meetings and two specific workshops throughout the time that the 3 new projects run. (QLRT – 2001 - 00856 MAFCONS; QLRT – 2001 - 00799 ETHOFISH and QLRT 2001 - 00787 RESPONSE).

The co-ordinator(s), or other representative of the two on-going projects (QLRT–2000–993 COST-IMPACT and QLRT–2000 – 1685 EFEP) will also be invited to attend and contribute to these meetings and workshops.

- Coordination of the informal Cluster:

Dr. Demestre, coordinator of RESPONSE project and Dr. Lancaster coordinator of MAFCONS project will co-coordinate the informal cluster. They will both be responsible for the organisation of the joint meetings and in the dissemination of the results of the informal cluster.

- Joint meetings:

The first cluster meeting has to be organised when the 3 new projects have started. MAFCONS is the last to start in January 2003, so the first cluster meeting will be held after the MAFCONS first meeting (location to be finalised). The participants of the different projects (MAFCONS, RESPONSE, ETHOFISH, COST-IMPACT, EFEP) will present the objectives of each study and the approaches taken to achieve them. The exchange of as much information as possible can facilitate synergies between specific research. The duration of this meeting will be 1-2 days.
Note: The timing and location of the subsequent meetings and workshops is only a suggestion and they will be finalised at, or soon after, the first meeting.

The second cluster meeting will be held to coincide with the 2nd meetings of RESPONSE and ETHOFISH (Sept/Oct. 2003). The cluster participants can present a progress report of their projects.

The third cluster meeting will be devoted to presenting the progress of the projects and discussing the analysis and results obtained. This will be held to coincide with the RESPONSE meeting and workshop (end of 2004/start of 2005).

- Specific workshops:

The first cluster-workshop (1-2 days) will be held close to the mid-term of the projects. RESPONSE has planned a WS for February/March 2004, so the cluster-WS could be in Barcelona. There is the possibility of holding the MAFCONS workshop at the same time, which is currently timetabled for February 2004. The participants will work on specific subjects of common interest to discuss the development of a proper network of excellence and the organisation of a website.

The second cluster-workshop will be organised at the end of MAFCONS project in March 2006. The main objective will be to discuss the achievements of the cluster and finalise the possibilities available for the dissemination of our results. The cluster will offer a greater impact value for dissemination of results, compared to that achieved by the individual projects separately, and will provide more possibilities for contact with scientific institutions, end-users, governmental organisations, policy makers and the public at large. Responsibility for the activities carried-out by the cluster are indicated in the following time table:

Activities	Cluster meeting 1 Jan. 2003	Cluster meeting 2 Month 12*	Cluster meeting 3 Month 28*	Cluster workshop 1 Month 18*	Cluster workshop 2 Month 43*	Communication
RESPONSE coordinator		X (RESPONSE)	X (RESPONSE)	X (Shared)		X
MAFCONS coordinator	X (MAFCONS)			X (Shared)	X (MAFCONS)	X

* The timings of these meetings & workshops will be finalised at the first cluster meeting

- Communication : A web site will be developed by MAFCONS and RESPONSE for dissemination of cluster achievements. Details of what to include (results from individual projects etc) will be discussed at one of the cluster meetings.
  Discussions will also be held about the possibility of circulating some written communication to interested parties outside the scientific community.

- Budget allocation

RESPONSE : The costs related to the cluster have been included in "other specific costs" on Form A7.3. The total amount of 60000 Euros is allocated for co-ordination of the cluster, to organize meetings and workshops, for travel and subsistence for cluster participants, and dissemination of the expected achievements and results through a web site. The creation of the web site will be shared between Mafcons and Response. The budget allocated to create the web site will be 2000 Euros approx. and will be found from within the 60000 Euros.

MAFCONS : The costs related to the cluster have been included in the “other specific costs ” section. The overheads for the administration of the expenses will be found from within the 60,000 Euros. The remainder of the budget is allocated for co-ordination of the cluster, to organize meetings and workshops, for travel and subsistence for cluster participants, and dissemination of the expected achievements and results through a web site. The creation of the web site will be shared between Mafcons and Response. The budget allocated to create the web site will be 2000 Euros approx. and will be found from within the 60,000 Euros.

5. EXPLOITATION AND DISSEMINATION ACTIVITIES

MAFCONS is an applied ecology research project. It will not develop products or ideas with direct economic value. The project is concerned with providing fisheries managers with a “tool” which should enable them to start to adopt a proactive ecosystem approach to fisheries management. This should be of economic benefit to all European Union member states with a stake in the North Sea fishing industry.

In the near future fisheries managers will be required to adopt an ecosystem approach to the management of fisheries. OSPAR has taken the lead in developing the ecosystem approach to management, through the application of Ecosystem Quality Objectives (EcoQOs) addressing a list of ten Ecosystem Quality Issues. Issues 5 and 6 directly concern fish and benthic communities and the time is approaching when managers will be required to manage fisheries so that targets set for benthic and fish communities are also achieved. Current management processes provide no way of doing this, other than by restricting fishing activity. Yet there is no way of determining the level of restriction required to achieve particular fish and benthos community goals. Such restrictions will have economic consequences for the fishing industry and affect local communities dependent on the fishing industry. It is important therefore, that an “informed approach” to balancing the needs of the fishing industry against the requirements for the ecosystem is taken. MAFCONS should provide the necessary tool for such an approach. MAFCONS will develop a management protocol that will allow managers to assess directly the consequences to fish and benthos species diversity of setting specific TACs, so enabling them to balance the needs of fishermen and the ecosystem. Ultimately, if successful, MAFCONS will provide a “blueprint” for future management, and the procedures, or protocols, developed during the project will become a routine part of the ICES/EC/Fisheries Ministers management process.

Sustaining a viable fishing industry is of great importance to the economies of many countries within the EC. It is important that the correct balance between the needs of the fishing industry and protection of the natural environment is maintained. It this way the fishing industry will not face needless restriction, thus safeguarding the way of life in coastal (fishing) communities on a continuing basis, whilst at the same time helping to maintain a healthy marine environment. Increasingly, natural marine resources are also contributing to local economies through activities such as so called “eco-tourism”. MAFCONS is designed to provide managers with the ability to maintain this balance. Both objectives are highlighted in the Quality of Life and Living Resources Programme Strategy (II.2). The improved understanding of the marine ecosystem that MAFCONS will provide may actually help to improve circumstances for the fishing industry. Better understanding of the interactions between demersal fish and their benthic food supply may actually lead to improved fisheries management, and help to stimulate the fishing industry.

The community ecology science carried out to date in the North Sea has tended to be descriptive, with little attention paid to defining the underlying ecological theory and testing specific hypothesis. MAFCONS should redress the balance, being theory orientated, with the emphasis on deriving and testing explicit hypotheses. Consequently, much of the work will be innovative, considerable emphasis has therefore been placed on the production of review documents covering the major developments of the science, and on fully documenting the results of the analyses carried out to test hypotheses. As far as possible, these documents and reports will be submitted as papers for publication in the refereed scientific literature where they will have the greatest influence on the future development of fisheries science. The more applied aspects of the work will be of greatest relevance from a management perspective. Close contact with ICES Working Groups and advisory committees will therefore be maintained. It is hoped that appropriate experts involved in relevant ICES Working Groups will attend the various workshops planned throughout the project, and that as far as possible, working documents can be prepared at these workshops for consideration at the relevant ICES Working Groups. Experts from outside the MAFCONS consortium will be invited to these workshops. Their attendance will serve two purposes. Their input to the project will serve to improve the work done, as well as helping to encourage interest in the project among the wider scientific community.

In addition to the disseminating the work within the scientific literature, and through working documents to ICES, a MAFCONS website will be established. It is intended that a full description of the work being planned for MAFCONS will be posted on the website. All formal documentation (deliverables) and published papers will be available for downloading from the website as Portable Document Files. The website will be regularly maintained and designed so as to appeal to a wide audience. As well as serving an important scientific purpose, it is intended that this website will serve to inform the general public of marine ecosystem issues. The inclusion of graphic material, as well as written documentation, will be an important aspect of the website’s development. Interest in the different components of marine ecosystems, is extremely variable, some components, such as fish, seabirds and marine mammals are extremely familiar to the general public. Others are less well known. The benthic invertebrate community is certainly one of the less appreciated sections of the North Sea ecosystem. The MAFCONS website should help to redress this.

6. ETHICAL ASPECTS AND SAFETY PROVISIONS

Ethical Aspects

The MAFCONS project involves research on:

Human embryos or foetus		No
Use of human embryonic or foetal tissue		No
Use of other human tissue		No
Research on persons		No
Use of non-human primates		No
Use of transgenic animals		No
Use of other animals	Yes	
Genetic modification of animals		No
Genetic modification of plants		No

Fish samples will be taken using standard trawl fishing gears and samples of benthic invertebrates will be collected using standard benthic sampling equipment. In all instances, the animals sampled will effectively be killed on board ship. This is not covered by legislation and will be carried out following national standards and procedures. No experimentation is planned for the fish and benthic organisms so sampled.

Safety Provisions

There will be no release of genetically modified organisms into the environment. Workers will not be exposed to biological agents. All national standard health and safety procedures will be adhered to, both onboard research vessels and in the laboratory. Chemical preservative agents used on board ship, and in the laboratory, will be handled following national standard procedures.