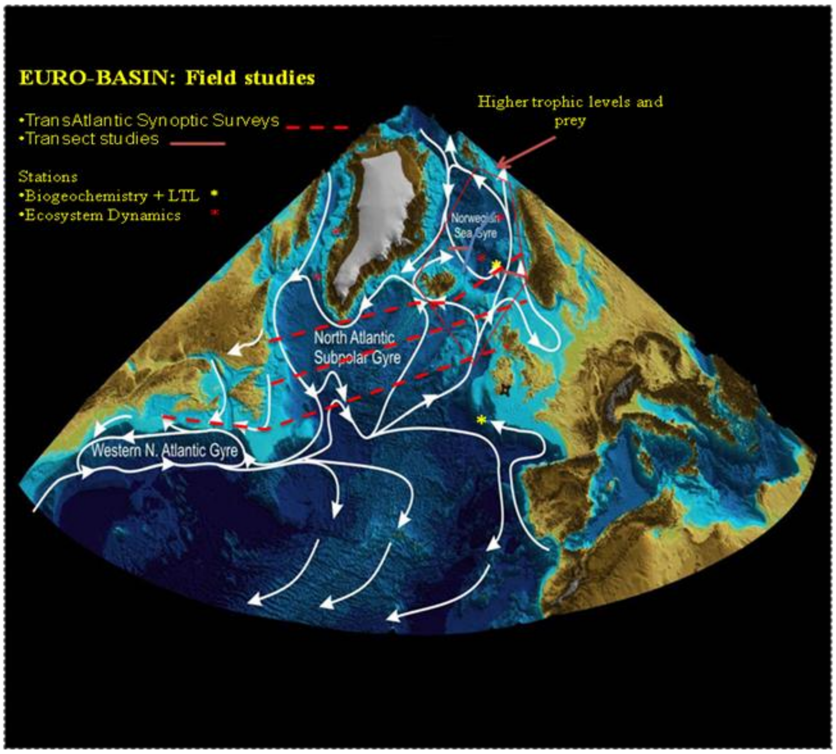
Call Identifier FP7-ENV-2010
Theme: Environment (including Climate Change)

Work programme topics addressed: ENV.2010.2.2.1-1 North Atlantic Ocean and associated shelf-seas protection and management options
Grant agreement for: Collaborative project; Large Scale Integrated Project

Annex 1 –"Description of Work"

Proposal acronym:: **EURO-BASIN**
Proposal Number: 264933

PROPOSAL FULL TITLE: European Basin-scale Analysis, Synthesis and Integration
Grant agreement number:
Date of Preparation: 06/18/10
Date of approval of Annex 1 by the commission:



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EURO-BASIN is designed to advance our understanding on the variability, potential impacts, and feedbacks of global change and anthropogenic forcing on the structure, function and dynamics of the North Atlantic and associated shelf sea ecosystems as well as the key species influencing carbon sequestering and ecosystem functioning. The ultimate goal of the programme is to further our capacity to manage these systems in a sustainable manner following the ecosystem approach. Given the scope and the international significance, EURO-BASIN is part of a multidisciplinary international effort linked with similar activities in the US and Canada. EURO-BASIN focuses on a number of key groups characterizing food web types, e.g. diatoms versus microbial loop players; key species copepods of the genus *Calanus*; pelagic fish, herring (*Clupea harengus*), mackerel (*Scomber scombrus*), blue whiting *(Micromesistius poutassou*) which represent some of the largest fish stocks on the planet; piscivorous pelagic bluefin tuna (*Thunnus thynnus*) and albacore (*Thunnus alalunga*) all of which serve to structure the ecosystem and thereby influence the flux of carbon from the euphotic zone via the biological carbon pump. In order to establish relationships between these key players, the project identifies and accesses relevant international databases and develops methods to integrate long term observations. These data will be used to perform retrospective analyses on ecosystem and key species/group dynamics, which will be augmented by new data from laboratory experiments, mesocosm studies and field programmes. These activities serve to advance modelling and predictive capacities based on an ensemble approach where modelling approaches such as size spectrum; mass balance; coupled NPZD; fisheries "end to end" models as well as ecosystem indicators are combined to develop understanding of the past, present and future dynamics of North Atlantic and shelf sea ecosystems and their living marine resources.

A3 List of Beneficiaries

List of Beneficiaries					
No.	**Beneficiary name**	**Short name**	**Country**	**Month enter**	**Month exit**
1	University of Hamburg	UHAM	Germany	1	48
2	University of Bremen	UNI-HB	Germany	1	48
3	Danmarks Tekniske Universitet	DTU-AQUA	Denmark	1	48
4	FundacionTecnalia-AZTI	Tecnalia-AZTI	Spain	1	48
5	Natural Environment Research Council	NERC	United Kingdom	1	48
6	Hafrannsoknastofnunin	MRI-HAFRO	Iceland	1	48
7	Morski Instytut Rybacki w Gdyni	MIR	Poland	1	48
8	Plymouth Marine Laboratory	PML	United Kingdom	1	48
9	University of East Anglia	UEA	United Kingdom	1	48
10	Aarhus Universitet	NERI	Denmark	1	48
11	Havforskningsinsituttet	IMR	Norway	1	48
12	Insitute francais de Recherche pour l´Èxploitation de la Mere	IFREMER	France	1	48
13	Sir Aister Hardy Foundation for Ocean Science	SAHFOS	United Kingdom	1	48
14	Institute pour Recherche le Development	IRD	France	1	48
15	Centre National de la Recherche Scientifique	CNRS	France	1	48
	Université de Bretagne Occidentale (third party to Partner 15 CNRS)	UBO	France	1	48
16	University of Strathclyde	USTRATH	United Kingdom	1	48
17	The Secretary of State for Environment, Food and Rural Affairs	CEFAS	United Kingdom	1	48
18	Høgskolen i Bodø	BUC	Norway	1	48
19	University Research	Uni Research	Norway	1	48
20	Instituto Espanol de Oceanografia	IEO	Spain	1	48
21	Collecte Localisation Satellites SA	CLS	France	1	48
22	Swansea University	SWANSEA	United Kingdom	1	48
23	Middle East Technical University	IMS-METU	Turkey	1	48
24	Universite Pierre & Marie Curie	UPMC	France	1	48

PART B

B1 Scientific quality, relevant to the topics addressed by the call

B1.1 General Objectives

The North Atlantic Ocean and its contiguous shelf seas are crucial for the ecological, economic, and societal health of both Europe and North America. For example the Atlantic Meridional Overturning Circulation (AMOC) is a focal point for the effects of climate change, and it plays a key role in the global carbon cycle. In addition both the deep ocean and shelf seas support major fisheries. An overarching property of the ecosystems of the shelf seas and the deep ocean is that they are influenced at the basin scale by a common atmospheric forcing. However there is a significant lack of information at a mechanistic level about how the forcing impacts marine populations and how impending climate changes may alter the ecology and biogeochemical cycling of the basin. Consequently there is pressing requirement to better understand the basin scale processes within the North Atlantic, to be able to predict likely future ecosystem states due to climate change, and to be able to integrate from the basin scale to the local scales the economically important basin shelf systems.

Furthermore, the need for an ecosystem approach to management of marine systems and their services has been clearly identified in all jurisdictions surrounding the North Atlantic basin (e.g. EC (IPTS-JRC 2000 Mega-challenge 2; Marine Strategy Framework Directive (Directive 2008/56); Common Fisheries Policy(Council regulation 2371/2002)), Canada (Fisheries and Oceans Canada, 2007) and the US (Burgess et al., 2005). Consequently, the European Strategy for Marine and Maritime Research (COM(2008)534) prioritises the following cross-thematic research challenges: 1) climate change and the oceans, 2) impact of human activities on coastal and marine ecosystems and their management, 3) ecosystem approach to resource management and spatial planning and 4) marine biodiversity and biotechnology. Addressing and meeting these challenges requires improved, scientific ecosystem-based approaches to conservation of natural resources, coastal zone management, fish stock assessment, management, and regulation, and maintenance of ecosystem health and sequestering of green house gases. These in turn need to be soundly based on genuine understanding of the dynamics of ocean ecosystems and their response to man's activities and natural climatic variation. EURO-BASIN is designed to address these goals and is part of a joint EC / North American research initiative to <u>improve the understanding of the variability, potential impacts, and feedbacks of global change and anthropogenic forcing on the structure, function and dynamics of the ecosystems of the North Atlantic Ocean and associated shelf seas and on their capacity to provide services.</u>

The underlying goal of EURO-BASIN is the creation of predictive understanding based on furthering the knowledge base on key species and processes which determine ecosystem dynamics and feed back to climate via carbon sequestration. To this end EURO-BASIN will use a range of approaches: exploiting <u>existing data</u> and <u>filling data gaps through targeted laboratory and field studies</u> as well as the <u>application of integrative modelling techniques.</u> The modelling approaches will range from simple to complex coupled ecosystem models (e.g. N,P,Z,D type), mass balance (e.g. ECOPATH & ECOSIM); dynamic higher trophic levels models (e.g. GADGET), fully coupled lower and higher trophic level models including fisheries and size spectrum models as well as integrated assessment approaches. These models will be used to create an ensemble of ecosystem responses and through an extension of the Integrated Ecosystem Assessment approach further our <u>understanding of the impacts of climate variability on marine ecosystems and the feedbacks to the earth system</u>. The furthering of our process understanding and development and application of this ensemble model approach will allow the projection of future states of <u>key species and ecosystems.</u> This will enable us to <u>assess ramifications of climate and fisheries activities on the population structure and dynamics of broadly distributed, biogeochemically and trophically important plankton and fish species,</u> the latter comprising some of the largest and most valuable fish stocks on earth. Based on these enhanced predictive capacities, the programme will <u>develop understanding and strategies that will improve and advance ocean management.</u> This will enable management to address the combined effects of climate change, species interactions and fisheries on major living resources of the region and thereby contribute to the realization of an ecosystem-based approach to the management of the North Atlantic basin. This approach is a major objective outlined in the revision of the CFP (COM(2009)163). As well, the underpinning of the ecosystem approach to marine management, through the implementation of the Marine Strategy Framework Directive (MSFD, Directive 2008/56) and the Maximum Sustainable Yield (MSY) concept (Green Paper; COM (2006) 360) is agreed upon by WSSD (2002). EURO-BASIN is designed to deliver substantial and necessary input to this process for the North Atlantic and its shelf sea ecosystems.

B1.1.2 Scientific and Technical objectives

Scientific Objectives: The overarching objectives of the EURO-BASIN initiative are to:

i) Understand and predict the population structure and dynamics of broadly distributed, biogeochemically and trophically important plankton and fish species of the North Atlantic and shelf seas.

ii) Assess impacts of climate variability on North Atlantic marine ecosystems and their goods and services including feedbacks to the earth system.

iii) Develop understanding and strategies that will contribute to improve and advance management of North Atlantic marine ecosystems following the ecosystem approach.

In order to achieve these objectives the programme will:

1) Resolve the influence of **climate variability and change,** for example changes in temperature, stratification, transport and acidification, on the seasonal cycle of primary productivity, trophic interactions, and fluxes of carbon to the benthos and the deep ocean. Answering questions such as:

- How will the ecosystem's response to these changes differ across the basin and among the shelf seas?
- How are the populations of phytoplankton, zooplankton, and higher trophic levels influenced by large-scale ocean circulation and what is the influence of changes in atmospheric and oceanic climate on their population dynamics?
- What are the feedbacks from changes in ecosystem structure and dynamics on climate?

2) Identify how **life history strategies and vital rates and limits** of key ecosystem and biogeochemical players contribute to observed population dynamics, community structure, and biogeography? Answering questions such as:

- How are life history strategies affected by climate variability?
- How will life history strategy influence the response of key species and populations to anthropogenic forcing and climate change?

3) Assess how the **removal of exploited species** influences marine ecosystems and sequestration of carbon? Answering questions such as:

- Under what conditions can harvesting result in substantial restructuring of shelf or basin ecosystems and initiate regime shifts/alternate stable states?
- Do such changes at higher trophic levels cascade to influence the level of autotrophic biomass?
- What is the potential impact of changes in ecosystem structure; composition and size on the sequestration of carbon?
- How is the resilience of the ecosystem to other drivers such as climate affected?

4) **Improve the science basis for ecosystem based management targets** outlined in the EC Common Fisheries Policy (CFP), the Marine Strategy Framework Directive (MSFD), the European Strategy for Marine and Maritime Research (COM(2008)534) and the Integrated Maritime Policy for the European Union(COM(2007)575). Answering such questions as:

- What are the potential economic impacts of changes in climate and resource exploitation on the North Atlantic carbon cycle?
- What is the future potential distribution and production of key fish stocks based on climate change projections and what are the implications for sustainable fisheries?
- How can the CFP ensure consistency with the MSFD and its implementation and how can it support adaptations to climate change and ensure that fisheries do not undermine the resilience of marine ecosystems?
- How can management objectives regarding ecological, economic and social sustainability be defined in a clear, prioritised manner giving guidance in the short term and ensuring the long-term sustainability and viability of fisheries?
- How can ecosystem and species indicators and targets as well as harvest control rules for be defined to provide proper guidance for implementation in management plans and decision including accountability? How should timeframes be identified for achieving targets?

Technical Objectives:

For the purposes of this section technical objectives are considered to be the development of new tools. These are as follows:

DATABASE Integration: EURO-BASIN in collaboration with initiatives in the US and Canada (see letters of support in Appendix 1) will develop protocols and methods to consolidate and integrate long-term observations from EC and international databases for modelling and prediction of the Atlantic Ocean ecosystem and related services. EURO-BASIN will build on best practices and technologies developed by European and international data management initiatives and will engage with DFO in Canada and BCO-DMO and NOAA in the U.S.A. to integrate North Atlantic and shelf seas ecosystem data at the basin-scale.

Development of an Integrative Modelling Framework: EURO-BASIN will in conjunction with advanced process understanding and rate parameterizations create a hierarchy of ecosystem and biogeochemical models having as the core the Nucleus for European Modelling of the Ocean **(**NEMO) as the ocean dynamics component for the EURO-BASIN integrative modelling. NEMO is a state-of-the-art modelling framework for oceanographic research, operational oceanography seasonal forecast and climate studies. It provides a consistent version control code, which can be run at both global and regional scales and both eddy resolving and eddy permitting resolutions. We will use NEMO as the general circulation model, with common forcing to harmonise the physical environment the various ecosystem models are coupled to facilitate the analysis and inter-comparison of different ecosystem models driven by common scenarios. In order to examine ecosystem and biogeochemical dynamics an ensemble of simulations will be performed using a range of simple and more complex ecosystem model, each with a NEMO coupler. This will allow us to build up a multi-model multi-scenario 'super-ensemble'.

B1.2 Progress beyond the State of the Art.

Research area: State of the Art.

The interaction of climatic forcing, ocean circulation and changes in greenhouse gas concentrations influence the dynamics of the thermohaline circulation of the North Atlantic, a factor that has being identified as a key influence on global climate (e.g. Sutton and Hodsen, 2005). Changes in the physical environment of the North Atlantic basin have been linked to fluctuations in the population dynamics of key mid trophic level species and exploited fish stocks in the basin itself as well as on associated shelves (e.g. Beaugrand *et al.*, 2003, 2005). Moreover, these climatic changes have been linked to the timing of the spring bloom (e.g. Reid *et al.*, 2001) thus having the potential to influence the match or mismatch of early life history stages of fish and copepods with their prey (e.g. Cushing, 1990). There are a number of key species distributed across the EURO-BASIN region (e.g. Heath *et al.*, 1999, Helaoueet and Beaugrand, 2007), which have been and will be impacted upon by these changes. For example, large - scale shifts have been observed in portions of the species ranges of key copepod species with impacts on higher trophic levels (e.g. Beaugrand, 2005). Changes in distribution and trophic interactions resulting from these shifts in the geographic range of ecosystem components have the potential to result in alterations of ecosystem resilience and productivity due to loss of critical habitat and changes in food web structure.

Adding further stress to the system, overfishing on higher trophic levels has resulted in fisheries in many parts of world switching to the harvest of lower trophic levels (Pauly *et al.*, 1998). In the North Atlantic this has a structuring effect as manifested by trophic cascades. Trophic cascades are the signature of indirect effects of changes in the abundance of individuals in one trophic level on other trophic levels (Pace *et al.* 1999). Trophic cascades can occur when the abundance of a top predator is decreased, releasing the trophic level below from predation. The released trophic level reacts by an increase in abundance, which imposes an increased predation pressure on the next lower trophic level, etc. In the case of marine systems, the outside perturbation often stems from fishing, but may also be influenced by changes in productivity caused by changes in the environment. Trophic cascades had not been thought to occur in marine systems (Steele, 1998), but recently trophic cascades have been demonstrated in several large marine systems: the Black Sea (Daskalov *et al.,* 2007), the Baltic Sea (Casini *et al*., 2008; Möllmann *et al.,* 2008) and parts of the Northwest Atlantic Frank *et al.*, 2005, 2006; Myers *et al.,* 2007). These trophic cascades have been observed to cover up to four trophic levels and reach all the way down to primary production. Despite the evidence for trophic cascades in some systems, trophic cascades appear to be absent in other systems, even though they are heavily perturbed by fishing—in particular, the North Sea (Reid *et al.,* 2000). The presence or absence of trophic cascades can be attributed to high temperature (which leads to faster growth rates and therefore less sensitivity to fishing) or to a higher diversity that stabilizes the system (Frank *et al*., 2007). Frank *et al*., 2007 stated that cold and species-poor areas such as the North Atlantic might readily succumb to structuring by top-down control and recover slowly (if ever) whereas, warmer areas with more species might oscillate between top-down and bottom-up control, depending on exploitation rates and, possibly, changing temperature regimes.

Critically for feedbacks to climate, the characteristics of trophic webs largely determines the fate of biogenic carbon, in particular its export below the euphotic zone, either by the sinking of particles or by the diel vertical movements of the organisms (Wilson *et al*., 2008). This is of fundamental importance for the climate system as the biological CO_2 pump in the ocean is one of the major sinks of atmospheric CO_2. These feedback processes, linking bottom up and top down processes, cannot be understood and described without an effective understanding of the links between lower and higher trophic levels, as well as with the biogeochemical cycles. Thus, to develop scenarios of the future, it is important to understand and capture the interactions between climate, ecosystem dynamics and fisheries production.

One of the major issues in marine science is understanding and providing predictive advice regarding how food webs are controlled or regulated by their environment and human activities. The ability to predict the emergent properties (e.g. carbon sequestration, biodiversity and production of exploited resources such as fish stocks) of the complex adaptive interactions within the food webs (St. John *et al*., 2010) has important implications for the management of marine resources, both for harvesting these resources and protection of species. The characteristics of food webs and their constituent species are ultimately the result of interactions between species with physical forcing, ocean biogeochemistry and system characteristics (e.g. Lehodey *et al.*, 2006). However, deterministic predictions of species or ecosystem responses have proven difficult (e.g. Myers, 1998). Short-term predictions of system characteristics based on the application of intermediate complexity models are however plausible (e.g. Hannah *et al.*, 2010; Allen and Fulton, 2010). These approaches are able to capture prominent system features however resolving the magnitude of the response is elusive. In part this is the result of the dynamic nature of the interactions within food web (e.g. Levin, 1998; Link, 2002; St John *et al*., 2010). In essence there is no “ecological steady state” upon which long term deterministic predictions can be based “physics and chemistry set the boundaries while biology finds the loopholes” (St. John *et al.*, 2010). Due to the complexity of interactions, ecosystem and key species dynamics need to be explored via controlled experiments, through the extensive use and extension of mathematical models and their iteration and comparative ecosystem analyses (Murawski *et al*., 2010).

Mathematical models follow a number of approaches to examine the dynamics of ecosystems and species. The limiting nutrient approach, based on Redfield stoichiometry or a modification is the core of most coupled hydrodynamic ecosystem models which are used to assess bottom up controls on ecosystems and biogeochemistry (e.g. Allen *et al.*, 2001). Simple NPZD schemes (incorporating one nutrient term, one primary producer, one consumer (zooplankton), and one detritus) employed since the late eighties (e.g. Fasham *et al*., 1990) may often capture bulk properties and the essential dynamics of events such as the North Atlantic bloom. This description can be elaborated somewhat (3N2P2Z2D models, for instance, Aumont *et al*., 2003) and may begin to capture certain key feedbacks in much of the world ocean. However, in order to describe the multidimensional behaviour of ecosystems and their interaction with many interlinked biogeochemical cycles, the degree of elaboration may have to increase substantially (Hood *et al.*, 2006).

Size spectrum approaches, based upon the distribution of biomass by size have been used to develop relationships between biomass spectrum slope, community assimilation efficiency and trophic structure (i.e. Basedow *et al.*, 2009). Relationships with biomass spectra have been found to be consistent with observed water types, current systems, and trophic players, even in closely associated locations such as shelf and off-shelf waters (Zhou *et al*., 2009). The mass balance approach, is based upon the flow of biomass between compartments, popular examples are ECOSIM an ECOPATH (e.g. Pauly *et al.*, 2000). This class of model solves a set of linear equations representing the steady state annual flux of biomass taxa in a feeding network, predicated on some assumptions or data on consumption/biomass or production/biomass ratios. ECOPATH uses sets of diet data, mainly for upper trophic levels, to compute mass-balanced fluxes of biomass between components of a food web. Finally, species interaction models, primarily the domain of fisheries scientists, include models such as the MSVPA and GADGET (Begley and Howell, 2004). The MSVPA, as an example calculates the fishing mortality at age, recruitment, stock size, suitability coefficients and predation mortality based on catch-at-age data, predator ration and predator diet information. The MSVPA allows the estimation of vital population rates and is used in the management of fishing resources. Recently spatially explicit fish life cycle models linked to hydrodynamic models (e.g. Huse, 2005) have been developed.

Each of these approaches has strengths as well as weaknesses (e.g. St. John *et al.*, 2010) one of the most important weaknesses is their inability to capture the complex and adaptive nature of interactions within the food web (e.g. Levin, 1998). Attempts to circumvent this problem require increasing model complexity by adding more compartments or processes. A fundamental problem is to find the appropriate level of complexity that will enable ecosystem models to have most skill predicting biogeochemical fluxes (Fulton *et al*., 2003). We must bear in mind that level of complexity also depends on how well we can parameterise interactions; the quest for greater detail has to be tempered by our ignorance of the ecology of the organisms in question (e.g. Allen and Fulton, 2010). Critically as outlined by Murawski *et al*., (2010) and St. John *et al*., (2010) all of the approaches outlined above require the advancement of process knowledge and model parameterizations in particular necessitating controlled experiments. These experiments need to assess an organism’s vital rates (e.g. growth, reproduction, mortality) and physiological limits (e.g. Pörtner and Farell, 2008) as well as their ability to modify these rates, which are critical for reproductive success. Furthermore, field observations are necessary in order to identify the habitats utilized by key species (e.g. Beaugrand *et al*., 2003). Their identification in conjunction with information on the effects of abiotic constraints on vital rates allows the future projection of habits using hydrodynamic modelling tools thus giving clues as to the future structure and function of marine ecosystems.

To provide a holistic impression of past ecosystem changes the aggregated approach of Integrated Ecosystem Assessments (IEAs) is being increasingly employed. IEAs are essentially multivariate statistical analyses (e.g. Principal Component Analyses, Canonical Correlation Analyses) of large data sets integrating knowledge on spatial and temporal trends of all important ecosystem components and driving forces. Examples exist for the northwest Atlantic ecosystems of Georges Bank US (Link *et al*., 2002) and the Scotian Shelf (Choi *et al*., 2005) as well as the North Sea and Baltic Seas (Möllmann *et al*., 2009; Kenny *et al*., 2009; Lindegren *et al*., in press). IEAs provide i) a possibility to visualize ecosystem changes using the “traffic light approach” used in fisheries management, ii) aggregated indicators of ecosystem change which can be used to investigate structural ecosystem changes such as “regime shifts”, “trophic cascades” and “oscillating controls” (Frank *et al*., 2005; Hunt *et al*., 2002; Litzow and Ciannelli, 2007), iii) to identify the major drivers of change (Möllmann *et al*,. 2009), and iv) to derive indications on the functional relationships between the most important ecosystem players as well as biotic and abiotic drivers.

State of the art for themes in EURO-BASIN

EURO-BASIN represents the first major multidisciplinary programme focused on creating predictive understanding of key species and the emergent ecosystem and biogeochemical features of the North Atlantic basin in order to further the abilities to understand predict and contribute to the development and implementations of the ecosystem approach to resource management. In order to keep the programme tractable EURO-BASIN is focused on pelagic processes and species with broad distributions utilizing the North Atlantic pelagic open ocean and regional seas. Activities are focused on key species or groups (as defined by their relevance for ecosystem functioning, biogeochemistry and resource exploitation) occurring or interacting with the euphotic zone. The areas with specific sampling activities to identify and quantify interactions, vital rates and habitats for the advancement of ecosystem modelling activities are shown in the cover page. Modelling activities to advance predictive capacities are focused on the North Atlantic basin proper as well as the European regional seas (i.e. Iceland; Greenland; Norwegian Sea; Barents Sea; North Sea and the western European continental shelf.

Ecosystems represent complex networks of interacting species (e.g. Link *et al*., 2002), some of which perform critical structuring functions in the system (e.g. keystone species). Furthermore some groups typify specific oceanographic regimes (i.e. diatoms; microbial loop). In order to keep the programme tractable, EURO-BASIN focuses on a number of key groups characterizing food web types e.g. diatoms versus the microbial loop players; key species copepods of the genus *Calanus* co-exist in the North Atlantic which have been linked to the dynamics of higher trophic levels; the small pelagic fish, herring (*Clupea harengus*), mackerel (*Scomber scombrus*) and blue whiting *(Micromesistius poutassou*) which are the most abundant in the system, having the ability to structure lower trophic levels; piscivorous pelagic fish bluefin tuna (*Thunnus thynnus*) and albacore (*Thunnus alalunga*) which inhabit the whole North Atlantic basin, and carry out large transatlantic migrations. Uniquely, EURO-BASIN will establish and quantify the links between these trophic levels and assess the implications of changes in the players on the flux of carbon.

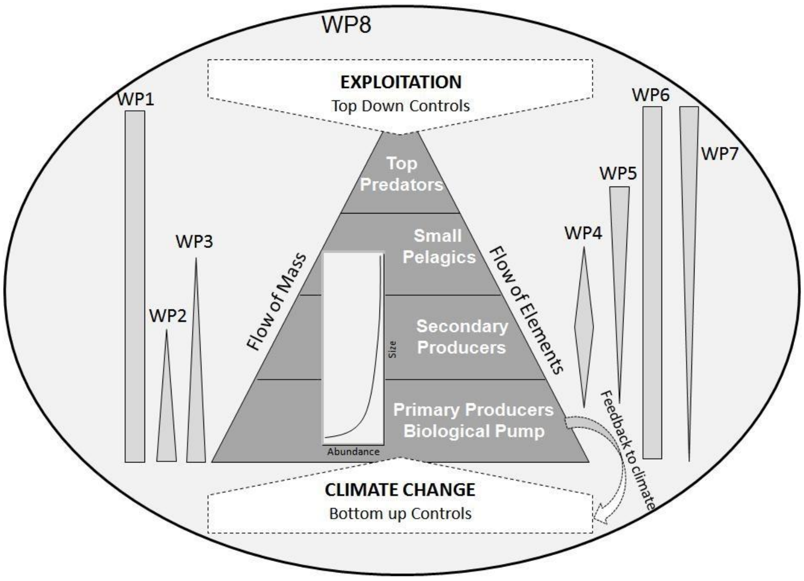


Figure 1 EURO-BASIN metrics of modelling and assessing ecosystem characteristics, the stressors influencing the trophic cascade from prmary producers to top predators as well as the domain and distribution of effort in the various WPs in EURO-BASIN.

In order to link ecosytems and key species to carbon flux EURO-BASIN follows a trophic cascade framework, quantifying the flow of mass and elements between key species and groups and a size spectrum approach both of which are used to assess the emergent properties of ecosystems, create metrics for the prediction of future states and contribute to the assessment and implementation of an ecosystem approach for the management of exploited resources. Figure 1 illustrates the various metrics of modelling and assessing ecosystem characteristics, the stressors influencing the trophic cascade from primary producers to top predators as well as the domain and distribution of effort in the various WPs in EURO-BASIN. As depicted in Figure 2 is composed of a number of research themes and technical activities. The state of the art with respect to these areas and advances in the state of the art are as follows:

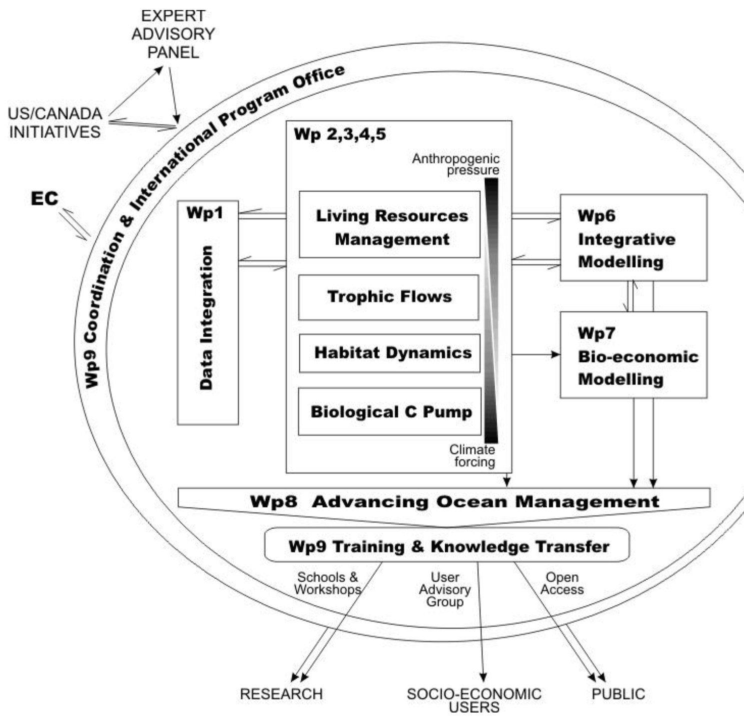


Figure 2. The structure and interactions of EURO-BASIN. For more details on strategies for International collaborations see B3.1.3

The Biological Carbon Pump: State of the art.

The biological term is a significant component of the global carbon cycle, transferring approximately 10GT C yr^{-1} derived from planktonic photosynthesis into the oceans interior, mainly in the form of sinking particles with an organic component (Boyd and Trull, 2007). It is responsible for a substantial storage of inorganic carbon dioxide in the ocean - without its existence atmospheric CO_2 levels would be 30% (Siegenthaler and Sarmiento, 1993) or 200 ppm (Parekh *et al*., 2006) higher than in a preindustrial world.

It clearly therefore represents an economically valuable service and as such has received substantial attention particularly since it is substantially larger than the annual accumulation of carbon dioxide in the atmosphere and hence small changes in its magnitude in response to climate drivers could result in an increased storage of carbon dioxide within the oceans. We currently have a good first order description from both models and ground truthed satellite observations of the amount of carbon sinking from the upper ocean due to biological processes (Laws *et al*., 2000). However our knowledge of how this sinking flux is recycled (and therefore stored) within the oceans is poor with most models using a simple parameterisation of carbon recycling based on the observed decline in flux with depth (Martin *et al.,* 1987). This is despite there being a clear qualitative understanding of potential factors, which drive efficient export of organic matter. These factors include ballasting by lithogenic and biogenic mineralphases (Klaas and Archer, 2002), aggregation mediated by the release of extracellular expolymeric particles which bind material together (Passow *et al*., 1994), grazing by mesozooplankton which aggregates and packages material into rapidly sinking aggregates (Ebersbach and Trull, 2008) and pelagic ecosystem structure, particularly the size distribution of photosynthetic organisms. These terms are all included in state of the art biogeochemical models with the logical next step being to replace these simple parameterisation of particle degradation with more complex ones, parameterized using descriptors of upper ocean ecosystem structure which are already explicitly modelled. The process of incorporating more advanced algorithms regarding particle sinking rates into models has already begun (Howard *et al*., 2006). Consequently more realistic particle flux fields, judged relative to deep sediment trap data, are now beginning to be modelled. This indicates that refining algorithms to reflect real oceanographic processes is a worthwhile task. However these new parameterisations are rather simplistic and incorporate little information regarding the role of upper ocean aggregation and ecosystem structure on sinking behaviour.

More observational and data synthesis activity is required effort is required to produce the next generation of particle flux algorithms suitable for inclusion in numerical models in this area. This is particularly the case because many factors which affect particle aggregation and sinking such as predation by higher trophic levels, lithogenic fluxes to the oceans and biomineral formation are susceptible to anthropogenically driven changes in ocean state resulting from warming, acidification, changes in wind fields (Schneider et al., 2008, Sarmiento et al., 2004, Orr et al., 2005) and fishing.

The Biological Carbon Pump: Progress beyond state of the art.

EURO-BASIN will advance the state of the art by:

1. Performing a systematic literature review to determine current existing alternative formulations to that of Martin *et al*., (1987) for particle aggregation, sinking and disintegration
2. Performing experimental work under controlled laboratory conditions to examine the relationship between biomineral concentration, organic aggregation and microzooplankton grazing.
3. Performing a mesocosm experiment in Norway in 2011 to examine under quasi-controlled field conditions the influence of phytoplankton community structure (size and composition) and grazing on aggregate formation and sinking characteristics.
4. Performing fieldwork on German and UK cruises to the Norwegian Basin (2012) and the PAP site (2013) to examine under open ocean conditions the links between aggregate formation, stability and disintegration and plankton community structure (size and composition) and grazing.
5. Constructiing new algorithms linking particle flux to upper ocean community structure (size and composition) using literature data and new information derived from EURO-BASIN field programmes
6. Implementation of these new algorithms in simple one dimensional models of plankton biogeochemistry
7. Transfer of the most environmentally realistic algorithms to WP6 for incorporation in global and shelf sea models of ocean biogeochemistry.

8. Contribute to the estimation of the current financial value of the Biological Carbon Pump and how this may change in the future.

Distribution of Key Species Habitats and Ecosystem Types: **State-of-the-art**.

The distribution of organisms and systems can be examined in a number of frameworks. For example, changes in the physical environment of the North Atlantic basin have been linked to observed changes in biogeography and population dynamics of key species and exploited fish stocks in the basin itself as well as associated shelves (e.g. Beaugrand *et al*., 2002; Pershing *et al*., 2005; Kane, 2007). These observed shifts in the biogeographic boundaries of important biogeochemical and ecosystem species and groups are an emergent system property governed by climate forcing on physiological rates, behavior and life history characteristics.

Building upon the relationship between species and the physical regime, habitats can be characterized by the distribution of biomass by size with significant advances occurring in the search for generalizations in aquatic ecology (e.g. Peters, 1983). For example, relationships with the biomass spectra have been found to be consistent with observed water types, current systems, and trophic players, even in closely associated locations such as shelf and off-shelf waters (Zhou *et al.,* 2009). Furthermore, these data on size and biomass have been used to develop relationships between biomass spectrum slope, community assimilation efficiency and trophic structure (i.e. Basedow *et al.,* 2009). Moreover, Sprules and Munawar (1986) proposed a relationship between the numerical value of the slope of the NBS-spectra and the trophic state of a pelagic ecosystem. Here, eutrophic ecosystems would present more positive slopes than oligotrophic ecosystems. However, due to both methodological difficulties and to the lack of sufficient data this hypothesis is still far from being tested (San Martin *et al*., 2006).

It is known that several size-dependent processes can alter community size structure. Size-selective predation can be a primary organizing force in some communities (e.g. Vanni, 1986) and the size structure of the grazers can influence the size structure of the phytoplankton community (e.g. Sheldon *et al*. 1986). Abiotic forcing has also the potential to modify biomass size distribution. For instance, Havens (1992) demonstrated that acidification could change the parameters of freshwater plankton size spectra and Samuelsson *et al*. (2002) show that nutrient enrichment in mesocosms resulted in higher biomass and changed plankton size structure.

The spatial and temporal scales over which sub-populations of a species can be identified and the strength of gene flow among them are of fundamental importance. Sub-populations, may possess novel characteristics that promote differences in vital rates such as growth or fecundity that, taken together, contribute to species-level, long-term adaptability and survival (Pauwels *et al.*, 2008, Dionne *et al*., 2008). An emerging challenge is to connect adaptations with the underlying genetic architecture; consequently, studies have moved from focusing on neutral genetic markers only, to the characterization of selectively important genetic polymorphisms (Vasemägi and Primmer, 2005). Furthermore recent advances indicate that the transcript process of genomes can conserve signals from ocean climate and biological interactions at a species level (Johansen *et al.*, 2009). EURO-BASIN will focus on novel approaches combining genome scans and transcriptomics to understand the response of marine organisms to global change and disentangle the ecological (phenotypic plasticity or modulating gene expression) and evolutionary response (selection for the most adaptive genotypes).

Critical for understanding the future structure of marine food webs and their services such as production of fish stocks and sequestration of carbon is the ability to project the future occurrence of habitats critical for key species and groups. This is a major challenge, which is acknowledged by the science community in EURO-BASIN. Molecular genomics can provide indications of ongoing adaptive processes at the population levels, relevant for scenario modelling concepts applied. The other approach taken is to use quantitative process models to substantiate the current ecosystem situations in the North Atlantic, well aware that this approach neglects the adaptive nature of marine species (e.g. Pörtner *et al*., 2006).

Statistical models relate present day geographical distribution of species and communities to their environmental conditions (Guisan and Zimmermann, 2000). Habitat models have successfully been used in terrestrial ecology for conservation and management issues and are currently being introduced into marine research (e.g. Loukos *et al*., 2003; Zarauz *et al*., 2008; Cheung *et al*., 2010). When properly developed these models have the potential to produce accurate predictions of the distribution, abundances and changes of key players on non-adaptive time scales for marine habitats (e.g. Planque *et al.*, 2007; Fernandes *et al*., in press). These predictive habitat models employ different approaches dependent upon type of data (Generalised additive models, Bayesian networks, ENFA, see Guisan and Zimmermann, 2000).

The second another approach employing agent-based models within which individual-based interactions and adaptive strategies are played out under prescribed physical settings is a promising way forward (e.g. Huse, 2005). Such models have been demonstrated as leading to emergent properties from complex systems, reflecting tradeoffs between survival, reproduction and competition with the potential to determine coexistence or exclusion of similar (genetic or functional) zooplankton species (e.g. Huse, 2005).

Distribution of Key Species Habitats and Ecosystem Types: Beyond the state of the art.

EURO-BASIN will advance the state of the art in the following areas by:

1. Using historic and newly collected data, EURO-BASIN will identify biogeographic shifts in key species distributions and thereby develop new understanding on the biogeographic regimes of the North Atlantic and shelf seas and their dynamics relative to climate change.
2. Using historic and newly collected data on community size spectrum EURO-BASIN will assess community assimilation efficiency, trophic structure and ecosystem state relative to hydrodynamic regimes.
3. Mapping the distribution of key biogeochemical groups in parallel with trophodynamic studies thereby resolving mechanisms by which changes in ecosystem structure can be related to food web interactions.
4. Disentangling the ecological (phenotypic plasticity or modulating gene expression) and evolutionary response (selection for the most adaptive genotypes) in a suite of key players to support validation of modelling the biogeography of the North Atlantic and shelf sea ecosystems.
5. Developing mechanistic and adaptive habitat models relating past and present day geographical distribution of species and communities to their environmental conditions.
6. Contribute to the development of future projections of ecosystem and key species dynamics based on the availability of critical habitats.

Tropic Flows: Production and Controls: State of the art.

Marine zooplankton represents the interface between the classical biogeochemistry focused on phytoplankton and the microbial loop, and the higher trophic levels. As both predator and prey they impact the population dynamics of exploited fish species and modify the flux of organic materials to the deep-ocean. Changes in climatic and anthropogenic forcing modify zooplankton traits such as vital rates, life cycles, population distributions and community structure, as well as moderating the role of zooplankton in transferring matter to other ecosystem components. The phenology and abundance of these key trophic players is a consequence of a species's ability to maintain itself in a range of habitats from optimal to suboptimal for which they employ a number of tactics including diapause in copepods and resting spores in phytoplankton. For a number of species, timing, whether the occurrence of reproductive adults or of early life history stages, is critical to population dynamics (e.g. the match mismatch hypothesis for fish stocks Cushing, 1990). Clearly, developing parameterizations that capture the spatial and temporal dynamics of zooplankton populations over their habitat range and over their entire life-cycle is critical for our ability to adequately represent zooplankton in biogeochemical models aimed at assessing the flux and sequestration of carbon as well as their role in determining the survival of their predators. Furthermore, changes in the temporal and spatial matching of zooplankton with their prey will affect the quantity and the taxonomic and stoichiometric quality and composition of the phytoplankton community.

In the past most investigations on the cycling of organic matter of arctic and temperate food web have focused on the larger zooplankters. Copepods and krill are considered key organisms in this regard with many of these species being rich in lipids, and directly supporting fish, seabird and marine mammal communities. Furthermore, some of these crustaceans (Wilson *et al*., 2008) are key drivers of the vertical export of material from the upper part of the water column by packing organic material into large fast-sinking fecal pellets. However, more recently the microbial part of the food web has been shown to dominate even in seasons or areas where mesozooplankton have been assumed to dominate the cycling of organic matter (Levinsen and Nielsen, 2002; Maar *et al*., 2002; Møller *et al*., 2006). In the transition from bloom conditions to more regenerated production, small species and juvenile mesozooplankton, together with the microbial community have a key role in nutrient and organic matter recycling in the euphotic zone. Links between the larger zooplankton and the microbial food web include that mediated by the role of microzooplankton as prey for mesozooplankton, and DOM release by grazing activity and of larger zooplankton supporting bacterial activity. It has also become apparent that mixotrophy is far more common than hitherto assumed in oceanic waters, providing another link from bacteria and other pico/nano plankton to particles large enough to support mesozooplankton production.

As a particular case, copepods of the genus *Calanus* co-exist in the North Atlantic. The large *C. hyperboreus* and *C. glacialis* are true arctic species while the smaller *C. finmarchicus* is subarctic species and *C. helgolandicus* is associated with temperate water. Within the areas of investigation, combinations of these species co-exist, each species impacting upon the system differently. This begs the simple question, why and how do the *Calanus* congenures co-exist in some areas and not others. In previous studies on invertebrates and fish, arctic populations and species have shown a smaller range in thermal plasticity than temperate species (Pörtner, 2001). The investigation of differences in vital rates, life history strategies, prey selectivity, behaviour, and biochemistry (i.e. fitness) of competing congenures will disentangle the different ranges of plasticity and tolerance limits as well providing information regarding past, present and future distributions. In order to help predict changes in population abundances under climate change, the potential of adaptation to changing environments needs to be investigated thoroughly. Critically the role of these different species in structuring the phytoplankton community and the flux of carbon is lacking.

Tropic Flows: Production and Controls: Beyond the state of the art.

EURO-BASIN will provide essential new baseline knowledge on trophic transfer at the base of the food web in specific habitats in the North Atlantic basin. Onboard and laboratory experiments will, in different regimes (see cover page) contribute new data and parameterizations that will make it possible to evaluate climate mediated changes in the food web structure and transfer in the different habitats of the North Atlantic in a warmer future. Specifically BASIN will improve the state of the art by:

1. Employing historic and new data collected within EURO-BASIN, develop new process understanding on climate-mediated changes at the base of the marine food webs of the North Atlantic and shelf seas.
2. Providing new high resolution habitat specific knowledge on the coupling and transfer of biomass between phytoplankton plankton blooms and higher trophic levels.
3. In the laboratory, investigating the plasticity of response of key organisms with respect to abiotic parameters that will change in the future and have changed in the past.
4. Contributing to the development of future projections of ecosystem and key species dynamics in relation to habitat availability via the development of model parameterizations and the provision of ground truth data.

Dynamics of living resources and their utilisation: State of the art.

Fishing has reduced the biomass of especially upper trophic level fish biomass by ca. 90% both in the entire North Atlantic basin (e.g. Steele and Schumacher, 2000) and in some of its regional seas (Jennings and Blanchard, 2004). Such changes have not only reduced the sustainability of the remaining populations and the fisheries they support (Worm *et al*., 2009), but can have important consequences for the structure and functioning of foodwebs and their roles in carbon sequestration (e.g. Steele and Schumacher, 2000).

For example, fish biomass at lower trophic levels can increase due to relaxed predation pressure, and entire foodwebs can become re-organized so that less primary production reaches higher trophic levels and instead fuels detrital-based and gelatinous consumers (Steele and Schumacher, 2000; Jackson *et al*., 2001; Daskalov *et al*., 2007). In addition, carbon sequestration is caused by carbonate production of teleost fish species due to osmoregulation, which increases with temperature and CO_2 concentration in the water (Jennings and Wilson, 2009; Wilson *et al*., 2009). Dissolving carbonates then contribute to reducing acidity in the top ocean layers (Wilson *et al.*, 2009). Given the historical changes in fish biomass and their impacts on trophic flows in marine foodwebs, it is imperative to develop and increase our understanding of the temporal-spatial variability of fish populations and their role as trophic regulators, if we are to fully understand and predict how fishing and climate change affects such flows, including carbon fluxes, in marine ecosystems.

The North Atlantic Ocean basin harbours some of the largest populations of commercially exploited stocks as well as broadly distributed highly migratory fish species. On the EasterNorth Atlantic side, herring (*Clupea harengus*), mackerel (*Scomber scombrus*) and blue whiting *(Micromesistius poutassou*) are the most highly abundant planktivorous fish species. Herring and mackerel are also widely distributed on the western North Atlantic side, while the ecological equivalent to blue whiting is Atlantic Menhaden (*Brevoria taranus*). All three species move to a varying degree on and off the shelf, providing a link between on shelf and offshore production. In contrast, bluefin tuna (*Thunnus thynnus*) and albacore (*Thunnus alalunga*) are top predator species, which inhabit the whole North Atlantic basin, and carry out large transatlantic migrations. Key drivers of the dynamics of these stocks are climate variability, fisheries and interactions between and within species. Through predation, and as outlined above, these stocks impact the dynamics of lower trophic levels as well as carbon sequestration.

Both species of tuna are under strong fishing pressure (ICCAT 2009), and have been declining and changing their spatial distributions (e.g. ICCAT, 2008; MacKenzie *et al*., 2009; Fromentin, 2009; Dufour *et al*., 2010). As tuna are top-predators, this leads to concern about their long-term viability and potential top-down cascading effects. At the same time, environmental variability leads to important bottom-up foodweb and distributional effects on larvae and juvenile fish (e.g. Borja *et al*., 2002; Arregui *et al*., 2006; Heino *et al*., 2008; Hátún *et al*., 2009; Payne *et al*., 2009). In recent years, spawning stock biomass (SSB) of Norwegian spring spawning herring doubled from 5 to over 12 Mt and that of North East Atlantic mackerel increased by 50% to 5.3 Mt. In contrast, blue whiting recruitment has failed and SSB has been halved from its historical peak in 2003-04 to 3.6 Mt in 2009. Simultaneously, pronounced spatial changes have led to an increased proportion of the herring and mackerel populations feeding in Faroese and Icelandic waters and north along the Arctic Front (ICES, 2009). Physical oceanographic features such as the location of the Arctic Front may drive parts of the summer distribution. Links between the location of the sub-Arctic gyre and the spatial distribution of spawning blue whiting have also been shown (Hátún *et al*., 2009). These changes in major parts of the planktivorous fish biomass probably have large-scale effects on zooplankton (Olesen *et al*., 2007), fish recruitment (Hallfredsson and Pedersen, 2009), predators (Bogstad *et al*., 2000; ICES, 2009) and commercial fisheries (ICES, 2009).

Considered together and from a North Atlantic basin-wide perspective, the biotic and abiotic factors affecting abundance and spatial distributions of large highly migratory predators and their prey species are poorly known and a major source of uncertainty in management (ICCAT 2008; Fromentin, 2009; ICES, 2009). Even if stock assessments are more reliable for the North Atlantic small pelagic stocks, such as herring, mackerel and blue whiting, the interacting key drivers climate variability, fisheries and interactions between and within species are not understood and consequently the impact these fish stocks have on lower trophic levels through predation, are difficult to quantify.

Dynamics of living resources and their utilisation: Beyond the state of the art.

EURO-BASIN will move beyond the state of the art by;

1. Developing and applying new modelling methods that will improve our understanding of factors impacting on stock and ecosystem dynamics.
2. Implementing modern end-to-end biogeochemical-based trophic models (SEAPODYM; Lehodey *et al*., 2008; Senina *et al*., 2008; Lehodey *et al*., 2009) using advection-diffusion-reaction (ADR) equations to simulate the spatial dynamics of fish populations in interaction with their environment.
3. Further developing and implementing new IBM based stock dynamic models that account for adaptive foraging behaviour of predators to spatial variations in prey abundance, resulting species interactions and have a closed lifecycle (Huse and Ellingsen, 2008).
4. Applying these models to understand the temporal and spatial dynamics, habitat utilisation and trophic controls on large open North Atlantic and shelf sea pelagic stocks and their prey populations.

Finally, spatial foodweb models (GADGET; Begley and Howell, 2004), spatial population models combined with a size-structured food uptake (Andrews *et al.* 2005; Speirs *et al.* 2005, 2006) and new size-spectral approaches (Andersen and Beyer, 2006; Andersen and Pedersen, 2009) will be used on a regional basis in the North Atlantic to evaluate how temporal and spatial variations in fish predation propagate down and in certain cases up the entire foodweb, and therefore reveal wider ecosystem impacts (e. g., carbon fluxes) of fishing- or climate-driven changes in fish biomass.

The information required to apply these new modelling approaches is sufficient though dispersed for exploited species such as tuna, herring, blue whiting and mackerel. The existing information needs to be compiled and aggregated, and models will be adapted for the EURO-BASIN key species. Project resources will be deployed to compile and integrate present knowledge and data at large scales in the North Atlantic and for parameterization and optimization of these models as well as projection.

EURO-BASIN will advance the state of the art by:

1. Improving the understanding of processes affecting large and regional scale spatial distributions, habitat use and migratory behaviour for highly migratory, commercially valuable, ecologically important and charismatic top predator species.
2. Making major new advances in modelling the temporal and spatial dynamics and trophic impacts of these fish populations at large and regional spatial scales.
3. Improving the understanding of the temporal and spatial dynamics, interactions and predation pressures of ecologically and commercially important small pelagic species on lower trophic levels and hence carbon sequestering.
4. Improving the scientific basis for fisheries management for North Atlantic and regional sea large piscivorous and smaller planktivorous pelagics under various scenarios of climate change/variability.

Integrative modelling: State if the Art

A major driver for ecosystem model development is the demand for quantitative tools to support ecosystem-based management initiatives (Pikitch *et al*., 2004). It has been long recognized that there are strong interactions and feedbacks among climate, upper ocean biogeochemistry, and the lower trophic level components of marine food webs and that food web structure and phytoplankton community distribution are important determinants of variability in carbon production and export from the euphotic zone.

To address these issues, modern modelling systems for open-ocean and shelf seas physics have evolved from somewhat different origins, focused on different scientific questions, and hence use different approaches. Open ocean models tend to use geopotential or isopynic vertical coordinates; whereas shelf sea models tend to use terrain following coordinates. Similarly, the focus of parameterizations differ in the two cases: the developments of sub-grid scale parameterizations in open-ocean models have tended to focus on horizontal mixing, while in shelf-seas modelling, more attention has been paid to vertical mixing, especially in tidally active shelf seas. While there is substantial cross-fertilization of ideas between the two communities, they remain distinct and it is uncommon for a model developed for the open-ocean to be applied specifically to a shelf sea region (e.g. with appropriate resolution and process representation) and vice-versa. Regardless, physical modelling in both communities has reached a degree of maturity that has seen the advent of operational oceanography, with models routinely providing oceanographic products to a wide user base. Moreover, in both cases substantial simulations on decadal timescales can now be conducted both with some confidence of the accuracy of the results and, more importantly, a sophisticated understanding of their uncertainty.

It is also well understood that the shelf-scale nutrient budgets of the continental shelf are to a large extent controlled by oceanic fluxes and that shelf sea carbon export to the deep ocean makes a significant contribution to the basin-scale carbon budget (e.g. Thomas *et al.*, 2005). Furthermore, new observations show that the biomass integrated over the winter convection layer is of same order of magnitude as that in the summer thermocline yet the role of the winter biomass on the sequestering of CO_2 in the ocean and on its CO_2 budget (CO_2 uptake, export production etc.) is as yet almost unknown (Backhaus, 2003). Similarly, the key to the successful modelling of the oceanic biological sequestration of carbon dioxide is accurately simulating the depth at which downward sinking organic matter is recycled back to carbon dioxide, as this defines the timescale over which carbon dioxide is released back to the atmosphere and the magnitude of the oceanic CO_2 storage term. Currently this is frequently parameterized as a simple reduction in flux with depth using the Martin *et al*., (1987) parameterisation which includes no mechanistic understanding. The challenge is to understand these interactions and how they feedback on each other. The only way we can begin to explore and understand such feedbacks at the basin-scale in a dynamic framework is through numerical modelling.

The desire to better capture biogeochemical processes, especially the carbon cycle, resulted in a variety of models of different complexity, from simple NPZD schemes (e.g. Fasham *et al*., 1990) to Plankton Functional Type (PFT) models e.g. ERSEM (Blackford *et al*., 2004), PLANKTOM (Le Quere *et al*., 2005). A fundamental problem therefore, is to find the appropriate level of complexity that will enable ecosystem models to have most skill in predicting biogeochemical fluxes. Recent results suggest that models based on PFT are more responsive than NPZD model to the simulated environment in which they are placed and that they produce a more extensive range emergent properties (Sinha *et al*., in press). However, the question of how real these responses are remains and further data is required to resolve this issue. Since there is no consensus on how many PFTs are needed to represent which key processes, flexibility in approach is needed in order to select appropriate levels of complexity, depending on the question, geographical area, or research agenda. This suggests the construction of model frameworks in which models of different complexity can be compared is to be encouraged.

Oceanic micronekton includes a myriad of species providing forage for larger predators. They can be roughly characterized by a size spectrum in the range of 2~20 cm dominated by crustaceans, fish, and cephalopods. Developing modelling approaches that capture the essential features of these organisms is thus a critical and challenging step for a better understanding of the ocean ecosystem. At global scale, simple ecological theory, using primary production and temperature as inputs, can be used to formulate a model for predicting potential biomass, production, size and trophic structure of consumer communities (Jennings *et al.,* 2008). A more elaborate approach that includes size-structure and energy flow is developed by Maury *et al*., (2007). Another approach is the application of coupled biophysical models, an example is the individual based model for *C. finmarchicus* with detailed submodels for bioenergetics, reproduction, phenology and behaviour produced by Huse (2005). A final original approach is a functional group type MTL model (Lehodey *et al*., in press), connecting to the phytoplankton through size spectra modelling.

Numerical models representing the key processes using mechanistic formulations allowing the simulation of future states can be useful in advancing the understanding of ecosystem responses to climatic change. The general time scale of interest in EURO-BASIN is the recent past and the next 30 years, the period of most concern of policy and ecosystem management. For simulations to be useful in a policy context it is crucial that model uncertainty is quantified and that we understand how uncertainties propagate through multiple coupled model systems. Over this time period it is a reasonable assumption that model uncertainty (parameter & structural) will dominate over forcing uncertainty (emissions or inter annual variability); Hawkins and Sutton (2009), which requires a plan for enveloping our projections. The ensemble approach takes account of model uncertainty, but distinguishing forcing uncertainty requires a set of sensible scenario choices that give a low uncertainty answer vs. the set that gives a high uncertainty answer (of some key diagnostic).

Integrative modelling: Beyond the State of the Art.

EURO-BASIN will move beyond the state-of-the art in several important respects by:

1. Including plankton ecosystem models of differing complexity (PISCES, MEDUSA) into a common physical framework for the North Atlantic basin and shelf seas (NEMO), to quantify the inherent structural uncertainty ecosystem models.
2. Constructing models forced by climate simulations, in comparison with re-analysis forced models, and hence allowing future projections in line with the simulations conducted for IPCC-AR5.
3. Gaining a better understanding of which physical processes and parameterisations are most important for inclusion in end to end ecosystem models.
4. Coupling online and offline a suite of mid trophic level models to the plankton models to understand and quantify the structural uncertainty in such models and the feedbacks between higher and lower trophic levels.
5. Improving understanding and parameterisations of key processes (export carbon flux, role winter convection, biophysical interactions) on the basin-scale carbon budget.
6. Evaluating changes in, the biological carbon pump, biogeography and fish habitat in response to climate change and fisheries management strategies.
7. Providing an enhanced ability to make error quantified projections of basin-scale biogeography and fisheries habitat.
8. Performing an assessment of the sensitivity of the planktonic ecosystem of the North Atlantic and its shelf seas to future climate changes and changes in management strategy.

Bioeconomics: State of the Art.

A strong limitation in the application of the Ecosystem Approach Management (EAM) has been the mismatch between the large scale of many of the threats and challenges on marine ecosystems (such as climate change or resource overexploitation) and the traditional smaller scale of management and conservation applications. Institutions involved in the latter regularly ignore how their decisions contribute to the big picture beyond the regional, sectoral or agency boundaries. An integrated, systematic and hierarchical approach to conservation and sustainable use is needed, to allow nations to address various geographic scopes and scales of continental marine conservation problems simultaneously in a more holistic manner

(Griffis and Kimball, 1996). The focus of EURO-BASIN on the entire North Atlantic allows such broad thinking to be applied.

The Ecosystem Approach must consider multiple external influences, and strives to balance diverse societal objectives. It requires that the connections between people and the marine ecosystem be recognized, including with the implications of human activities along with the processes, components and functions of ecosystems. Differences in the way countries that share a marine ecosystem values its services can be an obstacle to the implementation of the EAM. These obstacles need to be removed, by comparing the benefits and shortcomings of particular societal decisions, both on existing and on projections of future ecosystem goods.

Predicting the size of future fisheries resources can only be done with low confidence. Jennings *et al*. (2008) predicted future fish production from projected primary production and temperature, based on macroecological theory. The method assumes that the fundamental size-based processes that determine the use, and transfer of, energy in communities respond to changes in temperature and primary production in consistent and predictable ways, based on empirical observation of these processes in contemporary marine ecosystems ranging from the poles to the tropics. An alternative approach involves the use dynamic bio-climate envelopes that predict changes in habitat suitability, larval transport, adult migrations and population growth, to estimate potential fish production (Cheung *et al*., 2009).

Such predictions need to be incorporated into bioeconomic models, designed to determine the activity threshold for which a biological system can be effectively and efficiently utilized while protecting its sustainability. The principle behind the bioeconomic analysis conducted in EURO-BASIN is to couple the ecological and economic components of North Atlantic fish resources, to evaluate the robustness of the system to perturbations on both components, and their interactive dynamics. Global bioeconomic models of marine resources are only recently being developed. Mullon *et al*., (2009), for example, developed a global model for the fishmeal and fish oil production-consumption system, which has been used to determine the impacts of economic globalisation and climate change on the system (Merino *et al*., 2009).

One particular shortcoming of the Mullon *et al.,* (2009) modelling is the fact that the author’s grouped resources (species) into two single commodities (fishmeal and fish oil), which are market traded commodities. However, this approach is not adequate for full ecosystem modelling, because each species is expected to respond differently to climate and exploitation patterns (Lehodey *et al*., 2006; Barange and Perry, 2009). This complexity suggests that predictions of total fishery production that are based on predictions for multiple populations may also be inaccurate, especially when interactions between populations change as they redistribute and change in abundance. Likewise, estimates of fish biomass potential based on macroecological principles or bioclimate envelopes currently rely on imprecise ocean conditions and primary productivity estimates from low resolution (typically 1º) Ocean Atmosphere models.

Bioeconomics: Beyond the state of the art.

EURO-BASIN will move beyond the state of the art by:

1. Coupling high resolution ocean circulation and ecosystem models with fish estimation models.
2. Addressing the fact that strong interactions between species and size classes are expected to occur when the bioclimate envelope model predicts that parts of the spectrum are ‘over-occupied’ and weak interactions when parts of the spectrum are ‘under-occupied’.
3. Based on the activities above, ascertaining the consequences of particular climate and exploitation scenarios on the ecosystem and economic components of marine ecosystems
4. Providing a new framework in support of negotiations concerning a shared management of North Atlantic goods and services.

Advancing Ocean Management: Carbon sequestration: State of the Art.

The oceanic biological carbon pump (BCP) is a significant component of the global carbon cycle, transferring approximately 10GT C yr^{-1} derived from planktonic photosynthesis into the oceans interior, mainly in the form of sinking particles with an organic component (Boyd and Trull, 2008). It is responsible for a substantial storage of inorganic carbon dioxide in the ocean - without its existence atmospheric CO_2 levels would be 30% (Siegenthaler and Sarmiento, 1993) or 200 ppm (Parekh *et al*., 2006) higher than they are today. The BCP is substantially larger than the annual accumulation of carbon dioxide in the atmosphere and hence small changes in its magnitude in response to climate drivers could result in an increased storage of carbon dioxide within the oceans. Clearly exploitation of marine living resources influences the structure of marine ecosystems (e.g. Frank *et al*., 2005), and thus has also the potential to alter the structure of primary production with unknown influences on the resultant sequestering of carbon. Targeting some of the largest pelagic fish stocks on earth, EURO-BASIN will investigate the potential impact of fisheries on carbon sequestering.

It is likely that carbon sequestering by the North Atlantic ecosystems will not only depend on exploitation, but will alter as well with climate change. What these potential changes in regulatory service may mean in financial value is unknown. As carbon is now traded on the market and has a financial value, the value of the North Atlantic, in terms of gas and climate regulation can be calculated. Based on climate change scenarios, it can be investigated how these values may alter with climate change and compared to values of other goods and services, such as fisheries yield.

Advancing Ocean Management: Carbon sequestration: Beyond the State of the Art.

EURO-BASIN will address fisheries effects on the biological carbon pump and will thereby establish the state of the art as the question has as yet to be addressed. By employing the modelling tools developed in WP6 and using a mass balance approach and coupled hydrodynamic ecosystem models, we will:

1. Identify the sources and sinks of carbon within the North Atlantic and the volumes of carbon involved.
2. Investigate how these pathways might change with a restructuring of the ecosystem caused by climate change and fisheries.
3. Examine primary productivity in relation to particle size structure to identify the extent to which it shadows the balance of carbon and therefore, its potential use as an indicator of CO_2 and climate regulatory services.
4. Calculate the value of carbon sequestered and emitted; given the emerging nature of the existing carbon markets, and their current volatility, the full social cost of carbon will be used to calculate this value, i.e. based on the full global cost today of an incremental unit of carbon emitted now, summing the full global cost of the damage it imposes over the whole of its time in the atmosphere.
5. Assess the positive or negative contribution of fisheries to carbon sequestering, linked to analyses conducted in the following section.

Advancing Ocean Management: Ecosystem approach to management: State of the Art.

Key elements in supporting the Ecosystem Approach to Management (EA) are assessment, monitoring and research, which provide a sound scientific basis for identifying ecological and associated operational objectives, selecting indicators, and identifying reference points (ICES, 2005a). Evaluating the ecosystem status is one of the starting conditions for management within the EA and requires information on the state of the ecosystem, the extent and intensity of activities impacting it, and measuring the progress of the management towards objectives (Jennings, 2005; ICES, 2005a).

Generally two approaches have been applied in using indicators: (i) to consider a single (or suite of) metrics, and (ii) to use a large suite of indicators in multivariate analyses to summarize the aggregate picture given by multiple time-series (Hall and Mainprize, 2004). The latter integrative approach has developed relatively recently (Hall and Mainprize, 2004) and has now been applied to a range of marine systems, e.g. identifying major reorganizations in marine ecosystems, especially so-called ecosystem regime shifts characterized by infrequent and abrupt changes in ecosystem structure and function, occurring at multiple trophic levels and on large geographic scales (Bakun, 2005; Collie *et al*., 2004; Cury & Shannon, 2004; de Young *et al*., 2004; Lees *et al*., 2006).

To provide a holistic impression of past ecosystem changes the Integrated Ecosystem Assessments (IEAs) is being increasingly employed. IEAs are essentially multivariate statistical analyses of large data sets integrating knowledge on temporal trends of all important ecosystem components and driving forces in specific regions. Examples exist for the northwest Atlantic ecosystems of Georges Bank US (Link *et al*., 2002) and the Scotian Shelf (Choi *et al*., 2005) as well as the North Sea and Baltic Seas (Möllmann *et al*., 2009; Kenny *et al*. 2009; Lindegren *et al*., in press).

With respect to an integrative assessment of ecosystem status, the **Marine Strategy Framework Directive** (MSFD, Directive 2008/56) throws down a significant challenge to the European marine science community. The MSFD requires assessments of integrated status of marine waters and the integrated response of the system to the combined impact of human activity. The basis for this development is embodied in the Task and Working Groups to examine and elaborate the 11 indicators of Good Environmental Status (GES) specified in the MSFD. The revision of the **Common Fisheries Policy** (CFP) as outlined in the Green Paper in 2009 ((COM/2009)163) envisages the implementation of the ecosystem approach to marine management including fisheries within the MSFD as environmental pillar of the EUs Integrated Maritime Policy (COM(2007)575). The first five of the 11 GES descriptors require scientists and managers to adopt an integrated view of the biological structure and function of marine ecosystems:

1. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
2. Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
3. Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
4. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
5. Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

The only way to deliver such advice is through an integrated analysis of the food web system. The reality is that the science community is some way off being able to deliver equivalent advice on the status of the marine food webs and their services to meet GES descriptors 1-5 for all EC waters. Adequate models and data analyses do exist for some areas, but the approaches and data preparations vary from region to region.

A tool for this analysis is mass balance models, such as ECOPATH, typically using sets of diet data, mainly for upper trophic levels, to compute mass-balanced fluxes of biomass between components of a food web. There are two drawbacks with ECOPATH resulting from its top-down format where each predator-prey link is determined by predator consumption, not prey production, as in bottom-up models (Steele, 2009) these are as follows:

1. The microbial food web, including recycling, is ignored. The “output” from ECOPATH consists of estimates of Phytoplankton (P) and Detritus (D) consumed in the diets of higher trophic levels
2. The top-down analysis means that any “what if” changes in the middle of the food web tell you how much more (or less) P and D would be needed to produce the same fish production.

The more traditional bottom-up webs have information flowing in the same direction as energy. This is more acceptable than top-down causation, but is still one-way, as required by linearity. Bottom-up has the disadvantage that estimations of links require determinations of mortality rates that are notoriously difficult to achieve. A bottom-up solution for production is needed and is in principle straightforward (Steele, 2009). In practice, it requires linking the ECOPATH solution to a microbial web v, and simplifying the large number of top predator inputs (that become outputs) to give a more uniform food web structure.

Advancing Ocean Management: Ecosystem approach to management: Beyond the State of the Art.

To improve our understanding of the variability, potential impacts, and feedbacks of global change and anthropogenic forcing on ecosystem structure, production of exploited fish stocks and sequestration of carbon changes in ecosystem, EURO-BASIN will:

1. Conduct a comparative analysis of food web structure and functioning by deploying mass balance models to assess the role of keystone species, ratios of production by integrated functional groups, and a variety of other network metrics, e.g. benthic:pelagic production, benthic invertebrate:demersal fish production.
2. Include the microbial food web and recycling into the mass balance models allowing both one-directional bottom-up flows and top-down analyses.
3. Conduct scenario testing to determine, e.g. ecosystem consequences of changes in fishing patterns, by deploying Ecosim, but also other food web, fisheries and climate change models implemented by EURO-BASIN.

Present-day ecosystem and foodweb models are unable to represent the full biodiversity and multiple drivers influencing complex ecosystems such as the North Atlantic. To provide a holistic impression of past ecosystem changes EURO-BASIN will deploy the Integrated Ecosystem Assessments (IEAs) approach, providing:

1. A possibility to visualize ecosystem changes using the "traffic light approach" used in fisheries management.
2. Aggregated indicators of ecosystem change which can be used to investigate structural ecosystem changes such as "regime shifts", "trophic cascades" and "oscillating controls".
3. Indications on major drivers of change and indications on the functional relationships between the most important ecosystem players as well as biotic and abiotic drivers.

These integrated analyses allow the assembly of different modelling approaches (size spectrum; mass balance; coupled NPZD; time series) and will provide a holistic picture of changes in ecosystem structure, both as a test of model output for internal integrity, i.e. that various variables are related to each other in a historically observed way and secondly enabling forecasts of variables not projected in the bio-physical models by means of multivariate statistics.

Ecosystem changes of different subareas of the North Atlantic will be visualized using the "traffic light framework" and structural changes will be investigated. By doing these analyses for sub-areas of the North Atlantic and on the complete data sets (all variables), as well as separately for drivers (abiotic and anthropogenic variables) and biotic response variables, EURO-BASIN will derive indications of if and how distinct changes in pressure variables precede changes in food web structure. Furthermore, through the development of future scenarios in WP6, the future states of the ecosystem and key species will be examined.

Advancing Ocean Management: Exploitation of marine living resources: State of the Art.

The objective of the EC **Common Fisheries Policy** (CFP) is "*to provide for sustainable exploitation of living aquatic resources and of aquaculture in the context of sustainable development, taking account of the environmental, economic and social aspects in a balanced manner*" (Council regulation 2371/2002). The CFP does not set priorities for these objectives and, while direct references are made to adopting a precautionary and an ecosystem approach, it is not clear how this relates to economic and social conditions. (Green paper, 2009). However, the EC does not perceive this as an obstacle: "*the economic and social viability of fisheries can only result from restoring the productivity of fish stocks. There is, therefore, no conflict between ecological, economic and social objectives in the long term*".

The MSFD puts focus on achieving good ecological status and focusing the ecosystem approach to fisheries management on not compromising the good ecological status, does not consider the wider definition of the ecosystem approach to marine management proposed by COM (2008) 187 "The role of the CFP in implementing an ecosystem approach to marine management" to ensure goods and services from living aquatic resources in line with the Integrated Marine Policy (COM (2007) 575). Apart from the CFP and related EC directives (e.g. MSFD), fisheries management is embedded in a framework of international agreements, i.e. the UNCED Conference on Environment and Development (1992), the FAO Code of Conduct for Responsible Fisheries (1995), the UN agreement on the conservation and management of straddling stocks and highly migratory fish stocks (1995) and the WSSD Maximum Sustainable Yield approach (2002).

With respect to ecological sustainability UNCED (1992) defined the overarching objective as maintenance of the reproductive capacity of the living resources to ensure sustainable exploitation. In contrast WSSD 2002 is more ambitious and agreed on the objective to restore stocks to levels that can produce the **Maximum Sustainable Yield** (MSY) at the latest by 2015. In the interpretation by the EU, the MSY approach translates "*into the maximum annual catch which on average can be taken year after year from a fish stock without deteriorating the productivity of the fish stock"*, being besides the implementation of the ecosystem approach the second ecological pillar of the revised CFP to be implemented in 2012 (Green paper 2009). In recognition that the MSY is not necessarily constant over time, as e.g. productivity of fish stocks change, the EC commission foresees the implementation of the MSY approach through target fishing mortalities leading to stock sizes producing the MSY (COM (2006) 360). However, available stock simulations (e.g. Köster *et al*. 2009) indicate that even relative measures such as target fishing mortalities will not be suitable under changing environmental conditions.

Advancing Ocean Management: Exploitation of marine living resources: Beyond the State of the Art.

By addressing the dependence of fish stock productivity of some of the world's largest and economically most valuable fish stocks on drivers partly out of human control, such as climate change and species interactions, EURO-BASIN will:

1. Utilise coupled fisheries, higher and lower trophic models forced by regional climate scenarios to investigate whether the expectation of the EC commission that management can restore and sustain these fish stocks in the long term is realistic.
2. Elucidate potential consequences for the marine ecosystem structure and functioning of failure to achieve the objective of sustaining the stocks.
3. Estimate the gains and losses in fisheries yields and carbon sequestering including economic costs by bioeconomic models.
4. By simulations evaluate different management strategies and indicators for robustness against variability in environmental drivers and deliver key knowledge to enable informed management decisions in case of conflicting ecological and economical objectives.

These activities are in line with those identified in the EC Commission working doc. "Reflections on further reform of the CFP" (2008), which identified significant knowledge gaps in relation to the responses of marine living resources and ecosystems to climate change, including critical thresholds and points of no return. Independent which of the definitions of the ecosystem approach to marine management is implemented, i.e. the ecological focus addressed within the MSFD or the wider frame proposed by COM (2008)187, EURO-BASIN will contribute to both settings. The concept of defining indicators of good ecological status inclusive limit values under global change will be tested by applying scenario forecast of ecosystem dynamics under various climate scenarios specifically to isolate the response to management measures. This will help to develop the concept of adaptive indicators as basis for adaptive management systems and will identify related research needs.

A specific problem, however, is the implementation of the MSY approach, as the concept needs revision and it needs embedment in the ecosystem approach, e.g. the MSFD. This requires:

1. Close monitoring of resources.
2. Assessment of their productivity.
3. Development of predictive capabilities to allow for management, economic and social adaptation.

EURO-BASIN will improve these predictive capabilities based on spatially explicit coupled physical, biogeochemical, ecosystem and fisheries models and it will also allow drawing conclusions on future monitoring and assessment procedures to provide the necessary scientific advice for management.

Data Management and Integration: State of the Art.

European Framework Programmemes and other European and international programmemes call for integration of marine scientific data through several initiatives addressing for example standard vocabularies (e.g. GEBICH, WoRMS,), data infrastructures (e.g. SeaDataNet, EMODNET), multidisciplinary research (e.g. GLOBEC, IMBER, CARBOOCEAN,), and Networks of Excellence (i.e. EUR-OCEANS, MarBEF, MGE, ESONET). While scientific research and data management both increase their capacity for integration, the lack of interactions between the two undermines our overall capacity to integrate long-term observations.

National Oceanographic Data Centres (NODC) have a mandate to archive physical and chemical data from their country, and only a few such as SISMER in France and BODC in the U.K. have the capacity to handle biological data. In contrast World Data Centres (WDC) and other international permanent archives such as NMFS-COPEPOD, OBIS and ICES, integrate data from large multidisciplinary research programmemes and hence have developed the capacity to curate data about taxonomy and biogeochemistry, trophic and metabolic rates, and large data file from imaging and acoustics surveys. In spite of this capacity, a wealth of plankton and fish related data for the North Atlantic Ocean and Shelf Seas still remains in institutional repositories such as SAHFOS, CEFAS, PML, BUC, NERC_NOCS, IMR, MRI, Dalhousie, WHOI, and Rutgers.

Safeguarding data in permanent archive such as NODCs, WDCs, NM-COPEPODS, OBIS and ICES offers the potential for integration via careful standardisation of metadata; this lack of metadata often does not encourage data sharing because intellectual property rights maybe threatened or lack of confidence in the quality of meta-analyses performed on the data.

Calls for open access to data have been growing since the first Organisation for Economic Co-operation and Development (OECD) Official Statement in 1994. There are now a number of position statements and policies, particularly from funding agencies, requiring institutions to archive their datasets, but this is rarely monitored or enforced. Treating data archives as publications that bring recognition of scientific work is now an important incentive strategy (Editor, Nature biotechnology 2009, 27, 579). Digital Object Identifiers (DOI) are now being used to identify published datasets, so that they can be cited directly and unambiguously, instead of indirectly via a parent journal publication. DOIs can be aggregated by web services to calculate per-datasets citation metrics and credit dataset authors for their contributions (Bollen et al. PLoS ONE 2009, 4, e-6022).

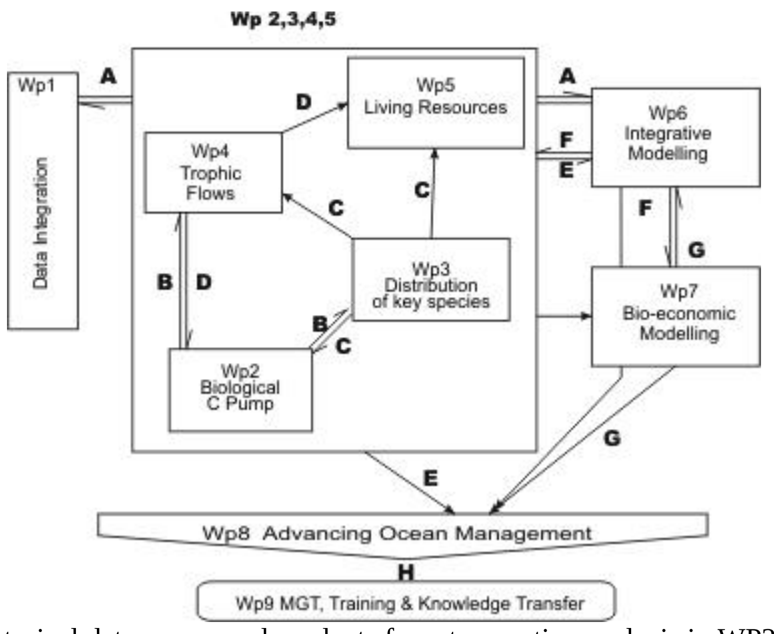
Data Management and Integration: Beyond the state of the art.

EURO-BASIN proposes advanced statistical and modelling approaches that require a broad scope of data including hydrography, nutrients, biogeochemical inventories and fluxes, trophic interaction and metabolic rates, and abundance and biomass of fish and plankton from pelagic trawls, plankton nets, plankton recorders (e.g. CPR and VPR) and acoustic sounders. The consolidation of these data at basin-scale requires improving the state of the art with simple but effective methods.

EURO-BASIN will move beyond the state of the art by:

1. Strengthening interactions between data managers and science partners and thereby contribute to the consolidation of datsets and utilization of datasets,
2. Undertaking Data Archaeology tasks, including “targeted data rescue” and “consolidation of historical data” adding value to existing data by re-analysing samples and digitising data of importance for WP2-5
3. Engaging with DFO in Canada and BCO-DMO and NOAA in the U.S.A. to integrate North Atlantic and Self Seas ecosystem data at the basin-scale thereby contribute to the consolidation of datsets (see letters of support).
4. Publishing consolidated datasets at PANGAEA® and in the online journal Earth Systems Science Data (ESSD) and thereby contribute to knowledge dissemination and scientific outputs.

EURO-BASIN PERT Chart Letters indicate the links between WPs as defined below:



A. WP1 provides historical data rescue and products for retrospective analysis in WP2-WP5 and modelling WP6; in return WP1 archives all observational data and modelling output.
B. WP2 will provide retrospective analysis (input from WP1) and generate new observations (see Section ‘B2.4 Resources to be committed’ for EURO-BASIN dedicated field campaigns) on lower trophic

levels ecosystem structure for habitat mapping (input to WP3) and constraining physiological vital rates and improved particle flux modelling (collaboration with WP4 and 6)

C. WP3 will provide retrospective analysis (input from WP1) and develop geographic habitat maps within which vital rates will be better constrained (WP4). WP3 will also provide prey fields for those key habitats to feed into WP5 and for basin-scale modelling in WP6.
D. WP4 will constrain key trophic flows (in collaboration with WP2) within the key habitats identified (WP3). WP4 will provide prey fields vital rates to WP5 and enhanced modelling parameterisation for WP6.
E. WP5 will use prey fields input, in terms of biogeography (WP3) and physiology (WP2 & 4), as well as retrospective analysis (WP2-5) and assess the dynamics of exploitable living resources under climate and anthropogenic pressure. WP2-5 provide ecosystem and key species indicators to WP6,7 & 8;
F. WP6 will simulate changes in ocean carbon storage, habitat evolution and dynamics exploitable resources under impact of climate and anthropogenic pressure, to test the effect of fisheries management strategies on biogeochemical cycling and the biological carbon pump (WP2-5).
G. WP7 will estimate the economic cost of sub-optimal basin-scale North Atlantic fisheries management and develop a bio-economic model of fish commodities linking supply (ecosystem) and demand (exploitation). WP7 feeds input to WP8 and receives simulation output from WP 6 and validation data from WPs 1-5.
H. WP8 Advancing Ocean Management integrates observational and retrospective analysis (WP2-5) and biogeochemical and ecosystem indices (WP6) to assess the basin-scale applicability of EC management measures and directives (e.g. Common Fisheries Policy, Marine Strategy Framework Directive) as well as provide scientific recommendations.

1.3 S/T Methodology and Associated Work Plan *(maximum size: 1 page).*

The project follows a logical structure; the first WP serves as a source of data for retrospective analyses performed in subsequent WPs. The next four WPs proceed from biogeochemistry to upper trophic levels, each perform retrospective analyses, acquire new data to further process understanding, developing process indicators for use in WP7&8, advanced process model parameterization for transfer and implementation in WP6 integrative modelling. The modelling tools in WP6 are then used to perform simulations, which are subsequently utilized in WP7 for bio economic modelling. The final scientific WP8, focuses on furthering Ocean Management. WP9 serves to coordinate activities both within the programme as well as liaison with International partners.

WP1. The primary objective is to <u>develop methods to consolidate and assess datasets as well as to integrate long-term observations from European and international databases</u> and use these methods to assemble historical data, new field observations and experimental results into comprehensive datasets.

WP2. Activities involve the performance of field and mesocosm studies examining how environmental conditions including plankton community structure (size and composition) and grazing drive aggregate formation, stability and sinking rate. These will be combined with literature data to generate new particle flux algorithms, which will be tested in 1Dmodels of plankton ecology and particle flux within the WP and then transferred to WP6 for advancement of the modelling tools.

WP3. This WP resolves the oceanographic habitats utilized by key biogeochemical and ecosystem species characterizing community size structure and habitat characteristics. This is achieved by the performance of retrospective analyses and field studies using dedicated cruise programmes provided by National agencies as well as ships of opportunity programmes.

WP4. The overall objective of this WP is to quantify, the key processes controlling the flow of carbon and energy within the plankton in the North Atlantic ecosystems. Information obtained via field and laboratory studies will be used to develop advanced parameterizations for use in WP6 and develop ecosystem and key species indicators for use in WP8.

WP5. Activities determine the role of key fish stocks on ecosystem structure and the determination of how carrying capacity and trophic controls may change with changing climate and impact on the production and role of economically and trophically important key fish stocks. The WP provides advanced model parameterizations for modelling activities in WP6 as well as simulations on the impact of fishing on ecosystems and key species by fully coupled hydrodynamic, lower and higher trophic level regional models to be used in WP7 for bioeconomic modelling and in WP8 for testing various fisheries management options under climate change.

WP6. This WP advances existing modelling tools based on process understanding obtained in WP1-5 and provides model output and indices for use in WP7 & 8. It employs a basin-scale modelling approach, simulating the response of marine ecosystems by considering four classes of experiments using coupled physical-biogeochemical-MTL models: re-analysis forced simulations, climate-scenario forced simulations, top down control perturbation experiments and a fully coupled end to end ecosystem model. The WP receives validation data and new parameterizations from earlier WP and provides simulation outputs to WP7 and 8.
WP7. The overall objective of WP6 is to “assess the impacts of Global Environmental Change (GEC), including climate change, fisheries management and market developments, on the productivity, dynamics and services of basin-wide fish commodities. The WP takes advantage of data, information and advanced process and regional models and size spectra information developed in WP1-5 and implemented in WP6.
WP8. This WP, based on information from the preceding WPs, develops understanding and approaches that will improve and advance ocean management by strengthening the ecosystem approach to resource management. The WP applies size spectrum, mass balance and ecosystem models and integrated assessment approaches to test and develop predictive capacities. Activities also assess the present recommended approaches for the implementation of an ecosystem approach to the management of marine resources (e.g. setting indicators of good ecological status within the MSFD and target indicators in harvest control rules of fisheries plans under the CFP) for their robustness against climate change allowing an assessment of the applicability of existing EC management measures and directives. Finally, the WP assesses the economic impact of climate change and resource exploitation on the North Atlantic carbon cycle.
WP9. The actions performed by WP9 serve to coordinate and manage activities within EUR-BASIN, as well as interact with international partners and reporting to the EC.

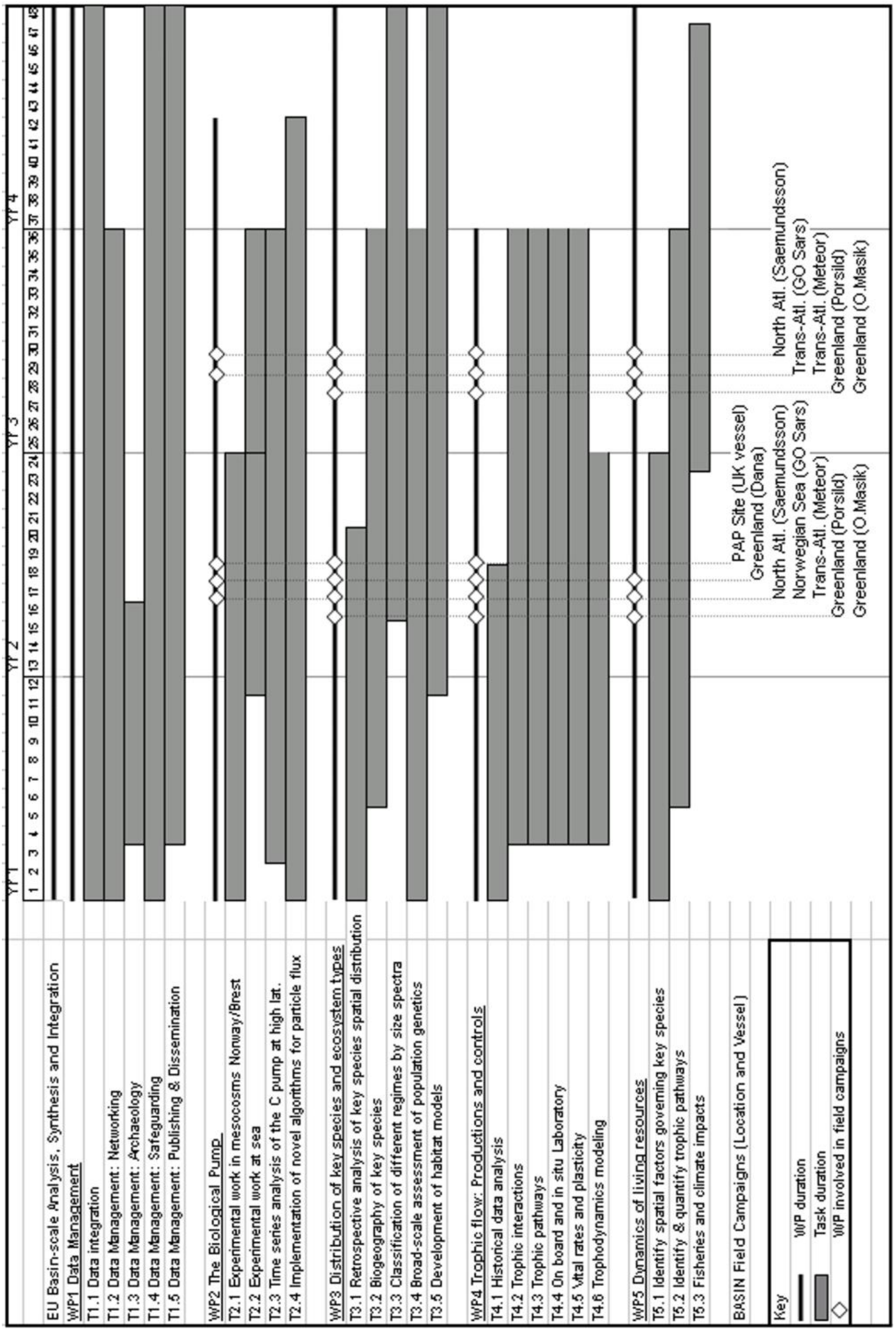
1.3.1 Risk assessment

The EURO-BASIN Consortium is comprised of a strong group of participants and institutions gathered in order to form the critical mass needed to achieve the project objectives and to ensure maximum value of the results. The consortium consists of leading research institutions, most of which have long experience with FP projects at partner and management level. The consortium has therefore the scientific and technical capability to carry out the proposed work and also the impact to disseminate the results throughout the European community, and maximise the return on investment for the Commission.

The major tasks and outcomes of the programme are not dependent on any one single partner thus minimizing the risk of failure for the consortium to deliver results. The task sharing across workpages, and overlapping but complimentary expertise of all partners involved, also insures that the consortium can compensate for one partner leaving the consortium or failing to deliver, so that the major outcomes of the programme are reached.

EURO-BASIN Gantt Chart

A (WP1-5)



EURO-BASIN Gantt Chart, continued
B (WP6-9)

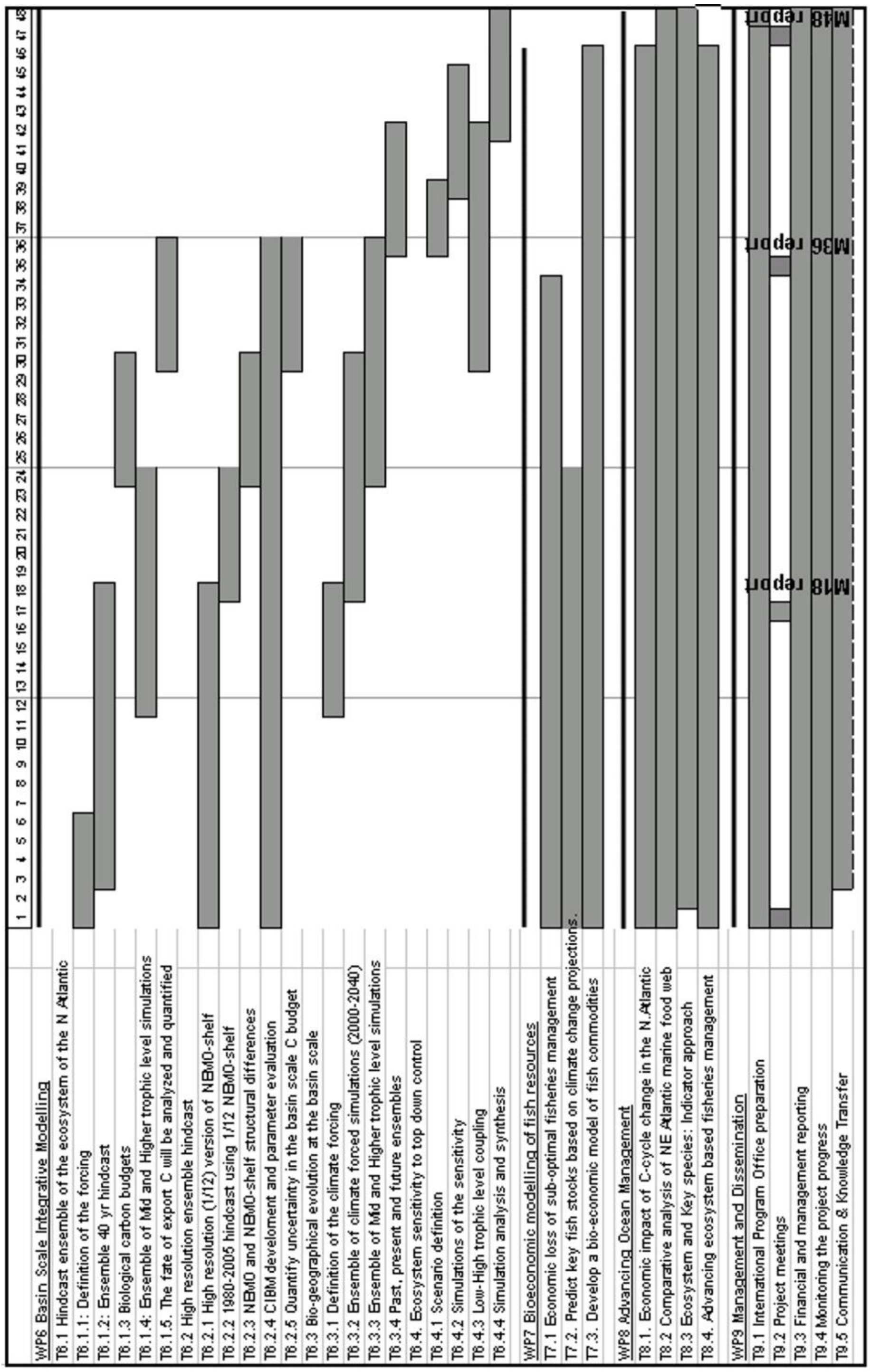


Table 1.3 a: Work package list

Work package No	Work package title	Type of activity	Lead part. No	Lead part. short name	Person-months	Start month	End month
WP 1	Data Management and Integration	RTD	2	UNI-HB	80.6	1	48
WP 2	Biological Pump	RTD	5	NERC	86	1	42
WP 3	Distribution of key species and ecosystem types	RTD	18	BUC	86.5	1	48
WP 4	Trophic flow: Production and controls	RTD	3	DTU-AQUA	142	1	36
WP 5	Dynamics of living resources and their utilisation	RTD	12	IFREMER	128.7	1	48
WP 6	Basin-scale integrative modelling	RTD	8	PML	168.5	1	48
WP 7	Bioeconomic modelling of N.Atlantic fish resources	RTD	8	PML	57.3	1	47
WP 8	Advancing ocean management	RTD	1	UHAM	50	1	48
WP 9	Coordination & Dissemination	MGT	1	UHAM	49.7	1	48
		TOTAL			**849.3**		

Table 1.3 b: Deliverables List

D9.2: Finalization and delivery of the Consortium Agreement to the Commission (M3, R, CO, Resp: UHAM)

Del. no.	Deliverable name	WP no.	Nature	Dissemination level	Delivery date
D9.1	Risk register, and process diagram and updated Gantt chart	9	R	CO	M2
D9.2	Finalization and delivery of the Consortium Agreement to the Commission	9	R	CO	M3
D9.3	Report on kick off meeting	9	R	PU	M3
D9.4	Webpage of scientific output of the programme, linked to the Web of Science	9	O	PU	M3
D9.5	Project Web-site, project timeline, deliverables calendar, including a map of objectives overlap with all other concurrent funded projects with a strong 'EU-US links' component	9	O	PU	M3
D2.1	Report on WP2 meeting at M01 Kick off meeting	2	R	PU	M6
D6.1	Initial conditions, boundary conditions and forcing functions	6	O	PU	M6
D8.1	Report specifying regions, taxa representation, data requirements and sources for linear food-web analysis .	8	R	PU	M6
D9.6	6 month, management report	9	R	PP	M6
D9.7	First draft of a Special Issue publication in the journal of `*Progress in Oceanography*` - review of state of the art knowledge and challenges in understanding North Atlantic basin ecosystems response to global climate change	9	R	PP	M6
D9.8	Tool box on optimizing research publications' impact	1,9	R	PU	M8
D1.1	Report and delivery of consolidated historical data by T1.3.1	1,2	R	PU	M16
D1.2	Report and delivery of consolidated historical data by T1.3.2	1,3	R	PU	M16
D1.3	Report and delivery of consolidated historical data by T1.3.3	1,4	R	PU	M16
D1.4	Report and delivery of rescued historical data by T1.3.4	1,4	R	PU	M16
D1.5	Report and delivery of rescued historical data by T1.3.5	1,4	R	PU	M16
D1.6	Report and delivery of rescued historical data by T1.3.6	1,5	R	PU	M16
D1.7	Report and delivery of consolidated historical data by T1.3.7	1,5	R	PU	M16
D1.8	Report and delivery of consolidated historical data by T1.3.8	1,5	R	PU	M16

D3.1	Report on the biogeographic regimes of the North Atlantic and the dynamics to climate change	3	R	PU	M16
D3.5.1	Adaptive habitat models past and present geographical distribution – preliminary model based on archived data	3	R	PU	M16
D1.9	First Data Management & Integration report, coordinated by T1.1	1	R	PU	M17
D2.2	Report describing preliminary algorithms and initial results of mesocosm experiment	2,6	R	PU	M17
D4.1	Synthesis report of abundance and copepod species composition in the GIN Seas over decadal time-scales	2	R	PU	M17
D4.2	Synthesis report and four cruise reports on spring field campaigns in the GIN Seas and Bay of Biscay	4	R	PU	M17
D6.2	CMIP5 climate forcing 2000-2040	6	O	PU	M17
D8.2	Report on the Ecosystem changes of different subareas of the North Atlantic	8	R	PU	M17
D8.3	Report on setup of analysis framework and compilation of initial input data for each region.	8	R	PU	M17
D2.3	Mesocosm experiments data delivery to WP1	2	R	PP	M18
D9.9	**18 month scientific, management and financial report**	**9**	**R**	**PP**	**M18**
D1.10	Submission of data manuscripts to ESSD by T1.1 : First EURO-BASIN special issue	1	R	PU	M22
D2.4	Report detailing cruise results and how mesocosm results affect the initial algorithms	2	R	PU	M24
D4.3	Analytical model on the processes governing the transfer of biomass and energy through the marine ecosystem	4	R	PU	M24
D7.4	Projected future changes in maximum catch potential of key fish populations	7	R	PU	M24
D7.5	A simulation model that account for trophic interaction in predicting distribution of exploited fish/shellfish populations	7	R	PU	M24
D3.5.1	Adaptive habitat models past and present geographical distribution – preliminary model based on archived data	3	R	PU	M24
D3.2.1	Report on community productivity efficiency, trophic structure ecosystem state relative to hydrographic regimes-preliminary overview	3	R	PU	M30
D2.5	Cruise campaigns data delivery to WP1	2	R	PP	M30
D4.4	Report on the estimates of vital rates and lipid composition of key zooplankton species	4	O	PU	M30
D4.5	Analytic model and synthesis report on the lipid pump	4	R	PU	M30

D6.3	Ensemble of hindcasts of basin-scale ecosystem (1/4 degree 1960-2005) and (1/12 degree 1980-2005); key variables which describe the carbon budget and are proxies for fisheries habitat	6	O	PU	M30
D8.4	Report on final tuned food web and key species analyses for each region	8	R	PU	M30
D3.3	Mapped the distribution of key biogeo-chemical groups in parallel with trophodynamic studies, related to food web interactions	3		PU	M34
D3.4	Report on molecular genomic data for validation of basin-scale scenario models on biogeography for use in projections of key trophodynamic players	3	R	PU	M34
D3.5.2	Adaptive habitat models past and present geographical distribution – refined on based on new data from EURO-BASIN	3	R	PU	M34
D5.1.1	Preliminary progress report on factors driving spatial distributions of key pelagic fish species	5	R	PU	M34
D5.2.1	Preliminary progress report on top down trophic control of key pelagic species on lower trophic levels based on existing and knowledge assembled in EURO-BASIN	5	R	PU	M34
D5.3.1	Preliminary progress report on predicting impacts of changing climate and fisheries on predator-prey spatial distributions and trophic interactions	5	R	PU	M34
D7.1	Hindcast estimation of potential and net economic benefits of N. Atlantic fisheries	7	R	PU	M34
D7.2	Scenarios for economic vs ecological optimisation in the future use of N. Atlantic fisheries	7	R	PU	M34
D7.3	Report on exploitation and management scenario workshop	7	R	PU	M34
D8.5	Report on the of pressures and processes causing structural ecosystem changes and key species dynamics in the different subareas of the North Atlantic	8	R	PU	M34
D1.11	Second Data Management & Integration report, coordinated by T1.1	1	R	PU	M35
D2.6	Report on revised algorithms based on cruise and mesocosm data	2	R	PU	M35
D4.6	Trophic dynamics model with validation supported via coupled stable isotope natural abundance sub-model	4	R	PU	M35
D6.4	Report on major controls on the ecosystem and biogeochemical cycling at the basin-scale	6	R	PU	M35
D6.5	Report on role of biophysical interactions on basin-scale C and N budgets	6	R	PU	M35

D6.6	Report on the role winter convection in controlling the basin-scale C budget	6	R	PU	M35
D6.7	Ensemble of climate forced of basin-scale ecosystem simulations (2000-2040);); key variables which describe the carbon budget and are proxies for fisheries habitat	6	R	PU	M35
D7.6	Scenario-based estimation of the consequences of climate change, resource use and economic development on the sustainability of North Atlantic fish resources	5,7,8	R	PU	M35
D7.7	A user-friendly integrated model allowing users to build their own scenarios and evaluate the consequences	7	O	PU	M35
D9.10	**36 month scientific, management and financial report**	**9**	**R**	**PP**	**M36**
D3.2.2	Assess community productivity efficiency, trophic structure ecosystem state relative to hydrographic regimes	3	R	PU	M40
D1.12	Submission of data manuscripts to ESSD by T1.1 : Second EURO-BASIN special issue	1	R	PU	M40
D8.6	Report on the future states, based on IPCC climate change scenarios from WP6, of the North Atlantic food web and key species in the different subareas of the North Atlantic	8	R	PU	M40
D8.7	Report on the evaluation of management plans for major pelagic fish stock in the open North Atlantic.	8	R	PU	M40
D2.7	COMPARION Revised algorithms and potential future implementation described	2	R	PU	M42
D2.8	Cruise campaigns data delivery to WP1	2	R	PP	M42
D5.1.2	Final progress report based on existing and knowledge assembled in EURO-BASIN on factors driving spatial distributions of key pelagic fish species	5	R	PU	M42
D5.3.2	Final report on predicting impacts of changing climate and fisheries on predator-prey spatial distributions and trophic interactions	5	R	PU	M42
D8.8	Concept for introducing the MSY approach for open North Atlantic pelagic fish stocks.	8	R	PU	M42
D3.5.3	Adaptive habitat models on past and present geographical distribution – final model	3	R	PU	M45
D1.13	Final Data Management & Integration report, coordinated by T1.1	1	R	PU	M46
D5.2.2	Final progress report on top down trophic control of key pelagic species on lower trophic levels based on existing and knowledge assembled in EURO-BASIN	5	R	PU	M46
D6.10	Peer reviewed publications	6	R	PU	M46

D6.8	Atlas of past and future changes in basin-scale biogeography/ and fisheries habitat based on model outputs	6	R	PU	M46
D6.9	Report on the sensitivity of the planktonic ecosystem of the North Atlantic to climate changes and changes in management strategy	6	R	PU	M46
D8.10	Report outlining the range of costs caused by changes in the Carbon budget of the North Atlantic, based on predicting modelling of future North Atlantic ecosystem states	8	R	PU	M46
D8.11	Report on performance of indicators of good ecological status and biological reference points used in fisheries management under climate change.	8	R	PU	M46
D8.12	Report on economic, ecological and social costs and benefits of open North Atlantic pelagic fisheries.	8	R	PU	M46
D8.13	Report on future monitoring and assessment procedures to provide necessary scientific advice for fisheries management in an ecosystem context and related research needs.	8	R	PU	M46
D8.9	Evaluate indicators identified within the MSFD or alternative indicators to characterise good ecological status with integrated food web analyses.	8	R	PU	M46
D2.9	Final report incorporating scientific papers detailing progress in field of particle aggregation and consumption made in grant	2	R	PU	M47
D7.8	Proposals for basin-scale governance based on scenario evaluation with stakeholders	7,8	R	PU	M47
D9.11	First draft of a Special Issue publication in the journal of `*Progress in Oceanography*` - synthesis of advances made in EURO-BASIN and implications for policy & ecosystem management	9	R	PU	M47
D9.12	Report on project foreground and dissemination activities	9	R	PU	M47
D9.13	Report on societal implications of EURO-BASIN including gender and science and society related issues	9	R	PU	M47
D9.14	**Final project scientific, management and financial report, including a report on social and gender issues**	**9**	**R**	**PP**	**M48**

Table 1.3 c List of milestones

Milestone number	Milestone name	WP(s) involved	Expected date	Means of verification
1	Program Office setup and Kick-off meeting	ALL	M1	Meeting held
2	Joint WP1/WP6 session at Kick-Off meeting regarding the algorithms of Task 2.4, identify key literature datasets	1,2, 6	M1	Meeting held
3	Risk register complete	9	M2	Report
4	International Expert Advisory Panel selected	9	M3	Written acceptance
5	User Advisory Group (UAG) selected	9	M5	Written acceptance
6	1st meeting of the Data Management Advisory Group coinciding with the 2011 UNESCO/IOC/IODE expert group meeting on biological and chemical data in Oostende	1	M6	D1.9
7	Definition of the structure of the model: entities, data	1, 7	M6	Demonstration
8	DRAKKAR forcing assembled	6	M6	D6.1
9	Joint WP1-WP5 on mesocosm and cruise planning	1,2,3,4,5	M6	Workshop held
10	Completion of food web specifications stage	8	M12	Report
11	Ecosystem models coupled to NEMO and tested in ¼ degree	6	M12	Demonstration
12	Testing of the models to project species distributions and potential catch and estimation of model parameters	7	M12	Demonstration, D7.4
13	Training Workshop 1 on Introduction to statistical modeling tools	2,3,4,5,9	M12	Workshop held
14	End of data archaeology activities and deadline for the delivery consolidated and rescued historical data by T1.3	1,2,3,4,5	M16	D1.1-D1.8
15	Estimation of Gordon-Schafer’s parameters and simulate past fishery trends	7	M16	Demonstration
16	Estimation of target reference points (MSY and MEY) and dynamic optimal exploitation for key species	7	M16	Demonstration
17	Training Workshop 2 on Vital Rates measurement techniques for plankton (incl. metadata collection)	1,2,3,4,5,9	M16	Workshop held
18	CIBM implemented in NEMO	6	M18	Demonstration
19	Cruise workplan for summer 2012	2, 3, 4	M18	Report completed
20	Development of a prototype model (all components, restricted set of data	7	M18	Demonstration
21	Results from mesocosm experiment available and impact on algorithms considered	2	M18	Report completed

22	Simulation of change in abundance and maximum catch potential	5,7	M18	Demonstration
23	Simulation of change in distribution of key fish populations	5,7	M18	Demonstration
24	1st General Meeting (Expert Advisory Panel and User Advisory Group)	ALL	M17	Meeting held

Month 18 Scientific Reporting to EC (D9.8)

25	Compilation of food web input data for each region and completion of data preparation stage	8	M20	D.1-D1.8
26	Cruise to Norwegian Sea	2, 3, 4	M21	D2.4
27	Second meeting of the Data Management Advisory Group, coinciding with the 2012 International Conference on Marine Data and Information Systems (IMDIS)	1	M21	D1.11
28	¼ degree, 45 year ensemble hindcast	6	M24	Demonstration
29	1/12 degree, 45 year hindcast complete	6	M24	Demonstration
30	1st International Summer School 2012	ALL	M24	Online
31	Climate forced scenarios defined	6,7	M24	Demonstration
32	First special issue publication of EURO-BASINdata in the peer-reviewed ESSD online journal	1,2,3,4,5,6	M24	Publication
33	Initial implementation of generation 1 algorithms in 1D model	2, 6	M24	D2.7
34	Joint WP2-5 Workshop mid-term synthesis	2,3,4,5	M24	Workshop held
35	Scenario development	6,7	M24	Demonstration
36	Training Workshop 3 on Optical Methods for taxonomy, feeding interactions and particle flux (incl. data management)	1,2,3,4,9	M24	Workshop held
37	Workshop to develop exploitation and management scenarios for the North Atlantic basin	7,8	M24	Workshop held
38	Workshop on performance of indicators of good ecological status and biological reference points under climate change	8	M27	Workshop held
39	Climate forced ensemble complete	6	M30	D6.3
40	Joint workshop WP2 to WP8 on model synthesis	2,3,4,5,6,7,8	M30	Workshop held
41	Model development and parameterisation finished	5	M30	Demonstration
42	Preliminary dataset from Cruise 1. Transfer of best algorithms to WP6. Impacts of mesocosm and cruise results on initial algorithms considered. Planning for PAP site cruise complete.	2, 6	M30	Report
43	Third meeting of the Data Management Advisory Group, coinciding with, coinciding with the 2013 UNESCO/IOC/IODE expert group meeting on biological and chemical data in Oostende	1	M30	D1.13

44	Field season to PAP site, NE Atlantic	2	M33	Cruise report
45	2nd General Meeting (Expert Advisory Panel and User Advisory Group)	ALL	M35	D9.8
46	Completion of Ecopath food web tuned analyses	8	M35	Demonstration
47	Development of a full model	7	M36	D7.7
48	Implementation of new algorithms in WP6 models presented. Full dataset from cruise 1 available, preliminary dataset from cruise 2 available, revision of algorithms to take account of results from mesocsom experiments and 2 cruises	1, 2, 6	M36	Data publication (D1.12), D2.8
49	Joint workshop WP5/WP6 for defining key forecast scenarios for top down control	5,6	M36	Workshop held
		Month 36 Scientific Reporting to EC (D9.9)		
50	Access of model outputs to stakeholders to determine governance pathways	7	M42	D7.8
51	Climate forced ensemble with modified top down control simulation analysis workshop	6	M42	Workshop held
52	Completion of a spreadsheet to compute the cost of changes in the North Atlantic Carbon budget	8	M42	Report
53	Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal	1,2,3,4,5,6,7,8	M44	Publication
54	2nd International Summer School 2014	ALL	M44	Online
55	Joint WP2/WP6 workshop on simulation synthesis using finalised algorithms	2, 6	M45	D2.10
56	Final General Meeting including stakeholders	ALL	M47	D9.9

Month 48 Scientific Reporting to EC (D9.11)

Table 1.3 d: Work package description

Work package number	1	**Start date or starting event:**		Month 1		
Work package title	Data Management and Integration					
Activity Type	RTD					
Participant number	**2**	3	5	6	11	13
Participant short name	**UNI-HB**	DTU-AQUA	NERC	MRI-HAFRO	IMR	SAHFOS
Person-months:	49	2.3	4.5	4	3.5	6.8
Participant number	15	21				
Participant short name	CNRS	CLS				
Person-months:	8	2.5				

Objectives

The primary objective is to develop methods to consolidate and integrate long-term observations from European and international databases. EURO-BASIN will use these methods to assemble historical data, new field observations and experimental results into comprehensive datasets for modelling and prediction of the Atlantic Ocean ecosystem and related services.

Description of work (possibly broken down into tasks), and role of participants

T1.1 Data integration

The methods proposed by EURO-BASIN to integrate data are to (i) strengthen interactions between data managers and science partners and thereby contribute to data archaeology and harmonisation, (ii) publish consolidated datasets at PANGAEA® and in the online journal Earth Systems Science Data (ESSD) and thereby contribute to knowledge dissemination and scientific outputs.
Responsible: UNI-HB;
Start: Month 1; End Month 48.

T1.2 Data Management: Networking

EURO-BASIN will use the first prototypes of data harvesters developed by SeaDataNet for the NODCs and by PANGAEA® for the WDCs. The latter technology extracts masses of data in a warehouse based on parameter-specific and method-specific queries, generating a single consolidated data matrix that will include for each datum, its geo-references (latitude, longitude, date, time and depth), sampling or analysis methods, the DOI of the original dataset and when applicable, the DOI of its supplementary journal publication. Data holdings of EURO-BASIN partners and associated international, national and institutional databases (including at minimum the International BASIN partners in Canada and the U.S.A.) will be harvested in different ways according to local data policies.

T1.2.1: Create and co-chair a Data Management Advisory Group including US and Canadian members to foster coherence in data management and integration between the EURO-BASIN project and International BASIN partners in Canada and the U.S.A.
Responsible: UNI-HB;
Start: Month 1; End Month 36.

T1.2.2: Access and assemble data holdings from mandated permanent archives (NODCs and WDCs) using SeaDataNet and PANGAEA®, and from other international, national and institutional databases (including at minimum the International BASIN partners in Canada and the U.S.A).
Responsible: UNI-HB;
Start: Month 1; End Month 36.

T1.2.3: Maintain and develop, as needed the database infrastructure (WDC-MARE) and information system (PANGAEA®), which form the technological backbone for database networking and interoperability in EURO-BASIN.

Responsible: UNI-HB;

Start: Month 1; End Month 36.

T1.3 Data Management: Archaeology

The key to data archaeology is to have privileged access to sample and data repositories and to have the expertise to accurately determine “who” measured “what” and “how”. EURO-BASIN has the keys in hand by directly involving its science partners in the Data Archaeology tasks, including “targeted data rescue” and “consolidation of historical data”. The former type of tasks will bring added value to existing data by re-analysing samples and digitising data of importance for WP2-5, whereas the latter type of tasks will harmonise data from public archives and institutional data repositories. BASIN’s data curator will perform quality control and assurance on the completeness, consistency and standardisation of metadata, including geo-references, currencies, units and controlled vocabulary describing parameters, taxonomy, size and functional groups, collection methods and analytical methods. EURO-BASIN will use authoritative vocabulary databases such as Taxonomic registers (WoRMS and ITIS) and the chemical substances registers (CAS). This task supports WP2-5 and by extension to WP6-8.
Responsible: UNI-HB Participants: ALL
Start: Month 4; End Month 16.

T1.3.1 Consolidate historical data on rates of particulate matter downward flux, decomposition and aggregation; transfer efficiencies. Sources: data archives and literature [supports T2.1 and T2.4]
Responsible: NERC; Participants: CNRS
Start: Month 4; End Month 16.

T1.3.2 Task 1.3.2 Consolidate recent data on plankton biogeography (including near surface distribution of key jellyfish species) and meso-to-basin-scale processes in the North Atlantic Ocean and Self Seas. Source: re-analysis of CPR samples (2008-2010) using genomic analyses [supports T3.1]
Responsible: SAHFOS ; IMR.
Start: Month 4; End Month 16.

T1.3.3: Consolidate historical data on abundance of key zooplankton species (*C. finmarchicus*, *C. hyperboreus*, *Oithona* and *Oncaea*) over decadal time scales for the North Atlantic. Sources: traditional net sampling [supports T4.1]
Responsible: DTU-AQUA ;
Start: Month 4; End Month 16.

T1.3.4: Rescue historical data with respect to abundance and biomass of plankton and fish in the North Atlantic Ocean and Self Seas. Sources: EurOBIS, US-OBIS and CanOBIS- Conversion of presence/absence data to corresponding abundance and biomass data [supports T4.1]
Responsible: UNI-HB;
Start: Month 4; End Month 16.

T1.3.5: Rescue historical data on abundance, size-spectra, biovolume and provide estimates of biomass for key zooplankton groups (e.g. Appendicularians, Chaetognaths, Cladocerans, Copepods, Decapods, Fish eggs, Gelatinous organisms and Pteropods) in the North-Atlantic Ocean and Shelf Seas. Source: re-analyse key historical zooplankton samples using an already established network of bench-top imaging systems (i.e. ZooScan) in Europe, and potentially U.S.A. and Canada. [supports T4.1]
Responsible: CNRS; Participants: MRI-HAFRO
Start: Month 4; End Month 16.

T1.3.6: Rescue historical data on catch and effort of North Atlantic fisheries. Sources: paper publications & reports from EU, U.S.A. and Canada identified by ICES Workshop on historical data on fisheries and fish. [supports T5.1]
Responsible: UNI-HB;
Start: Month 4; End Month 16.

T1.3.7: Consolidate historical data to provide spatially explicit estimates of stocks sizes, structure, biomass and diet of Tuna in the North Atlantic. Sources: ICCAT database and Trawl and acoustics data from ICES, DTU and MRI-HAFRO [supports T5.1 and T5.2]
Responsible: CLS; Participants: DTU-AQUA and MRI-HAFRO

Start: Month 4; End Month 16.

T1.3.8: Consolidate historical data to provide spatially explicit estimates of stocks sizes, structure, biomass and diet of Herring, blue Whiting and Mackerel in the North Atlantic. Source: Trawl and acoustics data from ICES, IFREMER, CEFAS, IMI, MRI-HAFRO,Tecnalia-AZTI [supports T5.1 and T5.2]
Responsible: IMR; Participants IFREMER, CEFAS , IMI, MRI-HAFRO,Tecnalia-AZTI
Start: Month 4; End Month 16.

T1.4 Data Management: Safeguarding
Following recommendations of IMBER Data Management Group (http://www.imber.info/DM_home.html), UNI-HB will hire a recent PhD in biological oceanography to be trained by PANGAEA® as data curator for BASIN. Two thirds of his/her time will be dedicated to safeguarding data and interacting with partners involved in data archaeology, and one third of his/her time will be dedicated to data publishing and dissemination. In support to integration of long-term observations, partner institutions commit to archive all data relevant to EURO-BASIN at the NODC designated by IODE for their country and/or to one of the WDCs established by ICSU, notably WDC-MARE in Europe.

T1.4.1: Define ontologies and standard vocabularies required to harmonise data in BASIN, in collaboration jointly with US and Canada as part of the UNESCO, IODE's Group of Experts on Biological and Chemical Data (GEBICH). Controlled vocabularies about plankton sampling and analysis methods are being reviewed by GEBICH, involving PESANT (UniHB), Kennedy (DFO) and Hernandez (NOAA). Standard vocabularies will determine which measurements can be combined (or not) and then converted to common units. Conversion factors will be determined/applied by partners of WP2-5 from literature and from laboratory experiments planned in EURO-BASIN. Inter-calibration of instruments and methodologies during EURO-BASIN cruises will be used to refine the conversion factors. In the end, a key element to address this issue is the full time EURO-BASIN data curator who will be hired by UniHB to stimulate/help the work of partners towards the seamless integration of data from the different collection schemes.

Responsible: UNI-HB;
Start: Month 1; End Month 48

T1.4.2: Quality check, harmonise and archive historical data consolidated and rescued in T1.3 at the WDC-MARE. Each dataset will be given a persistent digital object identifier (DOI).
Responsible: UNI-HB;
Start: Month 4; End Month 36

T1.4.3: Quality check, harmonise and archived experimental and observational data (WPs2-5) at the WDC-MARE. Each dataset will be given a persistent identifier (doi).
Responsible: UNI-HB;
Start: Month 4; End Month 48

T1.4.4: Quality check and archive key ecosystem parameters and proxies for fisheries management generated by meta-analyses and modelling (WP 2-6).
Responsible: UNI-HB;
Start: Month 4; End Month 48

T1.5 Data Management: Publishing & Dissemination
In support to the Directive of the European Parliament and of the Council on open access to environmental information and in support to the INSPIRE Directive, partner institutions commit to publish raw data relevant to EURO-BASIN at PANGAEA® thus ensuring open, online access to data and metadata, including a citation and persistent identifiers (i.e. DOIs). Restricted access to data, as recognised by the above Directives, will be discussed at the start of the project and adopted in EURO-BASIN's data policy.

T1.5.1: Publish data that were archived as part of T1.4.2 to T1.4.4 into the digital library of PANGAEA® to ensure dissemination to EURO-BASIN partners (T1.5.2) and to the wider public (T1.5.3)
Responsible: UNI-HB;
Start: Month 4; End Month 48

T1.5.2: Disseminate harmonised data from T1.5.1 to partners of EURO-BASIN and relevant partners in U.S.A. and Canada, using password protected access to PANGAEA® data warehouse.
Responsible: UNI-HB;
Start: Month 4; End Month 48

T1.5.3: Disseminate EURO-BASIN metadata and datasets to the wider community, using google-like information systems PANGAEA® (environmental, biogeochemical and trophic data), OBIS (presence/absence data), NMFS-COPEPOD (zooplankton data) and MegX (genomics).
Responsible: UNI-HB;
Start: Month 4; End Month 48

Workshops and Milestones:

2 Joint WP1/WP6 session at Kick-Off meeting regarding the algorithms of Task 2.4, identify key literature datasets (WP 1,2,6; M1)
6 1st meeting of the Data Management Advisory Group coinciding with the 2011 UNESCO/IOC/IODE expert group meeting on biological and chemical data in Oostende (WP 1; M6)
7 Definition of the structure of the model: entities, data (WP 1,7; M6)
9 Joint WP1-WP5 on mesocosm and cruise planning (WP 1,2,3,4,5; M6)
14 End of data archaeology activities and deadline for the delivery consolidated and rescued historical data by T1.3 (WP 1,5; M16)
17 Training Workshop 2 on Vital Rates measurement techniques for plankton (incl. metadata collection) (WP 1,2,3,4,5,9; M16)
27 Second meeting of the Data Management Advisory Group, coinciding with the 2012 International Conference on Marine Data and Information Systems (IMDIS) (WP1; M21)
32 First special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M24)
36 Training Workshop 3 on Optical Methods for taxonomy, feeding interactions and particle flux (incl. data management) (WP1,2,3,4,9; M24)
43 Third meeting of the Data Management Advisory Group, coinciding with, coinciding with the 2013 UNESCO/IOC/IODE expert group meeting on biological and chemical data in Oostende (WP1; M30)
48 Implementation of new algorithms in WP6 models presented. Full dataset from cruise 1 available, preliminary dataset from cruise 2 available, revision of algorithms to take account of results from mesocsom experiments and 2 cruises (WP1,2,6; M36)
53 Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6, 7, 8; M44)
57 Final Data sets assembled and final analyses initiated (WP1,8; M42)

Deliverables (brief description and month of delivery)

D1.1 Report and delivery of consolidated historical data by T1.3.1 (Resp:UNI-HB, R, PU, M16)
D1.2 Report and delivery of consolidated historical data by T1.3.2 (Resp:UNI-HB, R, PU, M16)
D1.3 Report and delivery of consolidated historical data by T1.3.3 (Resp:UNI-HB, R, PU, M16)
D1.4 Report and delivery of rescued historical data by T1.3.4 (Resp:UNI-HB, R, PU, M16)
D1.5 Report and delivery of rescued historical data by T1.3.5 (Resp:UNI-HB, R, PU, M16)
D1.6 Report and delivery of rescued historical data by T1.3.6 (Resp:UNI-HB, R, PU, M16)
D1.7 Report and delivery of consolidated historical data by T1.3.7 (Resp:UNI-HB, R, PU, M16)
D1.8 Report and delivery of consolidated historical data by T1.3.8 (Resp:UNI-HB, R, PU, M16)
D1.9 First Data Management & Integration report, coordinated by T1.1 (Resp:UNI-HB, R, PU, M17)
D1.10 Submission of data manuscripts to ESSD by T1.1 : First EURO-BASIN special issue (Resp:UNI-HB, R, PU, M22)
D1.11 Second year Data Management & Integration report, coordinated by T1.1 (Resp:UNI-HB, R, PU, M35)
D1.12 Submission of data manuscripts to ESSD by T1.1: Second EURO-BASIN special issue (Resp:UNI-HB, R, PU, M40)
D1.13 Final Data Management & Integration report, coordinated by T1.1 (Resp:UNI-HB, R, PU, M46)

Work package number	2	**Start date or starting event:**			Month 1		
Work package title	The Biological Pump (BCP)						
Activity Type	RTD						
Participant number	1	3	**5**	15	19	23	
Participant short name	UHAM	DTU-AQUA	**NERC**	CNRS	Uni Research	IMS-METU	
Person-months per participant:	9	11	22	18	18	8	

Objectives

EURO-BASIN WP2 will advance the state of the art by producing new observations of particle formation, aggregation, sinking and decomposition in a range of marine ecosystems, focussed on the North Atlantic basin. Within the North Atlantic there are significant uncertainties regarding how deep particle flux is mediated with a significant role proposed for biomineralising protists in the large autumn and spring fluxes of material which reaches the deep ocean (Lampitt *et al*., 2008, Martin *et al*., in press). The possibility that changes in predation pressure may have seriously impacted deep flux is therefore open. A particular feature of the work proposed will be to evaluate the role of such biomineralising predatory organisms on deep carbon flux. We will make new observations to resolve how environmental conditions including plankton community structure (composition and size) and grazing drive aggregate formation, stability and sinking rate. These will be combined with literature data to generate new particle flux algorithms, which will be tested in 1D models of plankton ecology, and particle flux and then incorporated into 3D models of the biological ocean carbon cycle in WP6. Large scale estimates of biological carbon sequestration will be made using field data from spatial surveys and these estimates compared to state of the art numerical model based estimates to assess our current skill in simulating oceanic biological carbon sequestration. Collaboration with WP8 will assess the current value of the BCP, how this may change in the future and how management decisions regarding the management of the marine ecosystem may affect this future valuation.

Specific objectives are as follows:

1. Perform laboratory experiments to establish the relationship between plankton community composition and size structure and aggregate formation, sinking rate and stability under idealised conditions.
2. Perform a mesocosm experiment to determine the influence of plankton community composition, size structure and grazing pressure on aggregate formation, sinking rate and stability under environmentally realistic conditions.
3. Perform observations at sea on the link between plankton community composition and size structure, grazing and aggregate formation, sinking and decomposition and organic carbon export.
4. Develop and apply new algorithms for particle export and decomposition based on experimental work above and on literature information available from WP1.
5. To implement these new algorithms in 1Dmodels and assess their skill in representing particle flux via a comparison of model output with a defined validation dataset assembled in WP1. The most environmentally realistic algorithms will be passed to WP6 for preliminary implementation in large scale models.
6. Perform surveys at the broad scale of the biological sequestration of carbon dioxide in the Nordic seas and high latitude North Atlantic and, in collaboration with WP6, to use these data to evaluate how well existing versions of models implemented in WP6 represent the Biological Carbon Pump.
7. Synthesise these previous activities in order to estimate, in conjunction with WP8, the economic value of the contemporary biological carbon pump and how this value may change as ocean functioning changes in response to an evolving climate and a changed exploitation of top predator species.

Description of work:

T2.1 Experimental work in mesocosms in Norway and in the laboratory at Brest.

The downward flux of organic carbon from the upper ocean mediated via large particles formed from the aggregation of small particles is likely the dominant component of the biological carbon pump and therefore a key term in the global carbon cycle (Fowler and Knauer, 1986). This aggregation process is required to give particles sufficient size to overcome the high effective seawater viscosity which very small particles experience and/ or to give them enough excess density relative to seawater to sink.

Currently, most of our parameterizations of sinking particle decomposition and sinking are based on field observations of changes in bulk particle flux with depth (Martin *et al.*, 1987). However these empirical relationships represent the summation of numerous processes, which vary greatly over time and place. A paucity of detailed observations currently impedes the construction of new mechanistic algorithms incorporating realistic particle behaviour and is a critical impediment to modelling the efficiency and capacity of the BCP to assimilate carbon from the atmosphere, both in the contemporary ocean and under likely climate change scenarios.

As a global community we have a reasonable qualitative understanding of the major processes involved in the critical processes of particle aggregation, formation, sinking and decomposition are well known. They include the role of transparent extracellular polymers (TEP) in particle aggregation (Kiørboe and Hansen, 1993), the extent of microbial colonization of sinking aggregates (Ploug and Grossart, 2000), the effect of zooplankton feeding on and mechanical breakup of aggregates (Steinberg *et al.*, 2008) and the incorporation of ballast biominerals (Klaas and Archer, 2002). However much of this information has been derived during small shipboard studies which considered only one factor in isolation in a complex environment or in the very deep ocean. Two important tasks are to conduct controlled experiments in the laboratory to probe the precise role of individual factors in isolation and to conduct broad shipboard programmemes in which all factors are considered simultaneously. Task 2.1 will undertake this first task by conducting experiments in the laboratory and in mesocosms to examine quantitatively the role of these various factors in particle dynamics in well controlled systems.

T2.1.1 LABORATORY In the laboratory we will resolve the impact of minerals (calcium carbonate, biogenic silica, and terrestrial clays) and the size structure of the planktonic ecosystem on the formation and character, sinking velocity, decomposition, and remineralization of aggregates. We will utilize an extensive suite of techniques (e.g spectrophotometric assays of TEP concentration, microscopic observation of microbial aggregation and elemental composition of aggregates) and experimental approaches (e.g. roller tank experiments) which CNRS have developed to form and monitor the behaviour, stability and sinking rates of aggregates in the laboratory (De la Rocha *et al.*, 2008).

T2.1.2 MESOCOSM We will undertake a mesocosm experiment (at the HYDRALAB mesocosm facility in Trondheim, Norway) in 2011. We have had preliminary discussions with the manager of this facility (see Letter of support B 3.1.2) and will submit a full application during 2010 once EURO-BASIN funding is confirmed. This activity will determine how particle formation, aggregation, remineralization, and sinking is controlled by various ecological parameters in a more natural environment. Ecological parameters we will consider include the dominant phytoplankton (diatoms versus coccolithophorids), and the magnitude of mesozooplankton grazing and community size structure. Aggregates formed under the various environmental conditions will be harvested and their properties, sinking rate and state of degradation monitored.

The evolution of the plankton community in the mesocosoms will be monitored (via measurements of primary production and phytoplankton species composition; nutrient, TEP, and DOC concentrations, particle sinking velocities, ectoenzyme activities, and shifts in the composition and activity of bacterial free-living and particle-associated bacterial populations) to interpret the nature and quantity of particles produced.

Preliminary planning of T2.1.2 will take places at the kickoff meeting in M1 with these plans being honed in at the workshop in M6. This strategy will allow the entire EURO-BASIN community (including numerical modelers, plankton ecologists and marine biogeochemists) to engage with this activity and maximize the scientific progress which it delivers. In particular insights obtained from the detailed retrospective analysis of literature observations and from WP1 T1.3.1 and incorporated into preliminary algorithms in T2.4 will contribute to the experimental design ensuring that the experimental work will be focused at testing key hypotheses emergent from the literature survey work. This will also allow us to identify the most appropriate form in which data should be supplied for model parameterisation.

Responsible: CNRS; Participants: Uni Research, UHAM, IMS-METU, NERC _NOCS and DTU-AQUA. Note: We will entrain US groups into the mesocosm effort once they have received the NSF funding they have currently applied for (see letter of support from Buesseler B3.1.2).

Start: Month 1; End Month 24

T2.2 Experimental work at sea: Cruise observations will focus on the key processes involved in mediating particle export using state of the art technologies including direct observations of sinking particle characteristics using the seacorer and marine snowcatcher and drifting sediment traps calibrated using 234^{Th} derived fluxes to link plankton community composition and size structure, grazing, and air sea CO_2 fluxes to particle aggregation, decomposition, sinking and the downward flux of organic carbon from the upper ocean in the different habitats of the North Atlantic.

Observations at sea are a key component of the global effort to better define the relationship between the nature of the organisms growing in the upper ocean, the downward flux of carbon they mediate and the resultant air sea flux of carbon dioxide. Currently the number of sites globally where the efficiency of the BCP (efficiency of penetration of organic carbon through the mesopelagic) has been directly measured and linked to community structure in the upper ocean is extremely low as identified in EURO-OCEANS 2007.
A key U.S. study known as VERTIGO (vertical transport in the global ocean) measured this parameter at two sites in the Pacific (Buesseler et al. 2007) and the VERTIGO team is following up with a study known as LETZGO (currently in review at NSF, see Buesseler letter of support B 3.1.2) to which our work proposed here will link should LETZGO be supported by NSF.

Observations within different oceanographic regimes and ecosystem types will be made for this task on two EURO-BASIN cruises supported by national funding agencies. See Gantt chart and B 2.4. These are the German Convection cruise on the Meteor in 2012 and a UK cruise to the PAP (NABE) site in 2013. These opportunities, provided free of charge to EURO-BASIN researchers, will allow our linkage to the LETZGO programme to include the participation (subject to funding) of US researchers on EURO-BASIN cruises in the eastern side of the North Atlantic (principally to PAP in 2013). In addition EURO-BASIN will allow EC researchers supported here to participate in LETZGO cruises to the western North Atlantic (in the Bermuda vicinity in 2011) to ensure intercomparability of methods and to determine best working practices.

The German convection cruise opportunity will focus on the high latitude North Atlantic, specifically the Norwegian basin (OWS Mike), a station at the shelf break north east of Scotland and a site in the Norwegian Sea, the UK cruise will focus on the PAP site. This is a key station in biological oceanography, being the site of the JGOFs North Atlantic Bloom study. It sits between the subpolar and subtropical gyres in an area highly susceptible to climate change and has an extensive mooring infrastructure supported by the FP6 programmeEurosites and UK infrastructure funding. On these two cruises WP2 will make a suite of observations designed to fully define the linkages between inorganic carbon and nutrient fields, air-sea CO_2 flux, plankton community composition and size structure, grazing and particle aggregation and downward particulate organic carbon flux. Observations of plankton community composition and size structure and of grazing impact as a mediator of particle flux will be derived by WP3 & 4. A feature of the observational programmewill be the full involvement of marine physicists to enable the biological observations to be set in the context of a thorough knowledge of water masses and circulation.

The air sea CO_2 flux will be defined using measurements of sea surface and atmospheric CO_2 levels and a transfer velocity, export using 234Th profiles and drifting neutrally buoyant sediment traps, ecosystem structure using biomineral, pigment and microscopic observations, setting particles collected using the seacorer, marine snow catcher and drifting neutrally buoyant sediment traps and grazing defined using experimental techniques. From these observations we shall deduce the dominant ecosystem controls over particle aggregation, sinking and decomposition in the environments studied.

Complementary information regarding the size structure of the planktonic ecosystem and the impact of grazing required constraining the influence of mesozooplankton and planktonic community size structure on downward pareticle flux will be supplied to WP2 from WP3, 4.
Responsible: NERC; Participants: DTU-AQUA, Uni Research and UHAM).
Start: Month 12; End Month 36

T 2.3. Time series analysis of the biological carbon pump at high latitudes.
In addition to detailed information required for the construction of novel algorithms linking particle flux to plankton community composition and size structure which we will obtain in Tasks 2.1-2.2 there is also a need

to conduct areal surveys to define the large scale operation of the biological carbon pump. This for two reasons, firstly the system is currently inadequately described and secondly the air sea flux is likely to change in response to global warming/ ocean acidification. These problems are particularly acute at high latitudes where data coverage is sparse and environmental change most rapid. In this task we will therefore synthesise and analyse data sets from large scale ocean surveys and time series stations accessible via WP 1 within the North Atlantic and Nordic Seas to place the local studies in a wider spatial context. We will analyse the seasonal, inter-annual and long term trends in the upper and intermediate ocean biogeochemical dynamics from existing datasets (e.g. OWS Mike, CARINA, AMT Atlantic Meridional Transect), enhanced with evolving data from EURO-BASIN cruises and national efforts (e.g. MERCLIM; Marine Ecosystem Response to a changing CLIMate; AMT), to elucidate the magnitude and variability of the North Atlantic and Nordic Seas flux of carbon to deep waters. Comparisons of the integrated changes in the vertical distribution of inorganic carbon and mineral nutrients (N, P, Si) will provide new information on the stoichiometry of new production (Lee, 2001; Koeve, 2006). From this we will calculate the local and regional fields of the stoichiometry of production and respiration and estimate net community calcification from nutrient-corrected alkalinity measurements (Bellerby *et al*., 2008).

To extend the envelope of our understanding of the evolution of the biological carbon pump in a changing environment, we will analyse new and historical datasets on seston stoichiometry from the North Atlantic to the Arctic from controlled perturbation (e.g. temperature, CO_2, nutrients) experiments from shipboard and mesocosm studies on natural pelagic ecosystems (e.g. PAME (Thingstad et al., 2008), PEeCE (Riebesell *et al*., 2008), MERCLIM. These analyses will investigate how primary production, stoichiometry and community structure may vary under environmental change.

This task will furnish the upper limits and composition of the biological carbon pump which will be compared to model diagnostics in WP6 to evaluate the level at which our current models represent this key process. New parameterisations of nutrient uptake stoichiometry will be provided to improve the model representation.
Responsible: Uni Research; Participants: NERC _NOCS, UHAM and DTU-AQUA
Start: Month 3; End Month 36

T2.4. Algorithm Advancement. Retrospective Analyses and development of new parameterizations for particle flux.

The ultimate aim of this workpackage is to develop, based on existing parameterizations and new information regarding the functioning and magnitude of the biological carbon pump (T 2.1-2.3) evaluate existing model descriptions of the BCP (WP6) and thus further the development of novel algorithms describing particle flux (T2.4). Task 2.4. will combine new and existing information regarding particle production, sinking and disintegration as derived from retrospective analyses as well as the heirarchical experimental strategy outlined above (laboratory, mesocosm and shipboard experiments T2.1-2.3) in which the degree of control over the system declines as the realism of the studied system increases. This activity, which is critical to ensure that the full benefits of data assembly in WP1 is realized via combining the results with new information to inform modeling actions will be undertaken via workshops conducted between experimentalists and numerical modelers. These workshops will be focused on generating a new cohort of flux algorithms suitable for inclusion in large scale numerical models. Thus the parameterizations proposed will be thoroughly grounded in the latest experimental observations ensuring that state of the art information regarding downward particle flux is rapidly pulled through into improving our numerical modeling capabilities. Parameterisations proposed in T2.4 will be tested in simple one-dimensional models by IMS-METU before being transplanted into more complex general circulation models in WP6. Algorithm skill will be assessed by comparison of output generated from models with various parameterizations to validation datasets selected from those assembled in WP1 which have not been used in T2.4. This task will operate in close collaboration with WP6 and **will continue throughout the programme**, to ensure that the process of upgrading our predictive ability is an ongoing exercise thus allowing the latest insights to be incorporated into modeling capabilities as they become available. To facilitate this task, regular workpackage meetings in M 6, 18, 30, 42 will consider the latest experimental work from both the shipboard and laboratory based campaigns. These workshops will ensure that ongoing algorithm development and advancement of BGC modeling in WP 6 remains a focus of activity throughout the programme. This is critical because it is only via the combination of new information and extant literature observations that continual progress can be made on improving the way in which the modeling of downward particle flux is modeled. A feature of these workshops will be the involvement of US collaborators and of the modelling group in WP6. An early focus of the effort will be examining the existing parameterization of downward particle flux within the three large scale models used in WP6 relative to the validation dataset defined in WP1. A successful transfer of novel algorithms will enable modelling experiments predicting the likely response of the BCP and hence ocean CO2 storage to anthropogenic changes to be conducted in WP6. Clearly it is important that the new knowledge and superior parameterisations of ocean carbon flux derived as described above in WP2 with input from WP1, 3, 4 are not only used to improve our representation of ocean carbon FP7-ENV-2010 flux in WP6 but also to determine likely changes in the value of the BCP into the future. This will beaccomplished in WP8 via a combined approach building on the techniques of bioeconomic modelling outlined later in the proposal.

Responsible: IMS-METU ; Participants: NERC, UHAM, Uni Research; DTU-AQUA
Start: Month 1; End Month 42

Workshops and Milestones:

2 Joint WP1/WP6 session at Kick-Off meeting regarding the algorithms of Task 2.4, identify key literature datasets (WP1,2,6; M1)
9 Joint WP2-WP5 on mesocosm and cruise planning (WP1,2,3,4,5; M6)
13 Training Workshop 1 on Introduction to statistical modelling tools (WP2,3,4,5,9; M12)
14 End of data archaeology activities and deadline for the delivery consolidated and rescued historical data by T1.3 (WP1,2,3,4,5; M16)
17 Training Workshop 2 on Vital Rates measurement techniques for plankton (incl. metadata collection) (WP1,2,3,4,5,9; M16)
19 Cruise workplan for summer 2012 (WP2, 3, 4; M18)
21 Results from mesocosm experiment available and impact on algorithms considered (WP2; M18)
26 Cruise to Norwegian Sea (WP2, 3, 4; M21)
32 First special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M24)
33 Initial implementation of generation 1 algorithms in 1D model (WP2,6; M24)
34 Joint WP2-5 Workshop mid-term synthesis (WP2,3,4,5; M24)
36 Training Workshop 3 on Optical Methods for taxonomy, feeding interactions and particle flux (incl. data management) (WP1,2,3,4,9; M24)
40 Joint workshop WP2 to WP8 on model synthesis (WP2,3,4,5,6,7,8; M30)
42 Preliminary dataset from Cruise 1. Transfer of best algorithms to WP6. Impacts of mesocosm and cruise results on initial algorithms considered. Planning for PAP site cruise complete. (WP 2,6; M30)
44 Field season to PAP site, NE Atlantic (WP2; M33)
48 Implementation of new algorithms in WP6 models presented. Full dataset from cruise 1 available, preliminary dataset from cruise 2 available, revision of algorithms to take account of results from mesocsom experiments and 2 cruises (WP1, 2, 6; M36)
53 Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M44)
55 Joint WP2/WP6 workshop on simulation synthesis using finalised algorithms (WP2,6; M45)

Deliverables:

D2.1 Report on WP2 meeting at Kick off meeting on algorithms (Task 2.4) and data needs (WP1) (Resp: NERC_NOCS with input from UNI-HB, PML; R, PU, M6)
D2.2 Report describing preliminary algorithms and initial results of mesocosm experiment (Resp: NERC_NOCS, CNRS; R, PU, M17)
D2.3 Mesocosm experiments data delivery to WP1 (Resp: NERC_NOCS, R, PP, M18)
D2.4 Report detailing cruise results and how mesocosm results affect the initial algorithms (Resp: NERC_NOCS, CNRS, PML; R, PU, M24)
D2.5 Cruise campaigns data delivery to WP1 (Resp: NERC_NOCS, R, PP, M30)
D2.6 Report on revised algorithms based on cruise and mesocosm data (Resp: NERC_NOCS, CNRS, PML; R, PU, M35)

D2.7 COMPARION Revised algorithms and potential future implementation described (Resp: NERC_NOCS; R, PU, M42)
D2.8 Cruise campaigns data delivery to WP1 (Resp: NERC_NOCS, R, PP, M42)
D2.9 Final report incorporating scientific papers detailing progress in field of particle aggregation and consumption made in grant (Resp: NERC_NOCS with input from all partners; R, PU, M47)

Work package number	3	**Start date or starting event:**				Month 1
Work package title	Distribution of key species and ecosystem types					
Activity Type	RTD					
Participant number	1	4	6	11	13	**18**
Participant short name	UHAM	Tecnalia-AZTI	MRI-HAFRO	IMR	SAHFOS	**BUC**
Person-months per participant:	11.5	27	10	7	11	**20**

Objectives

The primary objective of this work package is to resolve the oceanographic habitats utilized by key biogeochemical and ecosystem species in the North Atlantic. This will be done by:

1. Conducting retrospective analyses on different scales (basin, meso and small scale) of key ecological and biogeochemical species and trophic positions in relation to oceanography (e.g. T, S stratification and advection regime) and seasonality of the systems
2. Characterizing the distribution of food web types and key species in the basin and shelves in terms of abundance, biomass and size spectra
3. Characterizing the population genetic structures in keystone species within biogeochemical and trophic cycles using novel molecular approaches (temporal sampling in combination with genome scans) to determine evolutionary responses to climate change
4. Developing habitat and process models for monitoring and predicting the future changes in key species and food web biogeography due to prominent ecosystem drivers
5. Provide indices of the physical characteristics of key species and food web habitats for development of past present and future states to be simulated in WP 6 and the development of ecosystem trajectories in WP8 and bioeconomic modelling and management in WPs 7 and 8.

T3.1 Retrospective analysis of the spatial distribution of key species

This task will assemble datasets and perform retrospective analysis of past and present patterns of biogeography and meso–basin-scale processes in the North Atlantic and shelf seas using data from T1.3.3, T1.3.4 and T1.3.5. Furthermore, we will include the database developed during the TASC project (Trans-Atlantic Study of *Calanus*) containing data mainly for the northeastern North Atlantic waters, presently being held at IMR, and collaborate with US and Canadian scientists to access datasets for the northwestern North Atlantic (see attached US and Canadian support letters for their commitments and companion proposals). The retrospective analysis will focus on geospatial and long term variations of distribution, abundance, taxonomic compositions, population genetics and rates of key species of copepods, jellyfish and euphausiids over the basin-scale.

In order to foster the development of an International Strategy for the assembly of oceanographic, ecosystem and biogeochemical data we will carry out a workshop together with WP1, 2, 4 and 5 and international collaborators in the US and Canada as well as relevant individuals from the International Council for the Exploration of the Sea to establish the format and complementary data (taxonomy, population genetics, sizes, spatial position and environmental indices such as temperature, salinity, *chl a*, depth, and topographical features) needed to develop predictive habitat models for key ecologically and biogeochemically important species. One of the focus areas will include further development of standards, methods and protocols for archiving genetic, rate, taxonomic, optical and acoustic data used to characterize planktonic, nekton and fish populations, biomass and distributions.

All above feed directly to WP1, and will be exploited in T3.5, T4.1, T.6.2, and T.6.3 and T 8.3

Responsible: SAHFOS ; Participants IMR; MRI-HAFRO; BUC
Start: month 1, end month 20;

T3.2 Biogeography of key species

Critical for understanding the population dynamics of key ecosystem players is determining the habitats that contribute to the maintenance of their populations during ontogeny. In order to develop a predictive understanding of the development of these populations in the future this task will during field programmes identify the habitats utilized by key biogeochemical and ecosystem players. Future projections of the occurrence of these habitats will be performed in WP 6 enabling the potential dynamics of these species to be assessed in WP8. Activities will include dedicated cruises as well as cruises of opportunity where EURO-BASIN partners will modify existing programmes and/or contribute data from local ongoing activities in order to provide key species distributional data. EURO-BASIN specific cruises and ships of opportunity cruises are presented in the Gantt chart and B2.4. The cruise programmes are developed to address within season dynamics with a minimum of one cruise during winter, spring, summer and autumn in selected regions. The cruise programme will at a minimum cover transects sampling both on and off shelf: in the NE Norwegian Sea (the Svinøy transect), south of Iceland and off the west coast of Greenland. Furthermore although not funded by this proposal partners have submitted proposals to national funding agencies to perform synoptic Transatlantic cruises. We anticipate two major national funded cruises from Norway and Germany, respectively. These EC based synoptic cruises will be performed in conjunction with similar efforts in the US and Canada allowing a basin wide assessment of habitats, vital rates and plasticity of response of key rates relative to abiotic forcing.

The mapping programme will assess distributions of size groups less than nekton dependant upon availability using towed/cast mode sensor platforms

- Laser Optical Particle Counter (LOPC; Brooke Ocean Technologies, Dartmouth, Nova Scotia) Video Plankton Recorders(VPR), Lowering ADCP online or operated with in situ datalogging
- Multifrequency acoustics (18, 38, 70, 120 and 330 kHz)
- Conductivity–temperature–depth sensors (CTD)
- Fluorescence
- Rosette sampling for water, selected size categories of primary producers, protists and carbon, WP-2, Multinet 50,180, 500 um mesh size for preservation in lugol, formaldehyde and frozen (liquid N_2).
- Macroplankton and fish trawls with multiple codends for depth resolved samples of macroplankton and nekton..

Plankton and nekton samples will be analyzed for species, sizes, abundance, diversity, and population genetics and physical and biogeochemical data will be analyzed using statistics, geostatistics and process models for environmental indices and transport–retention–mixing of plankton by both EC and US participating scientists and institutions, and data will be distributed for further analysis and synthesis, for example, acoustic models and trophic dynamics. For size groups greater than nekton, mesopelagic and pelagic fish trawl, size and biomass data will be derived from the respective institutions to complete the biomass size spectra. All biological samples will be returned to laboratory and distributed to the key partners for analysis and processing. This work is dependant on input from T.5.1 and additional ground truth of size spectra from T4.3.

Activities within this Task will provide core information to T3.3, and data will also go to T2.1, T2.5, T4.3, T5.3, as well as deliver size spectra from lower trophic organisms including planktivorous fish for inclusion to full ecosystem key species, food web and size spectra in selected habitats of the North Atlantic to T7.2, as well as to WP8. The biogeography outlined for the basin on past and present data will be used for model validation in T6.3.5.

Responsible: BUC; Participants IMR; MRI-HAFRO; UHAM; SAHFOS
Start: Month 6; End Month 36

T3.3 Classification of different regimes by size spectra
The data obtained in T3.2 will be used to identify the key pelagic habitats and their relation to major physical regions. This task will calculate biomass spectra, their slopes to study biomass flow, community structures and trophic interactions in the targeted regions. Species adundance distributional data from the field sampling programme will be used to relate the above analysis to food web information.

This task will be strongly dependant on support from UHAM and MRI-HAFRO who will employ Video Plankton Recorders compositions to identify key species and abundance reconstructing size spectra derived from LOPC data, from BUC. Further information on size spectra will be acquired via net sampling which will be analyzed by BUC and applied in interpreting the size spectra to be delivered to T1.2. The ground truth for

size groups < nekton will be supported by VPR data stored in WP1. Contact data from size groups > nekton will be compiled directly into the biomass spectra using data derived in T3.2 and T2.15.
Classification of different regimes by size spectra will be important for T7.3 in the development of a bio-economic model of fish commodities in the North Atlantic.

Responsible: BUC; Participants IMR; MRI-HAFRO; UHAM; IMR
Start: Month 16; End Month 48

T3.4 Broad-scale assessment of population genetics

During the past decade the North Atlantic has been subjected to subtle shifts in sea water temperature and properties, in particular in the rim of the realized habitats of some of key pelagic species. The recent shift in the trophic role between the temperate *Calanus* species complex in the North Sea (Beaugrand et al., 2002), has underlined that alterations in the marine food web can take place over short periods of time. Similar shifts have the potential to occur in the north, where the retreat of the ice may challenge the success of *C. glacialis*. Conversely, a more southern species *C. helgolandicus* is found to extend its northward shelf associated distribution in the Norwegian Sea most likely through advection, it is also found to be able to be quite successful in exploiting the autumn peak production of protozooplankton on the shelf off Greenland, at periods where *C. finmarchicus* is diapausing at depth. Therefore, it is not unlikely that the overall productivity of these two congenures in the Norwegian Sea, might increase as a response to higher temperatures. Although the biogeography of this important complex has changed, it is very likely that it will undergo further changes in the near future. However, understanding the mechanisms in operation is not straightforward thus hampering our ability to develop prognostic models with regard to their competitiveness in relation to climate change.

One entry point to this is through modern molecular genetic approaches. Previous studies have demonstrated population structures in *Calanus finmarchicus* (Bucklin et al 2000). We will investigate the broad-scale population genetic structure of the cousin group of *Calanus* (i.e. C. *finmarchicus, C. hyperboreus, C. glacialis* and *C. helgolandicus*) using microsatellite loci (developed for *Calanus* Provan *et al*., 2007) and genome scans (AFLPs). This will create a needed baseline for the population structure. Furthermore we will use retrospective temporal sampling to investigate genetic changes over time. Such approach will allow us to identify molecular markers that are linked to selectively relevant loci. Genomics scans will be conducted using a capillary sequencer (ABI 3500XL). This knowledge is crucial for interpreting changes in the biogeography of key species and for understanding the nature of adaptation and plasticity. These data support T4.5, and will enable EURO-BASIN to evaluate output from testing of system resilience to climate forced scenarios in T6.3

Responsible: BUC; Participants PML
Start: Month 1; End Month 36

T3.5 Development of habitat models

Here we will use two approaches to resolve the oceanographic habitats utilized by key biogeochemical and ecosystem species. Firstly, we will draw the major part of the data together in synthesis using predictive habitat models. Theses statistical models relate present day geographical distribution of species and communities to their environmental conditions (Guisan and Zimmermann, 2000). When properly developed these models are extremely useful to produce accurate predictions of the distribution and abundances on the short medium term (non adaptive time scales). We will capitalize on the successfully use of these models in terrestrial ecology for conservation and management issues. Essential biological data will come from T3.1. Predictive habitat models will be established using the most adequate approach for each type of data, such as generalised additive models, Bayesian networks, ENFA (see Guisan and Zimmermann, 2000). In order to have a common basis a workshop/summer school will be carried out with introductions to the different statistical tools available, their advantages and their limitations. Predictive habit models produced will be made available in the project webpage. This work will feed to T6.3.

Secondly, another approach to habitat modelling in EURO-BASIN will be based on agent-based models; specifically targeted will be the *Calanus* complex. Work will be devoted to developing an individual based model for *C. helgolandicus* based on the existing *C. finmarchicus* model (Huse 2005, Huse & Fiksen, in press.). We will use the available literature and information on vital rates form WP4 to re-parameterize this model and validate it against historical data sets (T3.1) as well as from field observations in the basin and on the shelves (T3.3). The model system will then be integrated into the NORWECOM model along with the existing *C. finmarchicus* model and the species will be simulated together as competitors for resources over time in the Norwegian Sea. We will simulate the biogeography, population dynamics, and production of the two species under present day and a future climate scenario and evaluate how climatic variability and -change affects their interactions. This work will feed into T.6.1 and provide indicators for WP 8.3

Responsible:Tecnalia-AZTI; Participants: IMR; SAHFOS, BUC
Start: Month 12; End Month 48

Workshops and Milestones:

9 Joint WP1-WP5 on mesocosm and cruise planning (WP1,2,3,4,5; M6)
13 Training Workshop 1 on Introduction to statistical modelling tools (WP2,3,4,5,9; M12)
14 End of data archaeology activities and deadline for the delivery consolidated and rescued historical data by T1.3 (WP1,2,3,4,5; M16)
17 Training Workshop 2 on Vital Rates measurement techniques for plankton (incl. metadata collection)(WP1,2,3,4,5,9; M16)
19 Cruise workplan for summer 2012 (WP2,3,4; M18)
26 Cruise to Norwegian Sea (WP2, 3, 4; M21)
32 First special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M24)
34 Joint WP2-5 Workshop mid-term synthesis (WP2,3,4,5; M24)
36 Training Workshop 3 on Optical Methods for taxonomy, feeding interactions and particle flux (incl. data management) (WP1,2,3,4,9; M24)
40 Joint workshop WP2 to WP8 on model synthesis (WP2,3,4,5,6,7,8; M30)
53 Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M44)

Deliverables:

D3.1 Report on the biogeographic regimes of the North Atlantic and the dynamics to climate change (Resp: SAHFOS, R, PU, M16)

D3.2.1 Report on community productivity efficiency, trophic structure ecosystem state relative to hydrographic regimes-preliminary overview (Resp: BUC, R, PU, M30)

D3.2.2 Assess community productivity efficiency, trophic structure ecosystem state relative to hydrographic regimes-advanced analysis (Resp: BUC, R, PU, M40)

D3.3 Mapped the distribution of key biogeo-chemical groups in parallel with trophodynamic studies, related to food web interactions (Resp: IMR, R, PU, M34)

D3.4 Report on molecular genomic data for validation of basin-scale scenario models on biogeography for use in projections of key trophodynamic players (Resp: BUC, R, PU, M34)

D3.5.1 Adaptive habitat models past and present geographical distribution – preliminary model based on archived data (Resp:Tecnalia-AZTI, R, PU, M24)

D3.5.2 Adaptive habitat models past and present geographical distribution – refined on based on new data from EURO-BASIN (Resp: IMR, R, PU, M34)

D3.5.3 Adaptive habitat models on past and present geographical distribution – final model (Resp:Tecnalia-AZTI, R, PU, M45)

Work package number	4	**Start date or starting event:**			Month 1		
Work package title	Trophic flow: Productions and controls						
Activity Type	RTD						
Participant number	1	**3**	6	7	8	10	11
Participant short name	UHAM	**DTU-AQUA**	MRI-HAFRO	MIR	PLM	NERI	IMR
Person-months per participant:	15.5	**21**	23	25	5	10	10
Participant number	18	20	22				
Participant short name	BUC	IEO	SWANSEA				
Person-months per participant:	1	16	15.5				

Objectives

The overall objective of this WP is to quantify the key processes controlling the flow of carbon and energy, within and between trophic levels in the North Atlantic and shelf ecosystems. More specifically, the objectives are:

1. To quantify the role of key species and functional groups in the rate of transfer of biomass and carbon within the marine food web.
2. To evaluate the relative importance and interactions of top down versus bottom up controls on community structure and carbon sequestration.
3. Provide field and experimental data for understanding the physiological range of key ecological species i.e. vital rates
4. To quantify vital rates and potential competitive interactions between co-existing species
5. To develop rate parameterizations and and provide data for validation of the integrated models produced in WP 6.
6. Develop indices of key species and ecosystem status for use in WP8.

Description of work

T4.1 Retrospective data analysis.

We will conduct retrospective time series analysis using data collated in WP1 in T1.3.3, T1.3.4 and T1.3.5 on the abundance of key species on and off shelf of western Greenland, around Iceland and in the Norwegian Sea over decadal and seasonal time scales. An important focus will be the relative abundance of closely related species (e.g. *C. finmarchicus* vs. *C. hyperboreus*) or species with similar functional roles (e.g. *Oithona* vs. *Oncaea*. Time series will be analyzed with respect to external forcing (e.g. climatic variation, oceanography, ocean circulation, acidification, exploitation) as well as with respect to changes in community structure. In addition to traditional net samples, long-term data employing multifrequency acoustics (12, 38, 120 kHz) will also be explored in order to estimate the large scale spatial and temporal structure of mid-water acoustic scattering layers in the deep basins in the N-Atlantic.
Responsible: MRI-HAFRO; Participants: DTU-AQUA, IMR and IEO
Start: month 1, end month 18.

T4.2 Trophic interactions.

The focus of this task is to investigate the seasonal dynamics of trophic interactions, community structure and biomass during field programmes at three sites, West Greenland, Southern Iceland, and the Norwegian Sea. Field studies (see Gantt Chart and B2.4) will provide detailed information on processes governing the transfer of biomass and energy through the marine ecosystem and between marine provinces (i.e. shelf and basin). Study sites have been selected due to supporting historical time series (T4.1). The high temporal resolution field activities will be performed to resolve the influence of the spring bloom at to investigate match mismatch of the bloom with higher trophic levels. Furthermore, these studies will be supplemented by ships of opportunity cruises by the participating institutes, occurring during summer autumn and winter, surveying fish resources and the environment. These cruises will have their activities expanded to examine biogeochemical and ecosystem processes relevant to EURO-BASIN. Activities will include a mix of station and transects from the continental shelf to deep basins at all 4 locations with a common sampling programme.

Activities will include:

- Hydrographic data including CTD and ADCP.
- Carbon and nutrient biogeochemistry (inorganic and organic)
- Phytoplankton: Bio-optics and light attenuation, primary production (e.g. $^{14}C^{14}$ and Fasttracker), Chl a, species composition. Nutrient status, f-ratio, fatty acid trophic biomarkers.
- Microbial food web via flow cytometry, flow cam, samples for ciliates, bacteria, and production experiments.
- Zooplankton: VPR, Multinet, Krill trawl, Egg production, Naupliar survival, Fecal pellet dynamics, Lipid content, C & N Stable isotopes, fatty acids, feeding experiments, preservation of samples for subsequent molecular analyses
- Resolution of Vertical migration and particle flux via acoustics and in situ video e.g. VPR;
- Acoustics: 18, 38, 120, 200 kHz. Mapping of abundance, distributions and compositions. Detailed studies of predator-prey interactions

Responible: DTU-AQUA; Participants : NERI, MRI-HAFRO, IMR, UHAM, IEO, MIR
Start month 4, end month 36

T4.3 Trophic pathways

In conjunction with activities in 4.2 samples will be taken to assess the structure of the food web by employing stable isotope techniques i.e. carbon ($^{13}C/^{12}C$) and/or Nitrogen ($^{15}N/^{14}N$), experimental examination of step-wise enrichment between trophic levels. These analyzes will allow the development, calibration and thence validation of isotopic food web models thereby establishing trophic relationships within the ecosystem. In addition, group specific fatty acid biomarkers for assess the contribution of phytoplankton groups to higher trophic levels will be used to identify the food web sources of higher trophic level production. Isotopic signatures at the base of the food web will be estimated from measurements of natural abundance of isotopes in both phytoplankton specific molecules and in inorganic nutrients fueling the food web at each area.
Responsible: IEO ; Participants UHAM, MRI-HAFRO.
Start month 4, end month 36

T4.4 On board and *in situ* Laboratory studies

Field experiments will resolve the biological and physical limits of the interacting related species e.g. *Calanus finmarchicus*, *C. helgolandicus* and *C. glacialis* that are key trophic and biogeochemical spp. in the areas under consideration. Activities will include the examination of competition and selectivity of resources, interspecies predation and cannibalism. Juvenile growth and mortality responses and changes in lipid content of copepods will be monitored with respect to different food types, food quality and biomass, to evaluate how/if a potential a change in food environment may influence the competitive interactions between species. Protocols for DNA extraction and subsequent Real-Time PCR-based species-specific quantification in order to discriminate between species over ontogeny.
Responsible: DTU-AQUA; Participants NERI, IMR, MRI-HAFRO
Start month 4, end month 36

T4.5 Vital rates and plasticity.

Organism vital rates (e.g. growth, respiration, mortality) and their plasticity are critical for maintaining a species position and function in an ecosystem. Here we will in conjunction with field studies in this WP as well as in WP 3 via the performance of laboratory manipulations assess the plasticity of response to abiotic and biotic controls such competition for resources, interspecies predation and cannibalism of key ecosystem players. Our focus will be on key copepod species as they serve as a top down control on phytoplankton community structure; a key source of biomass for higher trophic levels as well as directly controlling the flux of organic material to depth via controls on fecal pellets (WP2). To determine species specific responses and their plasticity, standard protocols of reproductive success and/or egg viability during shipboard experiments (T 4.4) and laboratory experiments will be performed. Furthermore, following a common garden approach

and employing transcriptomics, a comparison of juvenile growth and mortality responses and changes in lipid content of copepods will be monitored with different relevant food types, to evaluate how/if potential changing food environment affects the cousin species. Environmental factors tested will include the full range of environmental gradients of key abiotic and biotic stressors according to the entire distribution in the North Atlantic and extremes outside these conditions in order to examine plasticity thresholds. Furthermore, during the nationally supported EURO-BASIN synoptic transatlantic survey, a transcriptomics analysis will be performed to study variations in the transcriptom of *Calanus* spp adult females during reproduction. The results here will feed directly into T6.3.2. This work will enable EURO-BASIN to project scenarios of climate forced changes in the biogeography of these engineering species in the North Atlantic, and thereby provide an estimate of system resilience to changing climate.
Responsible: UHAM; Participants SWANSEA, SAHFOS, BUC, PML; MIR
Start month 4, end month 36

T4.6 Trophodynamic modelling.

Mechanistic models describing different plankton groups will be used to explore trophic dynamics and the transfer of nutrients between plankton trophic levels using stoichiometric (quality) and quantity descriptions. These will be parameterized using data from the field and supported with data gained from field laboratory studies. These models will develop from those already built by Flynn (SWANSEA), describing bacteria, phytoplanktion (by type and size), mixotrophs (including different modes of nutrition), microzooplankton, and mesozooplankton (including age-size IBM of copepods). These models are more physiologically detailed than those commonly deployed and can thus also be used to provide reassurance for the behaviour of the simpler models (more appropriate for placement in complex 3D whole ecosystem simulators) deployed elsewhere in the EURO-BASIN project.
Responsible: SWANSEA; Participants: IEO, DTU-AQUA, NERI;
Start month 4, end month 24

9 Joint WP1-WP5 on mesocosm and cruise planning (WP1,2,3,4,5; M6)
13 Training Workshop 1 on Introduction to statistical modelling tools (WP2,3,4,5,9; M12)
14 End of data archaeology activities and deadline for the delivery consolidated and rescued historical data by T1.3 (WP1,2,3,4,5; M16)
17 Training Workshop 2 on Vital Rates measurement techniques for plankton (incl. metadata collection)(WP1,2,3,4,5,9; M16)
19 Cruise workplan for summer 2012 (WP2, 3, 4; M18)
26 Cruise to Norwegian Sea (WP2, 3, 4; M21)
32 First special issue publication of BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M24)
34 Joint WP2-5 Workshop mid-term synthesis (WP2,3,4,5; M24)
36 Training Workshop 3 on Optical Methods for taxonomy, feeding interactions and particle flux (incl. data management) (WP1,2,3,4,9; M24)
40 Joint workshop WP2 to WP8 on model synthesis (WP2,3,4,5,6,7,8; M30)
53 Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M44)

Deliverables

D4.1 Synthesis report of abundance and copepod species composition in the GIN Seas over decadal time-scales (Resp: MRI-HAFRO, with input from DTU-AQUA, MIR, IMR, Uni Research, M17)
D4.2 Synthesis report and four cruise reports on spring field campaigns in the GIN Seas and Bay of Biscay (Resp: DTU-AQUA, with input from NERI, MIR, MRI-HAFRO, IMR, Uni Research, UHAM, IEO, BUC, M17)
D4.3 Analytical model on the processes governing the transfer of biomass and energy through the marine ecosystem (Resp: DTU-AQUA, with input from Uni Research, UHAM, BUC; M24)
D4.4 Report on the estimates of vital rates and lipid composition of key zooplankton species (Resp: UHAM, with input from DTU-AQUA, SWANSEA, Uni Research, UHAM, BUC, NERI; M30)
D4.5 Analytic model and synthesis report on the lipid pump (Resp: DTU-AQUA; M30)
D4.6 Trophic dynamics model with validation supported via coupled stable isotope natural abundance sub-model (Resp: SWANSEA; M35)

Work package number	5	**Start date or starting event:**			Month: 1		
Work package title	Dynamics of living resources and their utilisation						
Activity Type	RTD						
Participant number	1	**3**	4	6	7	11	**12**
Participant short name	UHAM	DTU-AQUA	Tecnalia-AZTI	MRI-HAFRO	MIR	IMR	**IFREMER**
Person-months per participant:	15.5	26	7	12	6	10	**18**
Participant number	16	17	21				
Participant short name	USTRATH	CEFAS	CLS				
Person-months per participant:	17	9	8.2				

Objective

The objectives of this WP are:

- To determine the spatial and temporal dynamics of economically and trophically important key fish stocks and top down effects of these fish stocks on ecosystem structure and dynamics in the North Atlantic basin and its regional seas;
- To determine how carrying capacity and trophic controls may change with changing climate and its impact on the production and ecosystem role of these key fish stocks.
- Contribute to an assembly of key species and ecosystem indicators and conduct simulations on their performance under climate change for synthesis in WP8 Advancing Ocean Management

Description of work

T5.1 To identify and determine the factors governing the spatial structure of key species populations (leader: IFREMER)

We will identify the environmental factors determining the spatial distribution of key species as well as the habitat use during the life cycle, including prey availability. An important, often neglected factor, in spatial distributions are density dependent effects which will also be considered.

T5.1.1 Retrospective Analyses of the **Spatial structure of tuna populations**.

This task will conduct a data driven retrospective analysis of spatial and temporal variations of the historical abundances and distribution of two key **tuna** species of the North Atlantic basin, i.e. **bluefin** (BFT) and **albacore**, in relation to historic fishing effects and environmental conditions (e. g. hydrography, prey abundance). This will include describing historical ranges, biomasses and distributions and identifying reasons/mechanisms for disappearance from areas and changes in large-scale spatial distributions throughout the Atlantic. A reconstruction of BFT biomass in eastern population pre-1970s will be used for assessing potential roles of population abundance and competition on spatial distributions. The aim is to identify optimal habitat use under current climate, biomass and fishing levels and to compare these with distributions under past climate, biomass and fishing levels using observed data from various sources (e. g. catches, tagging, otoliths). From these analyses a spatially explicit IBM for adult BFT will be developed in Task 5.2.1. The end-to-end ecosystem model SEAPODYM will be parameterized for both North Atlantic albacore and BFT. Several hindcast reanalyses of distribution will be used to obtain the best parameterization of the model based on the likelihood predictions of spatially disaggregated catch and size frequencies of catch by the fishery. The results will serve for discriminating the impact of fishing from the natural variability, which is a key issue for the management of the species.
Responsible: DTU-AQUA; Participants: CLS
Start Month: 1; End Month: 24

T5.1.2 Spatial structure in small pelagic fish populations, Atlanto Scandic herring, blue whiting and mackerel

The recent warming and loss of sea ice has opened new feeding areas to planktivorous fish in the North

Atlantic. These northern areas often have a high standing stock of zooplankton, but lower productivity than more southerly Atlantic waters. This task will investigate the interaction between **herring** and zooplankton across the Arctic front. Cruise activities (see Gantt chart and B3.1.2 for details) will focus on the continuous monitoring of high resolution 3D distribution of hydrography, fluorescence, size resolved zooplankton, and fish. Trawl samples of fish and macro zooplankton, and multiple opening and closing net samples for meso zooplankton will be used for ground truthing of optical and multifrequency acoustic observations gathered from hull mounted and towed platform sensors on and off shelf. We will also use sonar to study fish migration and school dynamics along the path of the feeding migration. Stomach analyses will be performed on the fish looking at prey species and size using standard and state of the art molecular techniques. Apart from using standard stock assessment surveys, scientific cruises will be conducted in the Norwegian-Icelandic Seas across the Arctic front during the main herring feeding season. For **blue whiting** we will deploy spatial population modelling techniques and characterise their realized pelagic habitats at different spatial scales. For small to medium spatial scales, we will relate acoustic (multifrequency, multibeam) descriptors to biological (size, species) and environmental conditions (plankton, temperature) and exploitation (fishery catches) conditions using statistical models for describing preferred conditions and spatial overlap between predators and prey. For **mackerel** we will determine the factors that regulate the spatial distribution by relating ocean climate, plankton observations and model output to indicators of spatio-temporal distribution during spawning, feeding and migration using statistical modelling.
Responsible: IFREMER; Participants: IMR; DTU-AQUA; USTRATH; CEFAS; MRI-HAFRO, IMR, including Subcontractors Faroe Marine Research; PINRO.
Start month 1, end month 36

T5.2 To identify and quantity the trophic pathways (top down controls) acting upon mid trophic levels as driven by key fish species and fisheries dynamics (leader: IMR)

We will identify (size and composition) and quantify the trophic links between pelagic key species and their mid trophic level preys using existing information, prey abundance estimates, stomach content data analysis as well as lipid analysis and stable isotopes from field samples where no direct diet composition data exists. The aim is to calculate overall consumption by key species and determine the factors impacting this uptake (e.g. spatial distribution, physical conditions, competition) using data analysis and modelling.

T5.2.1 Top Down Controls: Tuna

Analysis of tuna diet data to characterize their prey species and determine the relative consumption of key species. Overall consumption rates and the selective pressure on the prey community, considering the variability in energy content of different types of prey, and the effect of age, time and area will be estimated through generalized additive models. IBM modelling approaches that are in development at DTU-AQUA and the LPRC (Univ New Hampshire, USA) will be tested using the oceanic environment provided by WP6, i.e. the oceanic variables (e.g. currents, oxygen, temperature) and the predicted fields of mid trophic levels (MTL) by SEAPODYM. Existing collaboration on bluefin tuna modelling with the LPRC (Univ New Hampshire, USA) will be reinforced. According to the accessibility to these different prey components and the energy content of prey, the energy allocated to the principal physiological function (somatic and gonadic growth, routine metabolism) will be computed at the individual level. The IBM will be coupled with hindcast NEMO+MTL simulations provided by WP6. We will simulate migration behaviour of adults between spawning and feeding areas, including North-South and East-West migrations, and estimate the size-specific food and temperature requirements for occupying and migrating to different habitats throughout range. We will develop and apply size-spectra models to estimate the predation impacts of BFT on lower trophic levels in the feeding areas of BFT. The model will be forced with the expected biomass-size structure of migratory BFT derived from the IBM simulations above. MTL biomass distributions as simulated in SEAPODYM will be optimized in WP6 and provided to partners of WP5 for analysis and modelling of albacore distribution and dynamics. Results for albacore and bluefin will be compared to analyze how these predator species with overlapping habitats in the North Atlantic exploit the MTL system.
Responsible: DTU-AQUA; Participants: Tecnalia-AZTI; MRI-HAFRO; CLS
Start month 6, end month 36

T5.2.2 Top Down Controls: Small Pelagic Fish, Atlanto Scandic herring, blue whiting and mackerel

The purpose of this task is to quantify the consumption by Atlanto Scandic **herring** and associated pelagic fish stocks such as **blue whiting** and **mackerel** and structuring of mid trophic levels, specifically macro- and mesozooplankton in the Norwegian Sea and further south. The interactions between planktonic prey and fish

predators affect early life stage survival, e.g. mackerel preying on blue whiting juveniles. Hence, these interactions will be quantified and the competition between the three pelagic species will be assessed. This activity requires distribution and abundance estimates of predators, diet compositions, and the development of consumption rate models as well as prey production rates. In case of limited diet composition information, stable isotope techniques will be deployed to determine the trophic level in the food web. Lipid analyses techniques will enable the determination of the type of plankton contributing to energetic reserves predators are relying upon, as well as provide a measure of nutritional condition. Furthermore, spatially resolved size-structured and simple multispecies models (e.g. Gadget, production model) will be implemented to quantify top-down pressure using input from WP6. This activity will enable an evaluation of management strategies in WP8. The performance of all models will be assessed via comparisons with survey and other data on fish and plankton abundance, length distributions and size-dependent diet data.
Responsible: USTRATH; Participants: IMR; IFREMER; CEFAS; MRI-HAFRO; UHAM;
Start month 6, end month 36

T5.3 To describe and predict fisheries and climate impacts on trophic pathways and ecosystems. (leader: DTU-AQUA)
The purpose of this task is to describe and predict the effects of changes in fisheries and climate on trophic pathways and carrying capacity of ecosystems for major pelagic fish stocks. In order to fulfil this task, scenario modelling will be carried out to predict expected changes in trophic relationships due to climate change based on predictions of future habitat and prey availability (WP3 and WP6) and changes in fisheries of the key species. The aim is to determine what the ecosystem wide impacts of such changes might be, when they propagate through the food web, in particular in terms of changes in carrying capacity. Different modelling approaches will be used, ranging from qualitative to quantitative models, while model development itself will be limited to extension and implementation of existing models.

T5.3.1 Future projections of Trophic controls: Tuna.
Using the optimized parameterization of the SEAPODYM and IBM models, projections of change in the abundance and spatial distribution of **albacore** and **bluefin** populations under IPCC scenarios and fisheries changes will be produced. Projection of habitat changes with IPCC scenarios will be provided by WP6 for oceanic environmental conditions (physical, biogeochemical and MTL variables) and used with IBM and Habitat models to investigate the potential impacts on tuna foraging habitats and the change in predation pressure on mid-trophic levels. Trophic interactions and fish community structure in the feeding areas of bluefin and albacore will be simulated forced by past, present and future-scenarios of biomasses and size-compositions derived from the IBM and SEAPODYM models. The models will simulate the equilibrium community structure and the transient trophic cascades in the feeding areas to assess bluefin and albacore trophic impacts on the fish community.
Responsible: CLS; Participants: DTU-AQUA
Start month 24, end month 47

T5.3.2 Future projections of Trophic controls: Atlanto Scandic herring, blue whiting and mackerel.
The purpose of this subtask is to develop quantitative and qualitative models of Atlanto Scandic **herring**, **blue whiting** and **mackerel** as the focal species for predicting the expected impacts of changes in climate and fishing on fish species interactions and the wider the food web dynamics. A novel biophysical 3D model system has been developed that simulates the feeding, bioenergetics and migration of NSS herring, to be extended for mackerel and blue whiting. These fish models are integrated with the NORWECOM model that now contains physics, phytoplankton and *Calanus finmarchicus*. All the levels are fully coupled so that the fish feeding removes Calanus from the model and similarly, *Calanus* grazes on the phytoplankton. The model domain covers the North East Atlantic and shelves from the Bay of Biscay northwards. Millions of identical individuals are pooled together in super-individuals, which are used to allow the IBM to represent the target fish populations and the *Calanus*. Thus. At present the model is initiated at the start of the year based on the data on stock abundance and structure taken from the respective ICES assessment working group reports (ICES 2008). Simulations will use and test the suitability of different habitats of herring; blue whiting and mackerel generated in Task 5.1 and include fish and zooplankton interactions described in Task 5.2 to assess the effects of these species on trophic cascades. Some model developments are needed in order to allow longer term simulations that involve climate change scenarios, modules that contain the spawning and subsequent egg and or larval drift phase will be developed for all the species as done recently for capelin. This will give us models that simulate the spatial distribution and growth survival over the full life cycle of

the three fish species. This will allow long term simulations aimed at investigating the effect of different climate scenarios generated in WP6 and fishing scenarios. The application of perturbation analysis to qualitative system models and projections with models from Task 5.2 will allow to evaluate the impact of global change predictions from WP6 on food web structure and system equilibrium states.
Responsible: IMR; Participants: IFREMER; USTRATH; MRI-HAFRO; DTU-AQUA
Start: Month 24; End Month 47

Milestones:
9 Joint WP1-WP5 on mesocosm and cruise planning (WP1,2,3,4,5; M6)
13 Training Workshop 1 on Introduction to statistical modelling tools (WP2,3,4,5,9; M12)
14 End of data archaeology activities and deadline for the delivery consolidated and rescued historical data by T1.3 (WP1,2,3,4,5; M16)
17 Training Workshop 2 on Vital Rates measurement techniques for plankton (incl. metadata collection) (WP1,2,3,4,5,9; M16)
22 Simulation of change in abundance and maximum catch potential (WP5,7; M18)
23 Simulation of change in distribution of key fish populations (WP5,7; M18)
32 First special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M24)
34 Joint WP2-5 Workshop mid-term synthesis (WP2,3,4,5; M24)
40 Joint workshop WP2 to WP8 on model synthesis (WP2,3,4,5,6,7,8; M30)
53 Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M44)

Deliverables:

D5.1.1 Preliminary progress report based on existing and knowledge assembled in EURO-BASIN on factors driving spatial distributions of key pelagic fish species (Resp: IFREMER; R; PU; M34)
D5.1.2 Final progress report based on existing and knowledge assembled in EURO-BASIN on factors driving spatial distributions of key pelagic fish species (Resp: IFREMER; R; PU; M42)
D5.2.1 Preliminary progress report on top down trophic control of key pelagic species on lower trophic levels based on existing and knowledge assembled in EURO-BASIN (Resp: IMR; R; PU; M34)
D5.2.2 Final progress report on top down trophic control of key pelagic species on lower trophic levels based on existing and knowledge assembled in EURO-BASIN (Resp: IMR; R; PU; M46)
D5.3.1 Preliminary progress report on predicting impacts of changing climate and fisheries on predator-prey spatial distributions and trophic interactions (Resp: DTU-AQUA; R; PU; M34)
D5.3.2 Final report on predicting impacts of changing climate and fisheries on predator-prey spatial distributions and trophic interactions (Resp: DTU-AQUA; R; PU; M42)

Work package number	6	Start date or starting event:			Month 1	
Work package title	Basin-scale Integrative Modelling					
Activity Type	RTD					
Participant number	1	5	**8**	11	15	21	23
Participant short name	UHAM	NERC	**PML**	IMR	CNRS	CLS	IMS-METU
Person-months per participant:	16	33	**24**	13.5	56	14	12

Objectives

The goal of this workpackage is to describe, understand and predict the impact of climate change and variability and mans activity (fisheries) on marine ecosystem structure and function in the North Atlantic Ocean and shelf seas. To achieve this we will take a basin-scale modelling approach, simulating the response of marine ecosystems by considering four classes of experiment using coupled physcal-biogeochemical-MTL models: re-analysis forced simulations, climate-scenario forced simulations, top down control perturbation experiments and a fully coupled end to end ecosystem model.

The integrative modelling objectives are:

- To simulate how changes in the climate induced changes in the hydrodynamics of the North Atlantic have impacted on ecosystem productivity, structure and function (T6.1)
- To understand and quantify the impact of key physical processes (meso-scale eddies, cross shelf exchanges and fluxes, winter convection) and their relative importance to the overall primary and secondary production and sequestration of carbon at the basin-scale (T6.2)
- To understand how bio geographic regions are maintained in the North Atlantic and how will they change with climate change (T6.3)
- To improve our understanding and quantify the basin-scale variability of the impact of top down (grazing) control on phytoplankton community composition and hence the sensitivity of biogeochemical cycling and the biological carbon pump? Are biogeochemical cycles in the North Atlantic sensitive to changes in fisheries management strategy?
- Contribute to an assembly of key species and ecosystem indicators for synthesis in WP8 Advancing Ocean Management.

Description of work and role of participants

A traceable hierarchy of models is a useful concept to consider (Table 6.1). We have chosen to use the Nucleus for European Modelling of the Ocean **(**NEMO) as the ocean dynamics component for the EURO-BASIN integrative modelling. NEMO is a state-of-the-art modelling framework for oceanographic research, operational oceanography, seasonal forecast and climate studies. It provides a consistent version control code, which can be run at both global and regional scales and allow both eddy resolving and eddy permitting resolutions. Starting in the MERSEA (FP6) project and continuing in the MYOCEAN (FP7) project NEMO has been systematically developed from its roots as an open ocean model to incorporate features needed to accurately represent shelf seas, such as the introduction of a non-linear free surface and variable volume, tidal forcing, and terrain following coordinates along with sophisticated calculation methods for horizontal pressure gradient and vertical mixing. We will use NEMO as the general circulation model, with common forcing to harmonise the physical environment. The various ecosystem models employedin EURO-BASIN are coupled to the NEMO physical model to facilitate the analysis and inter-comparison of different ecosystem models driven by common physical scenarios. Following this approach we will make an ensemble of simulations using a range of simple and more complex ecosystem model, each with a NEMO coupler. This will allow us to build up a multi-model multi-scenario ‘super-ensemble’. To describe the planktonic ecosystem we have chosen to use a suite of intermediate complexity (e.g. PICSES, MEDUSA) and the more complex plankton functional type (ERSEM) models. By running these different models in the same physical environment it allows us to begin to quantify structural and parameter error. The selection of mid to higher trophic level models reflects the range of approaches currently being developed and used in Europe including individual based models of zooplankton, functional group biomass models of mid trophic levels and size structured models and dynamic energy budget models. This diversity of models is required for two reasons, they extend the range of scenarios and perhaps more importantly as we are still learning how to model these processes, the comparison of approaches will inform future model development.

Table A. Models systems used in EURO-BASIN Integrative modelling

Model	**Complexity**	**Description**	**References**
NEMO Nucleus for European Modelling of the Ocean	Ocean Circulation	Z level C grid model	Madec 2008
NEMO-Shelf	Tides Free surface	Terrain following c-grid model	Being developed at NERC-POL as a component of the FP7 My-Ocean and NERC oceans 2025 programme.
NEMO-ERSEM European Regional Seas Ecosystem Model	Multi-PFT C,N,P,Si, 4P, 3Z, B, DOC, POC, Carbon chemistry	3D bulk biomass functional type pelagic-benthic ecosystem model. Optimised for massively parallel computers	Blackford et al 2004 Allen et al 2007a, b
NEMO-PISCES Pelagic Interaction Scheme for Carbon and Ecosystem Studies	2P / 2Z, DOM, POM, carbon chemistry Fe,Si,P,N co-limitation	3D global biogeochemical model. Coupled to IPSL climate model.	Aumont and Bopp, 2006
NEMO-MEDUSA Model of Ecosystem Dynamic nutrient utlilization and sequestration	2P / 2Z N, Fe,Si,	3D global biogeochemical model. Coupled to ¼ degree global NEMO.	MEDUSA is being developed at NERC_NOCS as part of the NERC Oceans2025 programme
Calanus IBM	Individual based model with for *Calanus* with super individuals,	Individual based model with super individuals for *Calanus finmarchicus*. The model relies on input in terms of phytoplankton biomass and produces 3D distributions of stage resolved abundance of *Calanus*. Key processes include bioenergetics, reproduction and behaviour.	Huse 2005; Huse & Fiksen in press.
SEAPODYM-MTL Spatial Ecosystem and Population Dynamics Model- Mid trophic levels (pelagic mid-trophic functional groups)	(1) epipelagic; (2) migrant mesopelagic; (3) non-migrant mesopelagic; (4) migrant bathy-pelagic; (5) highly migrant bathypelagic; and (6) non-migrant bathypelagic.	3-layer bulk biomass functional type pelagic- ecosystem model combining energetic and functional approaches based on the vertical behaviour of organisms and following a temperature-linked time development relationship. Adjoint code allowing parameter calibration from acoustic data.	Lehodey et al. (in press)
APECOSM Apex Predators ECOSystem Model	Whole ecosystem	Spatially explicit size based model of open ocean ecosystems. Dynamic energy budget based.	Maury et al 2007a and b
Convection IBM (CIBM)	Phytoplankton IBM. Parameterisations of convection.	The CIBM is a non-hydrostatic hydrodynamic model in which Lagrangian tracers ‘carry’ a biological model for primary production	Backhaus et al 2003

T6.1. Eddy permitting ensemble hindcast of the ecosystem of the North Atlantic
To investigate how climate induced changes in the hydrodynamic of the North Atlantic have impacted on ecosystem productivity and function this task will deliver an ensemble of past ecosystem states (phytoplankton, zooplankton and micronekton). The simulations will be for the period 1960-2005 and all forced with the identical external forcing taken from DRAKKAR to obtain commonality in the physics and assist the ensemble interpretation. The uncertainty in each component simulation will be determined by comparison with observational data collated in WP's 1-5. This information will be used to generate a weighted basin-scale ensemble of ecosystem states, which take account of structural and parameter uncertainty. These ensemble outputs will be coupled off-line to the suite of mid tropic level models (SEAPODYM-MTL, Calanus-IBM, APECOSM) to hindcast response to environmental change over the last 40 years. The ensemble of ecosystem states will be analysis focusing on the question what is the role of phytoplankton, zooplankton and micro nekton distributions in driving carbon either towards higher tropic levels (marine resources) or towards the deep waters (carbon pump, export flux, vertical migration of zooplankton). A full list of proposed simulations along with the responsible partner can be found in Table 6.2.

T6.1.1: Definition of the forcing (different atmospheric models and different scenarios) and boundary conditions for hindcast simulations. Tests on NEMO/DRAKKAR will be performed.
Responsible: CNRS;
Start month: 1, End month: 6

T6.1.2: Ensemble 40 yr hindcast (1970-2010) of the planktonic ecosystem of the North Atlantic. (MEDUSA, PISCES, ERSEM); Comparison with data, quantification of uncertainty and weighting of ensembles
Responsible: PML; Participants: NERC _NOCS and CNRS
Start month: 3, End month: 18

T6.1.3 Biological carbon budgets will be derived from the ensemble of ecosystem states (phytoplankton, zooplankton and micro nekton) to determine under what conditions carbon is either driven towards higher tropic levels (marine resources) or towards the deep waters (carbon pump, export flux, vertical migration).
Responsible: CNRS; Participants: with NERC, PML, CLS, IMR, IMS-METU
Start month: 24, End month: 30

T6.1.4: Ensemble of Mid and Higher trophic level simulations. The suite of MTL models will be coupled off-line to the weighted outputs of the planktonic ecosystem states. The SEAPODYM models will be calibrated using data assimilation techniques.
Responsible: CLS; Participants: IMR; CNRS
Start month: 12, End month: 24

T6.1.5. The fate of export C will be analyzed and quantified. The representation of the biodegradation and bio-mineralization of particles in the water column will be improved, in strong association with developments and findings of WP2. This improvement will be based on sensitivity studies on the parameterisation of relevant processes, using time sliced simulations, which will last no more than 10 years, depending upon the time scales of adjustment in the mesopelagic layer. To facilitate the process a simulation analysis workshop will be held in month 28.
Responsible: CNRS; Participants NERC, PML
Start month: 30, End month: 36

Table B Simulations in Task 6.1

Sub task	Region	Responsible Partner	Participants	Ecosystem Model	Simulation Period
6.1.2	1/4 North Atlantic NEMO	CNRS	-	PISCES	1960-2005
6.1.2	1/4 N Global NEMO	NERC	-	MEDUSA	1960-2005
6.1.2	1/4 North Atlantic	PML	CNRS	ERSEM	1960-2005

	NEMO				
6.1.3	Ensemble of planktonic ecosystem states	CLS	IMR (acoustic data) and other WP	SEAPODYM MTL and Tuna	1960-2005
6.1.3	Ensemble of planktonic ecosystem states	IMR		IBM	1960-2005
6.1.3	Ensemble of planktonic ecosystem states	CNRS		APECOSM	1960-2005

T6.2. High resolution ensemble hindcast of the ecosystem of the North Atlantic
To investigate the sensitivity of ecosystem response to key physical processes **the performance of retrospective** hindcast scenarios will be augmented by biophysical process studies. This task will develop model domains and parameterisations to quantify the impact of physical processes (cross shelf exchanges and fluxes, eddies and winter convection) and their relative importance to the overall primary and secondary production and sequestration of carbon at the basin-scale). We will set-up a high resolution (1/12 degree) NEMO-shelf model of the Northern North Atlantic (40N to 70N) and couple them with ERSEM and BFM (Table 6.3). The simulations will be for the period 1980-2005 and all forced with the identical external forcing taken from DRAKKAR to obtain commonality in the physics and assist the ensemble interpretation. The uncertainty in each component simulation will be determined by comparison with archived observational data collated in WP's 1-5. This information will be used to generate a weighted basin-scale ensemble of historic ecosystem states, which take account of structural and parameter uncertainty.

The structural differences between NEMO (z coordinates, rigid lid) and NEMO-shelf (s-coordinates, free surface volume, tides) will be investigated through comparable tracer experiments will be undertaken in 1/12 NEMO-shelf (POL) and an existing 1/12 NEMO (CNRS).
The Convection IBM model (CIBM; UHAM) will be used to parameterise the role of winter deep convection on phytoplankton dynamics and hence the basin-scale carbon budget; these parameterisations will then be implemented in the ¼ coupled physical-biological models to assess model sensitivity in comparison with simulations from tasks 6.1. A full list of proposed simulations along with the responsible partner can be found in Table 2

T6.2.1: High resolution (1/12) version of NEMO-shelf will be set-up for the northern North Atlantic coupled to both, ERSEM and BFM using the DRAKKAR forcing.
Responsible: NERC; Participants: IMS-METU
Start month: 0, End month: 18

T6.2.2: A 25yr hindcast will be made of the period 1980-2005 using the 1/12 NEMO-shelf model coupled to ERSEM and BFM forced with DRAKKAR forcing (see task 6.1)
Responsible: NERC; Participants: IMS-METU; PML
Start month: 18, End month: 24

T6.2.3: Investigation of the significance of the structural differences between NEMO and NEMO shelf in terms of the impacts on tracer distributions and ecosystem functioning. Comparable tracer experiments will be undertaken in 1/12 NEMO-shelf (NERC) and an existing 1/12 NEMO (CNRS) model to evaluate cross shelf exchange.
Responsible: CNRS; Participants: NERC
Start month: 24, End month: 30

T6.2.4: Development of CIBM and evaluation of parameterisations. CIBM will be run in selected regions with T-S-profiles and external met-forcing from our basin-models. Its predictions will be used to optimise the 'biological' parameterisation of convection. This work will be informed by fieldwork undertaken in WP's 2&4 on the METEOR convection cruise. The CIBM, thus, serves as a benchmark for checking the

quality of the parameterisation. These parameterisations will then be implemented in the ¼ coupled physical-biological models of basin to quantify the role of the winter biomass in terms of the carbon- or CO_2-budget in comparison to 'conventional' models.
Responsible: UHAM ; Participants: NERC; PML
Start month: 1, End month: 36

T6.2.5. Drawing on the simulations described in table 3 and the 1/4 NEMO-ERSEM/BFM hindcast simulation from task 6.1.2, basin-scale carbon budgets will be made to explore of the primary and secondary production and sequestration of carbon and the cross shelf exchange on C and N budgets over last 25 years. These will be analysed to determine the sensitivity and quantify uncertainty in the basin-scale C budget to key physical processes. Comparison will be made to assess the pro’s and cons of ‘shelf’ vs. ‘classical’ physics, ‘eddy resolving, 1/12’ vs. eddy permitting 1/4 ocean physics and parameterisations of winter convection. To facilitate the process a simulation analysis workshop will be held in month 30.
Responsible: POL; Participants: with CNRS, IMS-METU, UHAM
Start month: 30, End month: 36

Table C Simulations in Task 6.2

Sub task	Region	Responsible Partner	Particip ants	Models -	Simulation Period
6.2.2	1/12 NNorth Atlantic NEMO-Shelf	NERC	PML	ERSEM	1980-2005
6.2.2	1/12 NNorth Atlantic NEMO-Shelf	IMS-METU	NERC	BFM	1980-2005
6.2.3	1/12 NNorth Atlantic NEMO-Shelf	NERC	CNRS	Tracers	1980-2005
6.2.3	1/4 NNorth Atlantic NEMO	CNRS	NERC	Tracers	1980-2005
6.2.4	¼ North Atlantic NEMO-CIBM	UHAM	PML	ERSEM	1980-2005

T6.3. Bio-geographical evolution at the basin-scale (past, present and near future)
The second class of model simulations are forced by global climate simulations, which are unconstrained by observations and represent ‘typical’ conditions both in the past and under various atmospheric composition scenarios (defined in IPCC-AR5). The scenarios of GreenHouse Gas (GHG) emissions and land-use changes that will be used for these simulations are the Reference Concentration Pathways (RCP). RCP are divided according to the radiative forcing level achieved at the end of this century, therefore RCP8.5 is constructed to have an additional GHG-driven 8.5 W m^{-2} radiative forcing from the atmosphere. Three major levels have been selected in the RCP database (Fig. 1): RCP8.5 (Riahi and Nakicenovic, 2007), RCP4.5 (Clarke et al., 2007) and RCP3 (van Vuuren et al., 2007) that was developed in the framework of the EC FP6 ENSEMBLES project. Since EURO-BASIN focuses on the near future (+30 years), it is important to clarify what are the expected emissions during this time window that will affect the ocean climate conditions. The optimal choice would be to carry out simulations using two extreme conditions, although the focus up to year 2030 limits the GHG differences to a few ppm (CO_2 range is about 435 to 455 ppm).

This task aims to understand how bio geographic regions are maintained in the North Atlantic and how will they change with climate change. It will build on the methodologies developed in task 6.1. Once again using the medium resolution basin model (1/4) degree models, we will make an ensemble of targeted future climate states simulations, this time driven by IPCC climate scenarios from AR5 rather than the reanalysis forcing form DRAKKAR. The simulations will be analysed with a focus on the understanding of the processes controlling the historical evolution of the bio-geography and fish habitat of the North Atlantic basin and providing error quantified estimates of future states. The focus will be on the next 30 years to address the time frame of most concern to policy requirements. A full list of proposed simulations along with the responsible partner can be found in Table 6.4

T6.3.1: Definition of the climate forcing (AR5 climate scenarios) for the EURO-BASIN community. Suitable climate forcing for the basin region will be selected and obtained from the French and UK climate modelling centres.
Responsible: CNRS;
Start month: 12, End month: 18

T6.3.2: Ensemble of climate forced simulations (2000-2040): The planktonic ecosystem of the North Atlantic will be simulated using the suite of coupled ¼ models (MEDUSA, PISCES, ERSEM). These will be compared with the hindcast simulations and in-situ data to quantify uncertainty and weight the ensembles. This task will be coordinated by PML in collaboration with NERC_NOCS and CNRS, with each named partner being responsible for their own simulations;
Responsible: PML; Participants: NERC_NOCS and CNRS with each named partner being responsible for their own simulations
Start month: 18, End month: 30

T6.3.3: Ensemble of Mid and Higher trophic level simulations. The suite of MTL models will be coupled off-line to the weighted outputs of the climate forced planktonic ecosystem states to project present and future zooplankton and micro-neckton distributions,
Responsible: CLS; Participants: IMR; CNRS
Start month: 24, End month: 36

T6.3.4: The past, present and future ensembles (from T6.1, 6.2 and 6.3) will be analysed for changes in biogeography fish habitat and population dynamics. The hindcast simulations will be validated in a bio geographic sense drawing on T3.2, T3.3 and T5.1. We will sample the models to recreate where possible the data-sets used in WP3 and analyse them using the same statistical methods to assess how well the models reproduce observed patterns. The hindcast simulations will also be assessed to see if the model ensemble reproduces observed changes in phenology, community structure, 1980's regime shift, observed relationships with the NAO and position of the gulf stream. In addition we will use classification tools such as self organising maps along with multi-variate statistics to assess and define biogeographic changes. The climate forced scenarios will be analysed to project potential changes in biogeography and fish habitat along with estimates of uncertainty, from model structure, parameter choice and climate forcing. This information is crucial for assessing how reliable future ecosystem states might be. To facilitate the process a simulation analysis workshop will be held in month 42.
Responsible: PML; Participants: CLS, IMR, CNRS, NERC_NOCS, IMS-METU
Start month: 36, End month: 42

Table D Simulations in Task 6.3

Sub task	Region	Responsible Partner	Participants	Ecosystem Model	Simulation Period
6.3.2	1/4 North Atlantic NEMO	CNRS		PISCES	2000-2040 (climate forced)
6.3.2	1/4 Global NEMO	NERC_NOCS	CNRS	MEDUSA	2000-2040 (climate forced)
6.3.2	1/4 North Atlantic NEMO	PML	CNRS	ERSEM	2000-2040 (climate forced)
6.3.3	Ensemble of plantonic ecosystem states	CLS	Link with WP5 and WP7	SEAPODYM-(MTL and tuna)	2000-2040 (climate forced)
6.3.3	Ensemble of planktonic ecosystem states	IMR		IBM	2000-2040 (climate forced
6.3.3	Ensemble of planktonic ecosystem states	CNRS		APECOSM	2000-2040 (climate forced

T6.4. Ecosystem (phytoplankton, zooplankton and micronekton) sensitivity to top down control
The range of mid and higher trophic level scenarios run in tasks 6.1, 6.3, WP5 & 7 will be exploited to investigate the effects of top down control on planktonic ecosystem structure and function and the implications for biogeochemical cycling. Changes in the distribution and amount of predators will affect predatory interactions and thus alter the structure of planktonic ecosystems. This work will utilize the full range of models considered in EURO-BASIN. Scenarios will be designed to assess the sensitivity of planktonic ecosystems to top-down control by fish stocks and fisheries management. Emphasis will be

placed of looking for evidence of trophic cascades. Simulations are considered in hindcast mode and in climate forced mode. The results will be used in WP7 and WP8. A full list of proposed simulations along with the responsible partner can be found in Table 6.5

T6.4.1: Scenario definition: the impact of changes grazing pressure by mid and higher trophic levels on the cellular ecosystem will be investigate through imposing observed and simualted patterns and rates of grazing (spatially resolved prey fields from habitats from WP3 and spatially resolved predation rates from observations and modelling from WP 5) imposing simulated rates of grazing from SEAPODYM-MTL, IBM and APECOSM; Grazing pressure and the additional detrital pool from MTL detritus pool will be imposed on the plankton model by computing grazing values based on MTL production and distribution, and detritus pool proportional to the biomass of MTL defining scenarios which include changes in rates of grazing under the influence of management strategies and economics (from WP7). A workshop will be held in month 36 to define the scenarios.
Responsible: PML ; Participants: CLS, IMR, CNRS, NERC _NOCS
Start month: 36, End month: 39

T6.4.2: Simulations of the sensitivity of planktonic ecosystem models to changes in grazing pressure based on the scenarios defined in T6.4.1 will be made. The suite of coupled ¼ degree plankton models will be re-run with subsets of the scenarios from T6.1 & T6.3. A time-slice approach will be used; the precise length of simulations being determined by weighting a number of factors including, the excepted timescales of response, computational cost and statistical considerations.
Responsible: PML; Participants: NERC_NOCS; CNRS
Start month: 39, End month: 45

T6.4.3: In order to tackle both the climate change and predation pressure impact on the ecosystem functioning in the North Atlantic Ocean, biogeochemical models will be dynamically coupled to higher trophic level model making use of the 2 way couplers developed in the FP7 MEECE project (APECOSM-PISCES and Calanus-IBM-ERSEM). These simulations will consider both the 1960-2005 period and the IPCC years (until 2040). Comparisons with non coupled simulations, forced either by climate variability, or by offline top down forcing, will enable a quantification of the feedbacks mechanisms driven by the non-linear processes constraining the ecosystem behaviour.
Responsible: CNRS; Participants: PML, CLS and IMR
Start month: 30, End month: 42

T6.4.4 Simulation analysis and synthesis with the aim of attributing whether any changes are due to climate or management. For example can we induce a trophic cascade and what are the consequences? We will assess whether the planktonic ecosystem and its goods and services maybe sensitive to changes in fisheries management strategy. To facilitate the process a simulation analysis workshop will be held in month 44. The work will be undertaken in collaboration with M Follows subject to NSF funding.
Responsible: PML; Participants: CLS, IMR, IMS-METU, CNRS, NERC
Start month: 42, End month: 48

Table E Simulations in Task 6.4

Sub task	Region	Respon sible Partner	Partici pants	Ecosystem Model	Simulation Period
6.4.2	1/4 North Atlantic NEMO	CNRS	PML NERC	ERSEM PISCES MEDUSA Observed Grazing	Multi year (5-10yrs) (Drakkar forced)
6.4.2	1/4 North Atlantic NEMO	PML	CNRS NERC	ERSEM PISCES MEDUSA Off line Modelled Grazing	Multi year (5-10yrs) (Climate forced)
6.4.2	1/4 North Atlantic NEMO	PML	CNRS NERC	ERSEM PISCES	Multi year (5-10yrs) (Climate forced)

				MEDUSA Management strategies	
6.4.3.	1/4 Atlantic NEMO	CNRS		PISCES/APECOSM 2 way coupled	1960-2005 2000-2040 (climate forced
6.4.3.	1/4 Atlantic NEMO	PML	IMR	ERSEM/Calanus IBM 2 way coupled	1960-2005 2000-2040 (climate forced

Milestones

2 Joint WP1/WP6 session at Kick-Off meeting regarding the algorithms of Task 2.4, identify key literature datasets (WP1,2, 6; M1)
8 DRAKKAR forcing assembled (WP6; M6)
11 Ecosystem models coupled to NEMO and tested in ¼ degree (WP6; M12)
18 CIBM implemented in NEMO (WP6; M18)
28 ¼ degree, 45 year ensemble hindcast (WP6; M24)
29 1/12 degree, 45 year hindcast complete (WP6; M24)
31 Climate forced scenarios defined (WP6,7; M24)
32 First special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M24)
33 Initial implementation of generation 1 algorithms in 1D model (WP2, 6; M24)
35 Scenario development (WP6,7; M24)
39 Climate forced ensemble complete (WP6; M30)
40 Joint workshop WP2 to WP8 on model synthesis (WP2,3,4,5,6,7,8; M30)
42 Preliminary dataset from Cruise 1. Transfer of best algorithms to WP6. Impacts of mesocosm and cruise results on initial algorithms considered. Planning for PAP site cruise complete (WP2,6; M30)
48 Implementation of new algorithms in WP6 models presented. Full dataset from cruise 1 available, preliminary dataset from cruise 2 available, revision of algorithms to take account of results from mesocsom experiments and 2 cruises (WP1, 2, 6; M36)
49 Joint workshop WP5/WP6 for defining key forecast scenarios for top down control (WP5,6; M36)
51 Climate forced ensemble with modified top down control simulation analysis workshop (WP6; M42)
53 Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6; M44)
55 Joint WP2/WP6 workshop on simulation synthesis using finalised algorithms (WP2, 6; M45)

Deliverables

D6.1 Initial conditions, boundary conditions and forcing functions (M6, O, PU, Resp: CNRS)
D6.2 CMIP5 climate forcing 2000-2040 (M17, O, PU, Resp CNRS)
D6.3 Ensemble of hindcasts of basin-scale ecosystem (1/4 degree 1960-2005) and (1/12 deg 1980-2005); key variables which describe the carbon budget and are proxies for fisheries habitat (M30 O, PU, Resp: PML)
D6.4 Report on major controls on the ecosystem and biogeochemical cycling at the basin-scale (M35 R, PU, Resp: CNRS)
D6.5 Report on role of biophysical interactions on basin-scale C and N budgets (M35 R, PU, Resp: NERC_POL)
D6.6 Report on the role winter convection in controlling the basin-scale C budget (M35 R, PU, Resp: UHAM)
D6.7 Ensemble of climate forced of basin-scale ecosystem simulations (2000-2040); key variables which describe the carbon budget and are proxies for fisheries habitat (M35 R, PU, Resp: PML)
D6.8 Atlas of past and future changes in basin-scale biogeography/ and fisheries habitat based on model outputs (M46 O, PU, Resp: PML)
D6.9: Report on the sensitivity of the planktonic ecosystem of the North Atlantic to climate changes and changes in management strategy (M46 O, PU, Resp: PML)
D6.10. Peer reviewed publications (M46 O, PU, Resp: ALL)

Work package number	7	**Start date or starting event:**			Month 1		
Work package title	**Bioeconomic modelling of N.Atlantic fish resources**						
Activity Type	RTD						
Participant number	**8**	9	14	17			
Participant short name	**PML**	UEA	IRD	CEFAS			
Person-months per participant:	10	19.3	27	1			

Objectives

The overall objective of WP 6 is to "assess the impacts of Global Environmental Change (GEC), including climate change, fisheries management and market developments, on the productivity, dynamics and services of North Atlantic-wide Fish commodities. Specifically we will:

- Estimate the economic cost of sub-optimal fisheries management (hindcast)
- Predict the distribution and production of key fish stocks based on climate change projections.
- Develop and apply a bio-economic model of fish commodities in the North Atlantic
- Investigate the consequences of climate change and economic globalisation on the basin-wide fish production system
- Contribute to an assembly of key species and ecosystem indicators for synthesis in WP8 Advancing Ocean Management

Description of work

T7.1 Estimating the economic loss of sub-optimal fisheries management in the North Atlantic.
In this task we will estimate the loss of potential economic rent in the North Atlantic fisheries system providing retrospective analyses of the economic efficiency of past management activities over circa the last 50 years. Foc species will be the commercially exploited fishes and invertebrates (species reported in the FAO landing statisti contributes to top 95% of the reported landings) in the NE Atlantic (>10050 spp.). Analyses will be based on ca data from ICES, FAO and the "Sea Around Us" project database . The latter provides taxonomic and statisticall resolved information through algorithms that also minimize some inaccuracies associated with the original FAC landings statistics.

The loss is the difference between the potential and the actual net benefits, and can be attributed to a) depleted stocks, b) overcapacity c) inefficient governance. Classic single species bio-economic models (Gordon, 1954; Schaefer, 1954) will be used to evaluate past production trends to the potential economic benefit lost derived from a non (economically) optimal management. The ecosystems potential to generate equilibrium economic profits (MEY) and fish production (MSY) will be estimated based on published biological and economic parameters and will be compared with observed trends in catches (FAO data) and incomes. Dynamic optimal strategies will also be estimated and compared to logbooks records. The analysis to be employed has been used at the global level by the World Bank and is useful to understand the potential losses of a sub-optimal management.
Responsible: PML; Participants: IRD
Start month: 1, End month: 34

T7.2. Predict the distribution and production of key fish stocks based on climate change projections.
This task will use a simulation model to project future (from 2005 to 2050) distribution and production of the 50 species of exploited fishes and invertebrates that contribute the top 95% of annual catch in the North Atlantic in the 2000s. The simulation model will be based on the integration of the species-based models developed by Cheung et al. (2008a; 2009; 2010) and the size-spectrum model developed by Jennings et al. (2008). Scenarios of changes in physical and biogeochemical conditions of the North Atlantic (based on outputs from Task 6) will be evaluated. Specifically:

T7.2.1. A new version of the dynamic bioclimate envelope model, originally developed by (Cheung et al. 2008a, 2009), will be used to simulate changes in distribution of key fish stocks in the North Atlantic. This model will account for the effects of changes in physical (temperature, ocean current pattern, sea ice extent, habitat quality) and biochemical (salinity, pH, oxygen content) conditions on the ecophysiology, population

dynamics and distributions of marine fishes and invertebrates. The model is based on the principle that life history and growth characteristics of marine fish and invertebrates are dependent on temperature, ocean productivity and chemical content (e.g. pH, oxygen) in the ocean. Changes in life history and growth then affect population dynamics of the species. Moreover, changes in ocean pattern may also affect dispersal patterns. Also, habitat suitability for a species, which determines the species' carrying capacity in an area, is also dependent on ocean conditions. The dynamic bioclimate envelope model essentially links these components to gather to predict distribution and relative abundance of the studied fishes and invertebrates. The analysis will be applied to study the 50 species of commercially exploited fishes and invertebrates that are being used in tasks 7.1 and 7.3. The timeframe of the projections are from 2005 to 2050. For this purpose, a list of major fish stocks (in terms of catch volume and value) will be compiled. Data on the life history, ecology and distribution of these species will be collated from published literature, reports and available databases (e.g., FishBase). These data will be used as basic parameters for the simulation modeling, similar to the existing version of the dynamic bioclimate envelope model (Cheung et al. 2009). The new version of the model model will be RUN AT ½o lat. x ½o long. resolution and will be used to project changes in distributions of fish stocks. Projections of changes in ocean physical and biogeochemical conditions will be provided by work package 6.
Responsible: UEA;
Start month:1, End month: 12

T7.2.2. This task will examine the effects of trophic interactions on the projections from Task 7.2.1. The dynamic bioclimate envelope model in T7.2.1 will be further extended to incorporate size-based trophic interactions. Strong interactions between species and size classes are expected when the bioclimate envelope model predicts that parts of the spectrum are 'over-occupied' and weak interactions when parts of the spectrum are 'under-occupied'. Thus, increased competition from 'over-occupation' is predicted to reduce the probability of habitat colonization while reduced competition from 'under-occupation' will reduce it. The change in habitat suitability defined by physical conditions and degree of over or under- occupation will be predicted by integrating the size-spectrum model (Jennings et al. 2008) with the dynamic bioclimate envelope model (Cheung et al. 2008a; 2009). This model will be applied to project future distributions and production of the 50 key fishes and invertebrates in the NE Atlantic. The projections will be compared with those from Task 7.2.1. The range of results from Task 7.2.1 and 7.2.2 will be determined the sensitivity of the projections to different assumptions of key hypotheses determining distribution and production of the studied species.
Responsible: UEA; Participants: CEFAS
Start month: 1 , End month: 24

T7.2.3. Size and species based models derived from macroecological theory will be used to predict fish abundance for the thirty most heavlily expoited fish stocks,their productivity at the species-level (Cheung et al. 2008b) as well as abundance and productivity by size class (Jennings et al 2008) will be integrated. The size-based approach places constraints on overall system productivity while the species-based approach demonstrates how species redistribute and share the available production. Using these approaches and predictions from ecosystem models in work package 5 (Integrated Modelling) and outputs from 6.2.1, the effects of climate change on the fisheries potential of key North Atlantic fish resources will be projected.
Responsible: UEA; Participants: CEFAS
Start month: 1, End month: 24

T7.3. Develop a bio-economic model of fish commodities in the North Atlantic
In this task we will make use of the NEATS (Network Economics Approach to Trophic Systems) concept proposed by Mullon et al. (2009). This approach will allow an examination of the economics of ecosystems through a distributed model of the bio-economics of the North Atlantic basin. The model will relate as entities, the primary production grounds, the main biological compartments, the main fisheries and the main fish products markets. The model will be based on the Network Economics approach (Nagurney, 1993), a powerful approach that deals with the economics of stocks/ flows systems such as migration systems and supply chains. Network models are also particularly apt to represent ecological systems as they allow a multiplicity of interactions and their magnitude, upon many ecosystem properties (e.g. resilience) depend. An example of such model has been recently been completed regarding global fishmeal and fish oil resources (Mullon et al. 2009), here we will develop a similar model for global tuna resources, providing additional know-how and expertise. A central concept is to quantify the value of flows along the network links, i.e. the costs and benefits of the flow. The main principle of such a model coupling economics and ecology lies in

assuming that there is a transfer (of food along the path between predator and prey, of a commodity between a producer and a consumer in a market) if, for the agents, the benefits are greater than the costs. This trade-off is the core of the Networks Economics Approach to Trophic Systems (NEATS, Mullon et al. 2009). The network model will bridge the differences in species, spatial and temporal resolution between the ecosystem models developed in Task 7.2 and the socio-economic information of marine goods trade. Ideally, the model will include up to 50 spatial habitats (starting with FAO catch areas) , 50 fish stocks (mostly at species level, occasionally at functional group levels), 50-100 fleets (a combination of type of vessel and management units) and 50-100 fish markets. Selection of these will be done on the basis of economic value and trade, ecological role, and habitat, making extensive use of the habitat and trophic pathways investigated in WP4, 5 and 7. Availability of trade and production data is likely to be a constraint on the spatio-temporal-species resolution of the model. OECD and Eurostat databases have already been accessed. However, preparation of datasets will comprise a significant part of the initial phase of the activities, before the model resolution can be finalised. Simulations will be run for 30 to 50 years in a scenario-oriented perspective. Input parameters will be selected during scenario meetings of the project partnership. At the end the model will be run according to hypotheses examining the effects of global change on primary production (productivity), ecosystem functioning (changes in the structure of the mixed layer, trophic pathways) and the effects of economic globalization (changes in demand, costs). A special FOCUS will be put on the communication between scientists and other stakeholders that is provided by an integrated model. To this end a special interface will be developed allowing the visualization of scenario consequences. Responsible: IRD;
Participants: PML
Start month: 1, End month: 46

Milestones
7 Definition of the structure of the model: entities, data (WP1, 7; M6)
12 Testing of the models to project species distributions and potential catch and estimation of model parameters(WP7; M12)
15 Estimation of Gordon-Schafer’s parameters and simulate past fishery trends (WP7; M16)
16 Estimation of target reference points (MSY and MEY) and dynamic optimal exploitation for key species (WP7; M16)
20 Development of a prototype model (all components, restricted set of data (WP7; M18)
22 Simulation of change in abundance and maximum catch potential (WP5,7; M18)
23 Simulation of change in distribution of key fish populations (WP5,7; M18)
31 Climate forced scenarios defined (WP6,7; M24)
35 Scenario development (WP6,7; M24)
37 Workshop to develop exploitation and management scenarios for the North Atlantic basin (WP7,8; M24)
40 Joint workshop WP2 to WP8 on model synthesis (WP2,3,4,5,6,7,8; M30)
47 Development of a full model (WP7; M36)
50 Access of model outputs to stakeholders to determine governance pathways (WP7; M42)
53 Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6, 7, 8; M44)

Deliverables

D7.1 Hindcast estimation of potential and net economic benefits of N. Atlantic fisheries (Resp:PML; R; PU; M34)
D7.2 Scenarios for economic vs ecological optimisation in the future use of N. Atlantic fisheries (Resp:PML; R; PU; M34)
D7.3 Report on exploitation and management scenario workshop (Resp:PML; R; PU; M34)
D7.4 Projected future changes in maximum catch potential of key fish populations (Resp:UEA; R; PU; M24)
D7.5 A simulation model that account for trophic interaction in predicting distribution of exploited fish/shellfish
populations (Resp: UEA; R; PU; M24)
D7.6 Scenario-based estimation of the consequences of climate change, resource use and economic development on the sustainability of North Atlantic fish resources (Resp: IRD; R; PU; M35)
D7.7 A user-friendly integrated model allowing users to build their own scenarios and evaluate the

consequences
(Resp: IRD; R; PU; M35)

D7.8 Proposals for basin-scale governance based on scenario evaluation with stakeholders (Resp: IRD; R; PU; M47)

Work package number	8		**Start date or starting event:**		Month1	
Work package title	Advancing Ocean Management					
Activity Type	RDT					
Participant number	**1**	3	8	12	16		
Participant short name	**UHAM**	DTU-AQUA	PML	IFREMER	USTRATH		
Person-months per participant:	10.5	8.5	4	1.7	25.3		

Objectives

The overall objective of this WP is to synthesise and extend findings of earlier WPS to develop understanding and approaches that will improve and advance ocean management by strengthening the ecosystem approach to resource management. To this end, activities in this WP will buttress our understanding of the variability, potential impacts, and feedbacks of global change and anthropogenic forcing on ecosystem structure, production of exploited fish stocks, sequestration of carbon, changes in ecosystem state and key species abundance of the North Atlantic Ocean and associated shelf seas.

- Based on activities in WP1-6 to assess the future development and susceptibility of North Atlantic marine ecosystems and their key species to changes in climate and exploitation patterns.
- Evaluate existing and alternative ecosystem and key species indicators under contrasting environments and exploitation regimes.
- Furthering the activities in WP 7 assessing the impact of climate change and resource exploitation on the North Atlantic carbon cycle in economical terms.
- Assess the applicability of existing EC management measures and directives (i.e. CFP; MSDF) or their principals for application in the wider North Atlantic Ocean management.

Description of work and role of participants

T8.1. Estimate the economic impact of change in the North Atlantic carbon cycle.

This Task will resolve how the regulation of carbon by North Atlantic ecosystems may change according to predetermined climate change and fisheries scenarios and determine the financial value of this regulatory service. Drawing from the modelling undertaken in WP6 and using a mass balance approach), this task will identify the sources and sinks of carbon within the North Atlantic and the volumes of carbon involved. How these pathways might change as the climate changes will then be demonstrated. Additionally, the positive or negative impact of fisheries to carbon sequestration will be assessed. Primary productivity will be examined to identify the extent to which it shadows the balance of carbon and therefore, its potential use as an indicator of gas and climate regulatory services. The value of the North Atlantic, in terms of gas and climate regulation, can then be calculated. As carbon is now traded on the market and has a financial value, this is a straightforward procedure. Using the estimates generated from the model in WP7, the change in value of carbon sequestered and emitted can be calculated on a value/tonne basis. Given the emerging nature of the existing carbon markets, however, and their current volatility, the social cost of carbon will be used to calculate this value. The social cost is based on the full global cost today of an incremental unit of carbon emitted now, summing the full global cost of the damage it imposes over the whole of its time in the atmosphere. Key activities:

- Identify the extent to which primary productivity shadows the balance of carbon and therefore, its potential use as an indicator of CO_2 and climate regulatory services,

- Identify the sources and sinks of carbon within the North Atlantic, the volumes of carbon involved, and explore how the export flux of carbon might change with a restructuring of the ecosystem caused by climate change and fisheries.

- Estimate the Carbon-equivalent economic impact of changes in the North Atlantic carbon cycle due to climate change emissions and exploitation of living resources.

- Using the shadow price of carbon, calculate a value for current gas and climate regulation provided by the North Atlantic and estimate how this may change according to the climate change scenarios explored by WP6 and 7.

Responsible: PML;
Start month 1, End month 46

T8.2. Comparative analysis of North Atlantic marine food web structure and function.
This Task will focus first, on performing comparative food web analyses, based on the principles of Ecopath, for a set of North Atlantic regions. Then, the Task will conduct scenario analyses of the effects of changing fishing and environmental conditions in each region.

The aim of the food web analyses will be to distil out of historic data via retrospective analyses , metrics to describe food web structure and function such as are required for the EU-MSFD indicators of good ecological status. The approach will be to harvest the new information on diet and abundance coming from the other WP's in EURO-BASIN, and merge this with existing data sets. These data will form the basis for applying the linear Ecopath equations to estimate the steady state annual flux of biomass in feeding networks representative of each of the study regions. The analysis will allow assessment of the role of key species in each region, ratios of production by integrated functional groups, and a variety of network metrics. For example, ratios of benthic:pelagic production and benthic invertebrate:demersal fish production which have been found to be diagnostic of ecosystem status in a variety of regions.

Analyses based on the linear Ecopath equations provide steady state estimates of biomass fluxes. However they do not allow scenario testing to determine, for example, the ecosystem consequences of changes in fishing patterns or environmental conditions. For this, a dynamic simulation system is required. Ecosim – the dynamic version of Ecopath – is one of a number of options for dynamic simulation and forward projection. However, Ecosim does not represent environmental effects on primary production or nutrient recycling, so is of limited use for investigating bottom-up effects on the food web. For EURO-BASIN, we will develop an alternative simulation system incorporating more explicit representation of low-trophic level and nutrient processes drawing on output from models developed in WP5 and WP6. Finally, scenario analyses with Ecosim will be used to investigate interacting effects of climate change and fishing on food web structure and functioning, including the examination of indicators representing good ecological status within the MSFD.
Responsible: USTRATH; Participants: ALL
Start month 1, end month 48

T8.3. Integrative analysis of past and future ecosystem change
This task will perform an integrative analysis of changes in ecosystem structure (e.g. Key species) and function of the north Atlantic basin and shelf seas both in retrospective (Task 8.3.1), but especially for potential futures of climate and exploitation scenarios (Task 8.3.2). To achieve this, observational and modelled data from WPs 1-6 will be assembled in matrices of abiotic and biotic datasets integrating ecosystem components, key species and driving forces. Specifically these data are derived from WP1 (historical data and external databases), WP3 (restrospective analyses, size spectrum and habitat models, WP4 (historical data analyses and trophodynamic models), WP5 (fish distribution analyses and coupled fish-ecosystem models), WP5 (NPZD-type ecosystem models) and WP8.2 (mass-balance models). Multivariate statistical analyses (see Task 8.3.1) will then be applied on these data sets to extract the main modes of variability and to derive integrative indicators of ecosystem change and ecological status and key species status. Ecosystem changes of the North Atlantic and shelfs including structural reorganizations such as regime shifts will be further investigated using statistical techniques identifying discontinuities in time-series. The integrative analyses of these data will help understanding the effects of multiple drivers (i.e. climate, eutrophication and fisheries) influencing trophodynamics and functional biodiversity. It will further allow a reliable assessment of the future structure and function of North Atlantic ecosystems under different scenarios of climate and exploitation.

T8.3.1 Retrospective analysis of historical changes in ecosystem structure and function
This Task will apply a number of multivariate statistical analyses (e.g. PCA, CCA, RDA) on large abiotic and biotic datasets described above, integrating all ecosystem components and driving forces. Ecosystem changes of different subareas of the North Atlantic will be analysed for structural changes (i.e. regime shifts

ad species dominance) using statistical techniques such as Chronological Clustering and Sequential Regime Shift Analysis (STARS). By doing these analyses separately for sub-areas of the North Atlantic and on the complete data sets (all variables), as well as separately for drivers (abiotic and anthropogenic variables) and biotic response variables, EURO-BASIN will identify if and how distinct changes in pressure variables precede and cause changes in food web structure. The results of the extensive multivariate analyses will be visualized using the ”traffic light framework”.

A further aim of this Task is to identify the main pressures causing and/or maintaining potential changes in food web structure and key species influence in each sub-ecosystem. To this end direct ordination analyses (e.g. redundancy analyses) will be applied to identify which pressure variables explain most of the overall pattern in the biotic response variables. Furthermore, generalized linear and non-linear mixed effect models (GLMM and GAMM) will be applied using principal components derived by PCAs as response variables and pressure variables as predictors.

To identify processes (species interactions) that maintain a food web in an altered state following a compositional change, temporal trends in trophic control will be analysed and compared between potential regimes. For this, we will analyse temporal trends and discontinuities in predator-prey relationships. By comparing the timing of potential breakpoints in predator-prey correlations between different species, key interspecific processes from which further food web changes may cascade can be identified. In addition, thresholds leading to breakpoints will be determined by for example applying threshold-GAMs.
To understand the relative importance of different processes and pressures in causing changes in food web structure, the results will be synthesised in comparative analyses across different North Atlantic sub-areas. Time series of functional groups as well as scores derived from biotic variables through ordination methods will be investigated for common trends across sub-ecosystems. The overall effect of large-scale pressures, such as climate indices, temperature, salinity, and fishing, on these trends will be analysed using generalised mixed effects models to disentangle common trends and area (sub-ecosystem) effects. Additionally, time series analyses will be performed directly incorporating explanatory variables (e.g. dynamic factor analysis), or by subsequently correlating extracted common trends with pressure variables (e.g. min-max autocorrelation factor analysis).
Responsible: UHAM, Participants:ALL
Start month 2, end month 34

T8.3.2 Ecosytem Ensemble: Integrative forecasting of potential futures in ecosystem structure and function
This Task will provide potential future states of the north Atlantic and shelf sea ecosystem structure and function, using output of the various modelling approaches developed and applied in WPs. Specifically these are *size spectrum and habitat* models (WP3), *trophodynamic* models (WP4), *coupled ecosystem and fish* models (WP5), *NPZD-type* models (WP6) and *mass-balance* models (WP8). Using these models in “forecasting mode” in the different future scenarios of climate change and fisheries exploitation will provide this Task ensemble of time-series for the various ecosystem futures. The *ensemble scenario projections* will then be analysed in an integrative way using the same approach as described in Task 8.3.1 for the historical reconstruction involving multivariate statistical and discontinuity analyses. These integrative analyses will provide holistic pictures and indicators of future changes in ecosystem structure and function. They can furthermore serve as a test of model output for internal integrity, i.e. that various variables are related to each other in a historically observed and explainable way and secondly enabling forecast of variables not projected in the bio-physical models by means of multivariate statistics. These will be investigated with respect to their responsiveness for the change they are supposed to indicate and robustness against other drivers of change.
Responsible: UHAM, Participants: ALL
Start month 2 end month 48

T8.4. Advancing ecosystem based fisheries management in North Atlantic open waters under climate change.

Focus will lie on answering overarching questions raised by the commission in the Green Paper (2009) on the revision of the CFP touching on general principals to be considered in any fisheries management system, i.e. also outside EC jurisdiction:

- How can the objectives regarding ecological, economic and social sustainability be defined in a clear, prioritised manner which gives guidance in the short term and ensures the long-term sustainability and viability of fisheries?
- How can indicators and targets for implementation be defined to provide proper guidance for decision making and accountability?
- How could the MSY commitment be implemented?
- How can the future CFP support adaptations to climate change and ensure that fisheries do not undermine the resilience of marine ecosystems?
- How can conditions be put in place to produce high-quality scientific research regarding fisheries in the future, including in regions where it is currently lacking? How can we best ensure that research programmemes are well coordinated within the EU?
- How could the EC strengthen its role on the international stage to promote better global governance of the sea and in particular of fisheries?

The task will investigate the dependence of fish stock distribution and productivity of some of the world's largest and economically most valuable fish stocks on following drivers: i) climate change, ii) species interactions (both bottom-up and top-down control) and iii) fisheries. The analysis will be based on output from WP3 (habitat description), WP4 (lower and mid trophic level interactions), WP5 (fish stock and fisheries dynamics and linkage to the ecosystem), WP6 (integrative basin-scale modelling) and WP7 (bioeconomic modelling) as well as previous tasks under WP8. It will compare the economic, ecological and social importance of major North Atlantic pelagic fisheries as provider of food protein, as labour intensive primary production industries as well as environmentally impacting activity structuring ecosystems and affecting the oceans capability of carbon sequestration. Contrasting the economic value of fish production considering operational costs and investments, employment in the fishing sector and downstream industries as well as the environmental impact of fishing will help to define priorities for fisheries management directives such as the CFP. The task will inform managers, stakeholders and the public in a concise way on the importance of opeNorth Atlantic pelagic fisheries in economical, ecological and social context.

Simulations conducted in WP3-6 will be investigated for robustness of different management signposts (e.g. biological limit and target reference points, indicators of good ecological status) and management measures aiming at optimal resource utilisation, such as harvest control rules, against variability and trends in environmental drivers. Specifically, the task will test the concepts of defining indicators of good ecological status (as outlined by the MSFD) inclusive limit and target values (as used under the CFP) under global change by applying forecast of ecosystem and fish stock dynamics under various climate scenarios to isolate the response to management measures. This will help to develop the concept of adaptive indicators as basis for adaptive management systems, both with the aim to avoid detrimental effects on the ecosystem and optimise the utilisation of marine living resources.

Secondly, a concept of introducing the MSY approach for open North Atlantic fish stocks will be developed, considering explicitly changes in productivity and distribution as well as biological and technical interactions. It furthermore will consider the necessary embedment of the approach into the ecosystem approach as implemented via the MSFD.

Finally, implemented fisheries management plans or available concepts and templates for future management plans will be tested for their robustness against climate and ecosystem change as well as changing management systems and measures in response to the revision of the CFP and actions by NEAFC. The economic consequences of combined effects of climate change on ecosystems and fish stocks as well as fisheries management measures will be evaluated in cooperation with WP7.

Results from above work also will allow drawing conclusions on future monitoring and assessment systems and procedures to provide the necessary scientific advice for fisheries management in an ecosystem context and identify related research gaps and needs.
Responsible: DTU-AQUA, Participants: CLS, MIR; MRI-HAFRO; IMR; IFREMER
Start month 1, end month 46

Milestones:
10 Completion of food web specifications stage (WP8; M12)

25 Compilation of food web input data for each region and completion of data preparation stage (WP8; M20)
37 Workshop to develop exploitation and management scenarios for the North Atlantic basin (WP7,8; M24)
38 Workshop on performance of indicators of good ecological status and biological reference points under climate change (WP8; M27)
40 Joint workshop WP2 to WP8 on model synthesis (WP2,3,4,5,6,7,8; M30)
46 Completion of ECOPATH food web tuned analyses (WP8; M35)
52 Completion of a spreadsheet to compute the cost of changes in the N. Atlantic Carbon budget (WP8; M42)
53 Second special issue publication of EURO-BASIN data in the peer-reviewed ESSD online journal (WP1,2,3,4,5,6, 7, 8; M44)

Deliverables

D8.1 Report specifying regions, taxa representation, data requirements and sources for linear food-web analysis. (Resp:USTRATH; R; PU; M6)
D8.2 Report on the Ecosystem changes of different sub-areas of the North Atlantic (Resp: UHAM; R; PU; M17)
D8.3 Report on setup of analysis framework and compilation of initial input data for each region (Resp: USTRATH; R; PU; M17)
D8.4 Report on final tuned food web and key species analyses for each region (Resp:USTRATH, Participants: all; R; PU; M30)
D8.5 Report on the of pressures and processes causing structural ecosystem changes and key species dynamics in the different sub-areas of the North Atlantic (Resp:UHAM, Participants: all; R; PU; M34)
D8.6 Report on the future states, based on IPCC climate change scenarios from WP6, of the North Atlantic food web and key species in the different subareas of the North Atlantic (Resp: UHAM, Participants: all, M40)
D8.7 Report on the evaluation of management plans for major pelagic fish stock in the open North Atlantic (Resp: IMR, Participants: CLS, DTU-AQUA, MIR and MRI-HAFRO, M40)
D8.8 Concept for introducing the MSY approach for open North Atlantic pelagic fish stocks (Resp: DTU-AQUA, Participants: IFREMER and MIR-HAFRO, M42)
D8.9 Evaluate indicators identified within the MSFD or alternative indicators to characterise good ecological status with integrated food web analyses (Resp: USTRATH, Participants :all M46)
D8.10 Report outlining the range of costs caused by changes in the Carbon budget of the North Atlantic, based on predicting modelling of future North Atlantic ecosystem states (Resp: PML, M46)
D8.11 Report on performance of indicators of good ecological status and biological reference points used in fisheries management under climate change (Resp: USTRATH; Participants: all, M46)
D8.12 Report on economic, ecological and social costs and benefits of open North Atlantic pelagic fisheries (Resp: DTU-AQUA, Participants: all, M46)
D8.13 Report on future monitoring and assessment procedures to provide necessary scientific advice for fisheries management in an ecosystem context and related research needs (Resp: UHAM, Participants: all, M46)

Work package number	9	**Start date or starting event**			Month 1		
Work package title	Coordination and Dissemination						
Activity Type	MGT						
Participant No	**1**	12					
Participant ID	**UHAM**	IFREMER					
Person-months per participant:	48	1.7					

Objectives

The coordination objectives are:

- To ensure the project meets its objectives within the time and the budget limits
- To manage the evolution of the project and coordinate activities
- To facilitate communication between the partners, and with the commission
- To establish strong links and synergistic collaborations with current programmes and ensure interations with North American Programmes and researchers with a strong 'EU-US Links' component
- To transfer knowledge via summer schools, training workshops, open science meetings
- To transfer EURO-BASIN Programme research and synthesis to stakeholders, media and society

Description of work (possibly broken down into tasks), and role of participants

T9.1 International Programme Office preparation: The EC coordinator will set up a programme office that will be the foundation of an International Programme Office (IPO) for the International BASIN Programme. Subject to the availability of US-BASIN and CANADA-BASIN national funding in 2010, the IPO will be expanded based on co-funding from all successful partners. The IPO will be located either at home Insitute of the co-ordinator, or at the International Council for Exploration of the Seas (ICES) in Copenhagen if US and Canadian funding is available(see attached letter of support), in order to better integrate all international research activities focusing on North Atlantic Ocean Management.
Responsible: UHAM; Participants: US and Canadian participants as funding becomes available.
Start: month 1, End month 48

T9.2 Project meetings: A kick off meeting will be organised at the start of the project, and annual progress meeting will be held throughout the life of the project. The purpose of these meeting is to a) monitor progress and coordinate the multiple joint meetings, b) facilitate scientific discussion, c) encourage communication between partners and d) assist the reporting process to the EU.
Responsible: UHAM; Participants: all partners
Start: month 1, End month 48

T9.3 Financial and management reporting: will be undertaken on an annual basis by the coordination group, as required by the commission and defined in the consortium agreement and the workplan. Scientific and technical reporting will be undertaken on an annual basis; the workpackage leaders will be responsible for scientific and technical reporting at the WP level. The need for Financial Audit Certificates for all partners will be monitored based on funds transfers.
Responsible: UHAM; Participants: all partners
Start: month 1, End month 48

T9.4 Monitoring the project progress: All partners will report to the scientific steering committee on a 6 monthly basis using a simple web based pro-forma, requesting information on the progress off the project, and identifying delays and sticking points. This information will be used by the SSC to monitor progress and devise mitigation strategies as well as to update the commission on project status**.** The risk register and Gantt chart will be updated as the project proceeds and deviations from the workplan reported in the annual report to the commission.
Responsible: UHAM; Participants: all partners
Start: month 1, End month 48

T9.4.1 Links with US/CANADA initiatives An International Expert Advisory Panel chaired by a neutral party, as agreed upon by the International partners will be invited to the Annual General Meetings (AGM) to

witness the progress and provide independent advice on the programme's relevance to parallel non-EU initiatives, and offer guidance on fostering integration across the various funded US and CANADA national programmes of relevance to the BASIN International Science Plan (Wiebe et al., 2009). The task will support Tasks 9.1 International Project Office, and facilitate Task 9.3.2 Liaison with parallel programmes.
Responsible: UHAM; Participants: all partners.
Start: month 1, End month 48

T9.5 Communication & Knowledge Transfer: The task will focus on communication, dissemination of programme deliverables and knowledge transfer to key users, in 4 distinct areas: 1) within programme partners and the Commission (T9.3.1); 2) within the research domain (T9.3.2-4); 3) at the science/society interface (T9.3.5); and 4) beyond academia (T9.3.6). Furthermore, special issues in Progress in Oceanography will be submitted for publication in month 6 and month 48. The first series of articles will present the state of the art by WP as well as relevant issues for management and policy development while the second issue will focus on advances in the state of the art due to BASIN activities, highlighting implications for ocean management and policy development.

Responsible: UHAM; Participants: all partners
Start: month 1, End month 48

T9.5.1 Within project communication: Create a project webpage to communicate project reports, deliverables and progress of tasks, and report to Commission as described in B2.1.
(Lead by UHAM, Start: M3, end M48)
Responsible: UHAM, Participants: all partners
Start: month 1, End month 48

T9.5.2 Liaison with parallel programmes: To address strong dissemination and visibility within the research domain, the coordinator will map out concurrent EU/US/Canada projects with common scientific and/or 'EU-US links' objectives, disseminate overlap to project partners and use to construct a strategic roadmap for two-way integration of International BASIN Programme activities and output within existing funded programmes. Current calls/funded programme of interest include (not exclusive!):

EU programmes

- FP7 MEECE (Marine Ecosystem Evolution in a Changing Environment) http://www.meece.eu/, Coordinator PML (leader of WP6 and WP7 in this proposal)
- EUROCEANS Consortium on Ocean Ecosystem Analysis, www.eur-oceans.eu,
- FP7 Coordination actions (ENV.2010.2.2.1.3) 'FP6 NoEs durable integration' (2010-2012)
- FP7 Collaborative project (ENV.2010.2.2.1.2) to support global plankton data set building in view of ecosystem modelling
- EraNet MariFish project DEFINELT: Developing fisheries management indicators and targets – Coordinator: DTU-AQUA (co-leader of WP5 and WP8 in this proposal)
- FP7 FACTS (funded 2010-2013), Forage Fish Interactions – Coordinator DTU-AQUA
- FP7 JAKFISH Judgment and knowledge in fisheries involving stakeholders (2008-2011)
- FP7 MARCOM+ (funded 2010-2014) 6.2. 'Sustainable management of resources', Coordinator ICES
- FP7 Joint call Ocean of tomorrow: Quantification of climate change impacts on economic sectors in the Arctic (2010-2014)
- FP7 EUROSITES, Coordinated by NERC_NOCS (Co-leader of WP2 in this proposal)
- FP7 CARBOCHANGE; Data archiving is the responsibility of UniHB (leader of WP1 in the present proposal)
- FP7 HERMIONE (2009-2012) Hotspot Ecosystem Research and Man's Impact on European Seas;
- FP7 CoralFISH (2008-2012), Interaction between corals, fish and fisheries, in order to develop monitoring and predictive modelling tools for ecosystem based management in the deep waters of Europe and beyond;

EU-US links (for a detailed list US/Canada programs of interest see Section B3.1.3)

- FP7 INCO LINK2US - European Union United States research cooperation network: Link to the United States, 2009-2012, Coordinator Coleen Struss, AAAS

- FP7 INCO 2010-3, ERA-NET - Coordination of national policies and activities of Member States and Associated States in the field of international S&T cooperation
- EC DG External Affaires Pilot Project: Transatlantic Methods for Handling Global Challenges in the European Union and United States 2009, (2010-2011)
- US NSF CAMEO (Comparative Analysis of Marine Ecosystem Organisation) http://cameo.noaa.gov

Data and Research Dissemination

- FP7 MyOCEAN (funded 2009-2012) Operational Oceanography and Data dissemination, www.myocean.eu.org/
- FP7 OPENAIRE (funded 2010-2014) - Dissemination of research, www.openaire.eu

Responsible: UHAM; Participants: all partners
Start: month 3, End month 48

T9.5.3 Summer Schools & Training:
Rather than developing an all new summer school platform that will have to compete with biannual GIS Europole Mer/IMBER (2012, 2014) and SOLAS Summer Schools (2011, 2013), the programme will co-fund through seed funds, two international summer schools with GIS Europole Mer/IMBER in 2012 and 2014, which already cover broadly the scientific objectives defined in this proposal. This will insure cost-effectiveness and maximize transfer of new knowledge to young researchers, at mid-term and towards the end of the programme. The seed funds available at the onset of programme will also place the summer schools in a good position to bid for additional funding at national level and potentially expand to thematic training schools for up to 60 participants. The international summer schools will be open to the research community and candidates selected by the organizing committee based on motivation.

International Summer School 2012
North Atlantic Summer school on 'Basin-scale ecosystem analysis'. A multidisciplinary training structured around the programme objectives and expertise, from ocean biogeochemistry to ocean resources management, for 30 participants including internet dissemination of key lectures (and a digital archive) of all plenary lectures.
(Month 24, Resp UHAM with input from all partners)

International Summer School 2014
'Climate variability from ecosystems-2-economics (E2E) modelling' summer school, transferring advanced expertise and synthesis on integrative basin-scale and bio-economic modelling (WP6 and WP7).
(Month 44, Resp UHAM with input from PML (Allen, Barange) and IRD (Mullon)

Training Workshops (internal to the programme)
Three short (2-3 days) training workshops are planned (internal to the programme, for 10-12 PI and PhDs) to train researchers on techniques essential to the programme's field and analysis activities. Selection will be internal based on PI's/PhD's direct involvement in relevant programme tasks and activities.

Training Workshop 1 – Introduction to statistical modelling tools, related to Task '3.5 Development of habitat models' and Task 6.3
(Month 12, Resp: Tecnalia-AZTI with input from IMR, SAHFOS, BUC)

Training Workshop 2 - Vital Rates measurement techniques for plankton (relevance to WP 2, 3, 4 and Task 4.5 'Vital rates and plasticity', M30 and Task 6.3.2 M18-M30)
(Month 16, Resp: UHAM with input from SWANSEA, DTU-AQUA, SAHFOS, BUC, PML, MIR)

Optical Methods for taxonomy, feeding interactions and particle flux (relevance to WP 2, 3, 4)
(Month 24, Resp: UHAM)

T9.5.4 Optimize impact of research output
Produce and disseminate a tool box for programme PIs, of proven means and methods to add value to current research publishing practices, and optimize return on investment of the programme new knowledge output, by:

- increasing visibility of standard peer-review publications through open research repositories,

- better use of published data i.e. provide better access to programme data products discussed in publications through currently publisher/data center-developed online data mining and exploitation tools (complimentary to the primary data policy stated in Work Package 1);
- publishing data-only publications through peer-review, including funding sources.

The objective is to constantly inform and stimulate programme PIs of new techniques to optimize the impact of research output, by following progress on recommendations made by House of Commons[1], OECD[2] and SCOR[3] on how current publishing practices can be improved for internal (academia) and external (societal) benefits.
Responsible: UHAM; Participants: IFREMER (Merceur), UNI-HB (Pesant).
Start: month 3, End month 48

T9.5.5 Transfer of knowledge to stakeholders and society
A webpage on the project site will display the 'real-time' scientific output of the programme with full access to the publications (6-12 months after publication, subject to publisher restrictions) and will be maintained for 2 additional years after EC FP7 funding has ended (Resp: IFREMER).

To facilitate the transfer of research at the science/society interface, increase the visibility of the programme[4], provide more citations to its PIs[5] and optimize the return on investment and greater use of research, all programme scientific publications will be made available with full access, to all ocean management agencies, governance and policy stakeholders. To achieve this, the programme will adopt EC FP7 Special Clause 39[6] and actively deposit 90-100% of all research publications in the open repository Archimer (exploited by EC FP7 project DRIVER[7]) and in full accordance with publishers' embargoes.

Beyond access, and to facilitate the dissemination of programme's synthesis and output at the research/society interface, stakeholders will be targeted and engaged through the guidance of a User Advisory Group (UAG, consisting of stakeholders, users, government agencies and chaired by the coordinator). In order to engage key user group representatives, from funding agencies, policy makers and environmental agencies without imposing additional travel-time constraints, UAG meetings between shareholders and WP leaders will be held in months 19, 37, 48 in Brussels to strengthen the dissemination of the project. Presentations will highlight key WP specific findings which are of relevance to policy makers and user groups.

Finally, the consortium will provide advice and if necessary policy relevant synthesis of results as requested by the commission during the duration of the program.

Responsible: IFREMER (Merceur), Participants: UHAM.
Start: month 1, End month 48

T9.5.6 Press Office
In order to maximize the dissemination of key scientific output to media and society EU-wide, and beyond the programme hosting institution/country, the coordinator will construct a user list of relevant media outlets from each partner country. A 'Press Office' on the programme website will be a resource for all partners seeking to disseminated information to EC states other than their own, and provide regular press releases of

[1] UK House of Commons Science & Technology Tenth Report 'Publications on the Internet' 2004 http://www.publications.parliament.uk/pa/cm200304/cmselect/cmsctech/399/39902.htm
[2] Organisation for Economic Co-operation and Development 'Principles and Guidelines for Access to Research Data from Public Funding' 2007 http://www.oecd.org/dataoecd/9/61/38500813.pdf
[3] SCOR/IODE Workshop on Data Publishing, Scientific Committee on Ocean Research Report, UNESCO 2008 http://www.scor-int.org/Publications/wr207.pdf
[4] Dewatripont et al., 2006. Study on the economic and technical evolution of the scientific publication market in Europe http://ec.europa.eu/research/science-society/pdf/scientific-publication-study_en.pdf
[5] Harnad, S and Brody, T (2004) Comparing the impact of open access (OA) vs. non-OA articles in the same journals. *D-Lib Magazine*, 10 (6), (www.dlib.org/dlib/june04/harnad/06harnad.html).
[6] http://ec.europa.eu/research/press/2008/pdf/annex_1_new_clauses.pdf
[7] Digital repository infrastructure vision for European research (DRIVER II) http://cordis.europa.eu/fetch?CALLER=FP7_PROJ_EN&ACTION=D&DOC=275&CAT=PROJ&QUERY=011aa1a0607f:e03b:5fa97b6b&RCN=86426

the research publications (supporting Task 9.5.5 Transfer of knowledge to stakeholders and society).
Responsible: UHAM, Participants: all participants.
Start: month 1, End month 48

Milestones:

1 Programme Office setup and Kick-off meeting (WP ALL; M1)
3 Risk register complete (WP 9; M2)
4 International Expert Advisory Panel selected (WP9; M3)
5 User Advisory Group (UAG) selected (WP9; M5)
13 Training Workshop 1 on Introduction to statistical modelling tools (WP2,3,4,5,9; M12)
17 Training Workshop 2 on Vital Rates measurement techniques for plankton (incl. metadata collection) (WP1,2,3,4,5,9; M16)
24 1st General Meeting (Expert Advisory Panel and User Advisory Group) (WP ALL; M17)
30 1st International Summer School 2012 (WP ALL; M24)
36 Training Workshop 3 on Optical Methods for taxonomy, feeding interactions and particle flux (incl. data management) (WP1,2,3,4,9; M24)
45 2nd General Meeting (Expert Advisory Panel and User Advisory Group) (WP ALL; M35)
54 2nd International Summer School 2014 (WP ALL; M44)
56 Final General Meeting including stakeholders (WP ALL; M47)

Deliverables

D9.1: Risk register, process diagram and updated Gantt chart (M2, R, CO, Resp: UHAM)
D9.2: Finalization and delivery of the Consortium Agreement to the Commission (M3, R, CO, Resp: UHAM)
D9.3: Report on kick off meeting (M3, R, PU, Resp: UHAM)
D9.4: Webpage of scientific output of the programme, linked to the Web of Science (M3, O, PU, Resp: IFREMER)
D9.5: Project Web-site, project timeline, deliverables calendar, including a map of objectives overlap with all other concurrent funded projects with a strong ‘EU-US links’ component (M3, O, PU, Resp: UHAM).
D9.6: 6 month, management report (M6, R, PP, Resp: UHAM).
D9.7: First draft of a Special Issue publication in the journal of `*Progress in Oceanography*` - review of state of the art knowledge and challenges in understanding North Atlantic basin ecosystems response to global climate change (M6, R, PP, Resp: UHAM + all WP leaders).
D9.8: Toolbox on optimizing research publications’ impact (M8, R, PU, Resp: UHAM).
D9.9: 18 month scientific, management and financial report (M18, R, PP, Resp: UHAM).
D9.10: 36 month scientific, management and financial report (M36, R, PP, Resp: UHAM).
D9.11: First draft of a Special Issue publication in the journal of `*Progress in Oceanography*` - synthesis of advances made in EURO-BASIN and implications for policy & ecosystem management (M47, R, PP, Resp: UHAM + all WP leaders).
D9.12: Report on project foreground and dissemination activities (M48, R, PP, Resp: UHAM).
D9.13: Report on societal implications of EURO-BASIN including gender and science and society related issues (M48, R, PP, Resp: UHAM).
D9.14: Final project scientific, management and financial report, including a report on social and gender issues (M48, R, PP, Resp: UHAM).

Table 1.3 e: Summary of staff effort

Partner No	Partner Name	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	Total
1	**UHAM**	0	9	11.5	15.5	15.5	16	0	**10.5**	**48**	126
2	**UNI-HB**	**49**	0	0	0	0	0	0	0	0	49
3	**DTU-AQUA**	2.3	11	0	**21**	26	0	0	8.5	0	68.8
4	Tecnalia-AZTI	0	0	27	0	7	0	0	0	0	34
5	**NERC**	4.5	**22**	0	0	0	33	0	0	0	59.5
6	MRI-HAFRO	4	0	10	23	12	0	0	0	0	49
7	MIR	0	0	0	25	6	0	0	0	0	31
8	**PML**	0	0	0	5	0	**24**	**10**	4	0	43
9	UEA	0	0	0	0	0	0	19.3	0	0	19.3
10	NERI	0	0	0	10	0	0	0	0	0	10
11	IMR	3.5	0	7	10	10	13.5	0	0	0	44
12	**IFREMER**	0	0	0	0	**18**	0	0	1.7	1.7	21.4
13	SAHFOS	6.8	0	11	0	0	0	0	0	0	17.8
14	IRD	0	0	0	0	0	0	27	0	0	27
15	CNRS	8	18	0	0	0	56	0	0	0	82
16	USTRATH	0	0	0	0	17	0	0	25.3	0	42.3
17	CEFAS	0	0	0	0	9	0	1	0	0	10
18	BUC	0	0	**20**	1	0	0	0	0	0	21
19	Uni Research	0	18	0	0	0	0	0	0	0	18
20	IEO	0	0	0	16	0	0	0	0	0	16
21	CLS	2.5	0	0	0	8.2	14	0	0	0	24.7
22	SWANSEA	0	0	0	15.5	0	0	0	0	0	15.5
23	IMS-METU	0	8	0	0	0	12	0	0	0	20
	total	80.6	86	86.5	142	128.7	168.5	57.3	50	49.7	849.3

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B2. Implementation

B2.1 Management structure and procedures

B2.1.1 Organisational Structure

EURO-BASIN project management is structured around a Coordinator, Project Manager and Scientific Steering Committee interacting and delegating tasks to the WP level. The structure is familiar to all WP leaders, all of which are experienced in leading large national or European projects. Outside advice and guidance is provided by the International Expert Advisory Panel and User Advisory Group. The coordinator is responsible for reporting to the Commission.

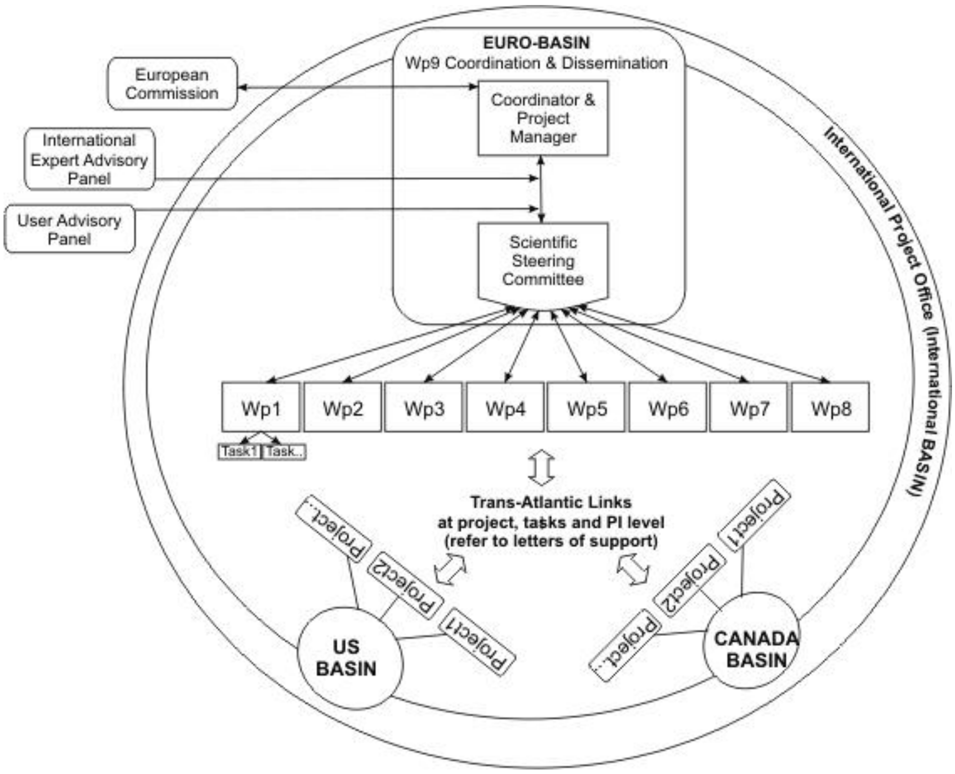

Figure 3. Schematic diagram of EURO-BASIN management structure and interactions with North American partners.

Coordinating Group

The coordinating group will be comprised of the coordinator, Mike St John, a recruited project manager and the representative of UHAM Financial and Legal Department, Katharina Berghoeffer. This group will take responsibility for financial, scientific and technical coordination of the partners, reporting to the Commission, as well as communication within and beyond the programme.

Scientific Steering Committee

The coordinator will be guided in major decision making and strategic planning and monitoring of the consortium by the Scientific Steering Committee (SSC), comprised of WP leaders, and co-leaders, and chaired by the coordinator. The responsibilities of the SSC will include

- monitoring progress and updating the Work Plan
- anticipating issues with high-risk deliverables
- propose budget and allocate funds to subcontractors
- make progress reports on the state of the project

Workpackage Leaders

WP leaders, and co-leaders, will be responsible for coordinating all WP and joint WP activities, and the timely completion of milestones and deliverables described in their respective WP (Table 1.3d). The WP lead pairs have been selected for their complimentary expertise to provide contingency for permanent availability of a leader or co-leader for WP or SSC activities. WP leaders will also be responsible for communicating completed deliverables to other relevant WPs concerned with the deliverables, and the coordinator, in order to facilitate communication within the programme and transfer of knowledge to international partners and beyond academia.

Table 2 Workpackage Leaders and Co-leaders

WP	Description	Responsible	Country
1	Data Management and Integration	S Pesant	DE
2	Biological Carbon Pump	R Sanders	UK
		C de la Rocha	FR
3	Distribution of key species and ecosystem types	Kurt Tande	NO
		X Irigoien	ES
4	Trophic Flow: Production and Controls	T Nielsen	DK
		A Gislason	IS
5	Dynamics of Living Resources and Utilisation	K Flynn	UK
		V Trenkel	FR
6	Basin-scale Integrative Modelling	B McKenzie	DK
		I Allen	UK
7	Bioeconomic Modelling of N.Atlantic Fish Resources	L Memery	FR
		M Barange	UK
		Chistian Mullon	FR
8	Advancing Ocean Management	William Chung	UK
		M St John	DE
		F Köster	DK

International Expert Advisory Panel

An International Expert Advisory Panel of external experts will be selected, and will include members from funded and potential US and CANADA national programmes and activities of relevance to the BASIN International Science Plan (Wiebe *et al*., 2009). The panel will be invited to the General Meetings (GM, month 17, 35, 47) to witness progress and provide independent advice on the programme's relevance and to identify and facilitate collaborations with parallel non-EU initiatives, and offer guidance on fostering integration across the various funded US and CANADA national programmes of relevance.

User Advisory Group

The coordinator will chair the User Advisory Group (UAG) composed of members of funding agencies, government agencies and industry stakeholders. The UAG that will be invited to the General Meetings (Months 17, 35, 47) to advise the consortium on the most efficient means of transferring programme gathered knowledge, synthesis and recommendations to relevant cross-Atlantic stakeholders on basin-scale ocean management.

Consortium Agreement

Before the onset of the project, the coordinator will establish a Consortium Agreement under advisement of the UHAM Administrative and Legal Office.

B2.1.2 Coordination and Monitoring

The success of a project requires a combination of careful planning, allocation of resources and monitoring of progress as well as quality control. Although the overall management of the project is the responsibility of the co-ordinator, the complex interaction between WP requires that WP leaders support the overall coordination through the organisation of a series of joint workshops designed to increase interaction and integration between tasks. The joint workshops will also insure that interdependent tasks are performed in a timely manner, or where difficulties occur, provide contingency plans as early as possible.

The coordination of the project is dealt with in WP9, and includes the following tasks:

- Scientific coordination

- Administrative and Financial coordination
- Communication & Dissemination
- Training

Scientific Coordination will cover the scientific and technical activities and involve;

- monitoring progress and insuring the fulfilment of deadlines;
- quality control deliverables, and preparation of 6 monthly reports for the Commission;
- resolve conflicts between partners and provision of solution to bottlenecks;
- monitor expenditure;
- organise annual meetings;
- chair the Scientific Steering Committee
- chair the User Advisory Group
- forge links with other EU-funded and international programmes under the advisement of the Expert Advisory Panel

Administrative and Financial Coordination. All administrative, legal, financial and ethical matters are the responsibility of the coordinator. The coordinator will implement the Consortium Agreement, handle transfer of funds from the Commission, all associated contractual and budgetary issues and deal with potential intellectual property issues.

Communication & Dissemination. The coordinator will engage in communication at several levels

- internal (project meetings, workshops, SSC meetings, EC Project Officer reporting)
- external to the programme
    - summer schools;
    - links with, parallel programmes and US/CANADA as advised by the Expert Advisory Panel)
- knowledge transfer to the research-society interface (as advised by the User Advisory Group)
- dissemination to public and media via the programme Press Office

Projects Meetings & Workshops. The project will begin with a kick-off meeting (Month 1) and 3 other regular General Meeting as well as a final project meeting to present and assess recent progress and gathered knowledge. In addition, a series of joint Work Package workshops and training workshops (Month 12, 18, 24) will also be held to foster close integration of tasks across WPs, and exchange of expertise and know-how. The Scientific Steering Committee will meet every 6 months, where possible, during existing planned workshops/GMs to review progress, anticipate difficulties and facilitate reporting. Other issues internal to the programme communication will be handled through the project website (Deliverable 9.3)

The **International Expert Advisory Panel** will participate at GMs, assist in communications external to the programme by offering guidance on fostering synergies with parallel funded programmes and initiative of relevance to EURO-BASIN, and integrate EURO-BASIN activities within the International BASIN Programme.

Summer Schools. The coordinator, with the aid of the Work Package leaders and GIS Europole Mer/IMBER, will co-fund and co-organize two summer schools (yr 2 and yr 4 of the programme) that will capitalize on the expertise gathered by the EURO-BASIN PIs, and transfer knowledge outside the programme to international young researchers.

Knowledge transfer at the research/society interface. The coordinator as the individual closest to the progress of the programme is uniquely placed to quickly and precisely disseminate the highlights of the programme. Through cooperation with IFREMER, the coordinator will insure that all scientific publications produced by the programme are freely available (6 months after publication) to stakeholders and society. This will insure maximum access and visibility for the programme-funded research. The coordinator will also chair, and be advised by, the **User Advisory Group** that will help identify potential stakeholders, as well as the most suitable means to transfer knowledge to them.

B2.1.3. Methods for monitoring and reporting progress

The essence of project monitoring is the identification of deviations from the schedule, budget or work plan. The SSC will establish a detailed Gantt chart, process diagrams and risk register (by WP and activity) as soon as the project starts. To maintain the risk register, investigators will report to work package leaders once every 6 months, by pro-forma. The project manager will collate this information and report once every six months to the External Board regarding the progress of the work. The report will provide information about the technical progress, results obtained, deliverables completed, resources invested, and compliance with the work programme. At the end of each reporting period the coordination group will prepare a consolidated overview of the budgetary situation of the project, on the basis of the cost statements received from the beneficiaries. This report will be submitted to the Commission. The payments that have been made will also be reported. The budgetary situation will be closely monitored and based upon the submitted budget plan. The coordination group will also, with support from work package leaders, summarize the overall project status and update the progress bar chart including man-months using the data received from all beneficiaries. The co-ordinator will coordinate the preparation of the project reports every six months and distribute them, and he will complete the internal reports (technical report, exploitation report/register of foresight, publishable summary, and synthesis report).

B2.2 Individual participants

B2.2.1.University of Hamburg, Institute of Hydrobiology and Fishery Science and Institute for Oceanography (UHAM)

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There are two contributing research groups of the **Institute of Hydrobiology and Fishery Science**. 'Biological Oceanography' and 'Fisheries Science'. The 'Biological Oceanography' group is led by Prof. Mike St. John and combines a variety of methodological approaches in process-oriented investigations of dynamic interactions within marine food chains, and between organisms and physical environment with the end goal being the development and application of advanced ecosystem models. The 'Fisheries Science' group led by Prof. Temming has a tradition of conducting interdisciplinary research in all fields of marine science and has been involved in a series of ecosystem research programmes. The combination of special expertise on both, top-down and bottom-up processes affecting marine temperate food webs and recruitment success of commercially important fish species in the North and Baltic Sea, makes the IHF an highly valuable contributor to synthesizing knowledge of climate impacts on essential habitat, recruitment and species interactions to develop testable hypotheses. The two groups currently have five international (EU-funded) and three national (Germany) ongoing projects dealing with marine ecosystem dynamics and global change.

Role in EURO-BASIN:

UHAM is the overall coordinator of the project as well as leading WP8 and 9. Furthermore the team will contribute to the idenification of habitats in WP3 providing access to two major cruise programmes which will provide data for WPs 2345. In WP 4 the team will participate in the resolution of vital rates and plasticity of response during field and laboratory programmes. In WP 5 the team will contribute to the resolution of the diets of small pelagic fish; mackeral, Blue Whiting and Herring. In WP6 the team will contribute to the development and validation of advanced ecosystem models. In WP8 the team leads the activities on ecosystem indicators.

Description of PIs involved in the project

Prof. Michael St. John (coordinator) (IHF at UHAM). He serves on the German Science foundations (DFG) Oceanography commission. He has extensive experience in the generation and management of EC funded programmes having acted as the coordinator for two programmes and on the scientific steering committee of nine programmes. Furthermore, he has been active in both the IGBP programmes IMBER and GLOBEC where he has served as the co-chair of the preliminary group on Ecosystems End to End as well as serving in the GLOBEC working group on process studies. His primary research focus has been that of coupling variations in species dynamics to physical oceanographic phenomena. Specifically he has focused on resolving the influence of climate driven variations in inter and intra annual physical forcing on the dynamics of phytoplankton and zooplankton populations and the impact of variations in these planktonic organisms on higher trophic levels.

Prof. Dr. Christian Möllmann (IHF at UHAM). His research focuses on direct and indirect effects of climate-induced variability and change as well as fisheries on the structure and function of marine foodwebs. The ultimate goal of his work is the integration of environmental processes into an ecosystem-based management of marine resources. In EURO-BASIN he will contribute to the Synthesis-WP 8 by applying an integrative indicator approach for assessing the development of the structure and function of large marine ecosystems, developed e.g. within the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB) .

Prof. Dr. Axel Temming (IHF at UHAM) has a long-standing expertise in feeding ecology (diet selection, feeding rates), predator-prey interactions and population dynamics of commercially-exploited fish in the North Sea and Baltic Sea. He has been a member of the ICES Multi Species Assessment WG since 1989 and has been the responsible scientist for several EC- and national (e.g. GLOBEC) projects.and coordinated "BECAUSE". Prof. Temming will be responsible for analysis of diet and consuption data of dominant planktivorous predators in WP 6-

Prof. Dr. Jan Backhaus leads the group for shelf sea oceanography in the **Institute for Oceanography** at UHAM. He is specialised in developing hydrodynamic models in close relation to field observations and is the originator of the HAMSOM shelf-ocean-model which is in service in interdisciplinary and European studies since more than 20 years.

B2.2.2. Universitaet Bremen (UNI-HB), Center for Marine Environmental Sciences (MARUM)

Short partner description:

The Center for Marine Environmental Sciences (MARUM), is a cooperative facility at the University of Bremen (UNI-HB) offering a number of technical and scientific services and developing innovative technology in support for scientific operations. Within the last decade MARUM became one of the leading groups in Germany and Europe to develop and operate sophisticated equipment for marine science applications (www.rcom.marum.de). Under the auspices of MARUM, the World Data Center for Marine Environmental Sciences (WDC-MARE) is aimed at collecting, scrutinizing, and disseminating geo-referenced data related to global change in the fields of environmental and biological oceanography, marine geology, and paleoceanography. According to ICSU's rules, WDC-MARE is operating on a long-term basis; it is partner in some 50 national and international projects. Core services include data and information infrastructure development and management; development of data policy and data implementation plan in co-operation with other data centers; project data management of space-time geo-coded data.

Role in EURO-BASIN

UNI-HB will lead WP1 of EURO-BASIN, which objectives are to (1) assemble the most comprehensive dataset for the parameterisation, data assimilation and validation of EURO-BASIN's ecosystem models and retrospective analysis; (2) coordinate retrospective analyses of key physical, chemical, biological and ecological parameters; and (3) develop methods to consolidate and integrate long-term observations from EC and international databases.

More specifically, Stéphane Pesant will lead WP1 and will be responsible for networking with other databases and information systems in Europe and internationally (Task 1.1); coordinating data archaeology in collaboration with WPs 2-5 (Task 1.2); and coordinating retrospective analyses in collaboration with WPs 2-5 (Task 1.5). Michael Diepenbroek will maintain and further develop the technological infrastructure WDC-MARE and PANGAEA® for database networking and interoperability in Task 1.1 of EURO-BASIN. A data curator will be hired for the duration of the project to undertake data safeguarding, publication and dissemination.

Description of PIs involved in the project

Dr. Stéphane Pesant, is a PhD in biological oceanography from Laval University, Québec (1999) working on plankton food webs and their associated biogeochemical carbon fluxes. He was scientific advisor for Marine Ecosystem Health and assistant to Jake Rice (stock assessments) at the Department of Fisheries & Oceans Canada, Ottawa (2000-01); Postdoc at the University of Western Australia, Perth (2002-04); and assistant to the Scientific Director of FP6-NoE-Eur-OCEANS, Villefranche/Mer (2005-09) for which he coordinated data integration in close collaboration with WDC-MARE / PANGAEA®. Since 2009, he joined MARUM at UNI-HB and is involved in the integration of scientific data for several European and national projects. He is also leader of the WP "Data Management and Integration" for an anticipated FP7 collaborative project (small medium scale) to support "global plankton data set building in view of modelling"

(ENV.2010.2.2.1-2) and leads the WP “Scientific Data Integration” for an anticipated FP7 coordinated action to support the “durable integration of FP6 marine research Networks of Excellence” (ENV.2010.2.2.1-3).

Dr. Michael Diepenbroek is senior scientist at MARUM. He elaborated the conception and implementation of the scientific information system PANGAEA. At MARUM he is the expert for scientific information systems and responsible for the operation of WDC-MARE and PANGAEA®. He took a leading role in the initiation of the ISCU World Data Center for Marine Environmental Sciences (WDC-MARE), founded in 2000. Since 1998 he leads the Center for Marine Environmental Sciences (MARUM) in Bremen.

B2.2.3 National Institute of Aquatic Resources, Technical University of Denmark, DTU-AQUA

Technical University of Denmark, (DTU-AQUA) is a leading technical university in northern Europe and consists of 20 institutes covering a wide variety of scientific fields. The National Institute of Aquatic Resources (DTU-AQUA) at DTU employs ca. 330 people and covers a wide range of marine and freshwater disciplines and undertakes research and provides advice concerning sustainable exploitation of marine and fresh water living resources. The institute was previously known as DIFRES - Danish Institute for Fisheries Research, and was part of the Ministry of Agriculture but has now been fully integrated with DTU. However, the Institute has maintained its advisory role for the Ministry of Food, Agriculture and Fisheries and continues to provide science-based advice on fishery and marine resources to the Commission, public authorities, international organisations, the industry and trade of fisheries and other organisations. DTU-AQUA has a high international standing within marine sciences and technology and extensive experience in coordinating and managing national and international scientific programmemes, including the coordination of EC framework programmemes. SUNFISH; MEECE, MESMA, PROTECT and FACTS.

Role in EURO-BASIN

DTU-AQUA will lead or co-lead wps 4 and 8 and contribute to wp 1, 2, and 5. Main roles are related to field process studies of lower trophic levels, data analysis and modelling of fish distributions and species interactions, and development of ecosystem-based apporaches to management.

Description of PIs involved in the project

Fritz Köster is Director of Institute; his scientific working area includes species interactions in marine fish stock dynamics and interaction between intermediate and upper trophic levels under variable environmental condition. More recently expanded more into research organisation (e.g. member of the ICES Baltic Committee 2002-2007 and Delegate of Denmark in ICES since 2004) and fisheries management (e.g. member of the Danish Delegation at the EC Council of Minister, member of the North Sea Commission Fisheries Partnership 2002-2005 and member of the ICES Advisory Committee on Fisheries Management 2005-2007). Duties include representation of the institute in activities of the European Fisheries and Aquaculture Research Organisation (EFARO), since 2008 as member of the board of directors. **Participates in WP5 and WP8**.

Prof. Torkel Gissel Nielsen, Ph.D. Dr. scient, leads WP4. He is a biological oceanographer working on the interaction between oceanography, chemistry and structure and production of the pelagic food web. He has performed extensive research in the environmental plankton ecology the last 20 years, with the overall focus on succession, composition and production of the marine pelagic food web. He has experienced as PI and coordinator of several multi –disciplinary projects sponsored by EC and the Danish National Research Council. Has published more than 100 scientific papers. ISI citations analysis 13. november 2009: # items = 101; total cites 2389; h-index = 27. Professor Nielsen will serve as the coordinator of WP 4 in the project.

Brian R. MacKenzie is a professor of Fisheries Oceanography whose research interests include natural and anthropogenic (climate change, fishing) effects on fish populations and marine ecosystems. His most recent interests have focussed on bluefin tuna in the northeast Atlantic, including aspects related to long-term changes in abundance, foraging ecology and distribution. He has published >45 publications in internationally-refereed journals (including three on bluefin tuna) and >24 reports and book chapters. He was PI in two EC NoE (Eur-oceans, MARBEF), a PI in the Census of Marine Life HMAP project, is Danish member of ICES Science Committee and is editorial board member of Fisheries Oceanography. **Participates in WP1 and WP5.**

Andre Visser is a senior researcher whose interests include bio-physical interactions in the marine environment and the effects of climate change. His recent interests focus on adaptive behavior and a means of improving ecosystem models. He has 45 peer reviewed articles in international scientific journals and > 50 publications of a non-reviewed or popular nature. He has been a PI on a number of EC projects (EurOceans, PROVESS, PROFILE) and is on the editorial board of Limnology and Oceanography, Fluids and Environment. **Participates in WP1, WP2 and WP4**.

Morten Vinther is senior advisory scientist with background in biology and computer science. He has a considerable knowledge of the North-East Atlantic fisheries and fisheries management acquired through his work with ICES fish stock assessments and as scientific advisor for the Danish Ministry of Fisheries. His experience in developing Multispecies models goes back to the 4M package (Multi-species, Multi-fleet, Multi-area Model-package) previously used by the ICES Multi Species Working Groups for both the Baltic and the North Sea. The SMS (Stochastic Multi Species model) used today by the group is also developed by him. Morten Vinther is responsible for the assessment of blue whiting and is Danish ACOM member. **Participates in WP5 and WP8.**

B2.2.4. Tecnalia-AZTI

AZTI (www.azti.es) is a private non-for-profit research organization involved in different EC projects. Currently, more than 30 EC projects are being performed. Last year 2007, the staff of Tecnalia-AZTI was more than 200 persons and its annual revenue was 11 M€. Furthermore, Tecnalia-AZTI belongs to the recently created research corporation called TECNALIA that has become the fifth EC private research organization in size. Tecnalia-AZTI practices an equal opportunity policy and the staff has a gender ratio of 55/45 male /female. The Marine Research Unit of Tecnalia-AZTI has a long experience in oceanographic studies and, particularly in the fields of hydrodynamics, ecology and fisheries. During the last 5 years the Marine Research Unit has been involved in more than 24 EC projects, published 91 reviewed articles, including a book dedicated to the Oceanography of the Basque Country (Oceanography and Marine Environment of the Basque Country. (Borja and Collins eds). Elsevier Oceanographic Series 70.). The Marine Research Unit collaborates with international institutions and organisations (ICES, NAFO, Plymouth Marine Laboratory, IFREMER, CEFAS, IRD, IMR etc) and has a memorandum of understanding with the Southampton Oceanography Center (UK). In the 6th Framework Programmeme, Tecnalia-AZTI-Tecnalia has participated in 27 proposals as a contractor, with a budget of more than 4 M€. The centre is currently coordinating 2 projects from FP6 (METAOCEANS and AFRAME) and one from FP7 (TXOTX).

Role in EURO-BASIN

AZTI participates in WP3 and WP5. In WP3 Tecnalia-AZTI will develop habitat predictive models for planktonic organisms. In WP5 Tecnalia-AZTI will provide diet analysis for bluefin tuna and albacore.

Description of PIs involved in the project

Xabier Irigoien is expert on plankton ecology and regional comparisons. His research is focused on basic laws controlling ecosystem dynamics. **Leader of WP3**.

Unai Cotano is expert on fish larvae ecology. His research is oriented to the understanding of factors controlling forage fish larval growth and mortality. **Participating PI in WP3**.

Guillem Chust is expert on habitat predictive modelling, biodiversity and spatial distributions. **Participating PI in WP3**.

Leire Ibaibarriaga is expert on fish population dynamics, fisheries modelling and fisheries management. **Participating PI in WP3 and WP5**.

Haritz Arrizabalaga is an expert on tuna dynamics and ecology. He participates in assessment groups and is chairman of the environmental committee in ICCAT. **Participating PI in WP5**.

Nicolas Goñi is an expert on tuna trophic ecology. He has expertise on diet analysis and energetic budgets. **Participating PI in WP5**.

B2.2.5. Natural Environment Research Council (NERC)

The National Oceanography Centre, Southampton (NOCS) is one of the world's leading centres for research and education in marine and earth sciences. The Proudman Oceanographic Laboratory (POL) in Liverpool is also a leader in oceanographic research. Both entities form a partnership the Natural Environment Research Council (NERC) which represents them legally, and is itself devoted to research, teaching, and technology development in ocean and earth science (the partners are thus referred to as NERC_NOCS and NERC_POL at task level).

Two NOCS research groups will contribute to EURO-BASIN; the Ocean Biogeochemistry and Ecosystems group (OBE) and the Ocean Modelling and Forecasting group (OMF). OBE has world class expertise in measuring the export of carbon from the upper ocean as a function of planktonic community structure. In particular it is at the forefront of the development of next generation neutrally buoyant sediment traps, coupling these to 234^{Th} derived estimates of export and interpreting these in the context of Pelagic Ecosystem structure. It is the only lab in the world routinely estimating the production, standing stock and export of organic carbon and the major biomineral phases opal and calcite. OMF has world-class expertise in high resolution ocean modelling, embedded models of marine bio-geochemistry and sea-ice, and innovative models of the climate system. In particular, it acts as the hub of UK development of the NEMO model, funded within the Natural Environment Research Council (UK) programmeOceans2025, and is the favoured ocean GCM for use within both the NERC research community and by the UK Met Office.

Role in EURO-BASIN

NOCS – OBE will lead WP [2], [Tasks 2.1 and 2] and contribute to WP6 (NOCS-OMF). In WP2 they will focus on leading the various components of the workpackage to achieve its ultimate aim of synthesising literature information, experimental and mesocsosm studies and cruise based observations into new parameterisations of particle flux, implementing these in simple one dimensional models and ultimately transferring this new information to WP6 where it will be used to formulate more realistic simulations of the oceanic biological sequestration of atmospheric carbon dioxide. Specifically they will lead the literature study task of WP2 and undertake detailed observations at sea of plankton community structure, carbon export and particle aggregation. They will lead one of the two EURO-BASIN cruises to the Porcupine Abyssal Plain time series site. In WP 6 they will implement selected particle flux algorithms in the NEMO general circulation models configured with the MEDUSA ecosystem model and validate the observed fields against data selected in WP2 Task 2.7. Hindcast and forecast runs will address the response of the North Atlantic ecosystem to changing climate. The scenarios will examine the impact of possible changes in fish stocks on the lower trophic level ecosystem

Description of PIs involved in the project

Dr Richard Sanders (WP2 leader; NERC_NOCS**)** is a senior Scientist within NOCS-OBE and leads the OBE research effort into the biological carbon pump funded under the UK umbrella programmeOceans 2025. He uses a diverse range of techniques in his research including naturally occurring radionuclides, nutrient observations, particle collection devices and satellite sensing. Dr Sanders will serve as the coordinator of WP [2] in EURO-BASIN.

Professor Richard Lampitt is a senior Scientists in OBE (NERC_NOCS). He focuses on the interpretation of the deep sediment trap records generated by NOCS deep sediment trap programmeme. These results are interpreted in the context of pelagic biogeochemistry and ecosystem structure. He leads the FP6 EUROSITES programmewhich coordinates research at >10 deep water observatory sites across Europe.

Dr Thomas R. Anderson (NERC Band 4, NERC_NOCS) is co-chair of the Ocean Modelling Forecasting group, as well as leader of Oceans2025 theme 9 (Next Generation Ocean Prediction Systems) at NOCS. He is respected internationally for his work in marine ecosystem modelling, with more than 50 publications (approx. half as first author). His many wide-ranging interests include ecosystem dynamics, biogeochemistry, marine stoichiometry and complexity.

Dr Ekaterina Popova (Research Fellow, NERC_NOCS) is highly skilled in coupling marine ecosystem models with three-dimensional physical models of the ocean, both at regional and global scales. She has carried out real-time forecasting, post-cruise modelling, data assimilation and analysis of mesoscale variability for interdisciplinary cruises. She is playing a leading role in the development and implementation of a new ecosystem model, MEDUSA, in NEMO at high resolution (1/4°).

Dr Jason Holt (NERC_POL) leads the 'Next Generation Ocean Prediction Systems' research theme at POL and is an expert in shelf sea modelling. He is PI of NERC Global Coastal Ocean Modelling project and coPI in NERC CASIX and QUEST programs, and sits of the National Central for Ocean Forecasting (NCOF) executive committee.

B2.2.6. The Marine Research Institute (MRI-HAFRO)

The Marine Research Institute (MRI-HAFRO) is a governmental institute under the auspices of the Ministry of Fisheries. The three main areas of activity of the MRI-HAFRO are: a) to conduct research on the marine environment around Iceland and its living resources; b) to provide advice to the government on catch levels and conservation measures; c) to inform the government, the fishery sector and the public about the sea around Iceland and its living resources. The institute runs two ocean going research vessels, has a staff of about 170 and of these about 80 have academic training. The institute cooperates with several universities both in Iceland and abroad on research and training in fisheries biology and oceanography, supervises the United Nations University Fisheries Training Programmeme, and has been involved in several international research projects over the years.

Role in EURO-BASIN
MRI-HAFRO will participate in assembling historical data (WP1), resolving oceanographic habitats utilized by key species (WP3), elucidating key processes controlling the flow of carbon and energy between trophic levels (WP4), and determining the carrying capacities of key fish stocks and how their harvest controls ecosystem structure and dynamics (WP5).

Description of PIs involved in the project
Dr Astthor Gislason is the leader of the zooplankton group at the MRI-HAFRO. Main areas of research are overwintering strategies, life histories and long-term changes of zooplankton, and fish-plankton interactions. He will co-ordinate the MRI-HAFRO contribution to EURO-BASIN. He will lead Task 4.1 and with other members of the scientific team contribute to WP1, WP3 (tasks 3.1, 3.2, 3.3), WP4 (tasks 4.1, 4.2, 4.3, 4.4), and WP5 (tasks 5.2, 5.3).
Hildur Petursdottir, MSc, is a marine ecologist specialising in food web analysis using fatty acid trophic markers and stable isotopes. She will mainly contribute to the trophic studies within WP4 (tasks 4.2, 4.3, 4.4).
Dr Kristinn Gudmundsson is a specialist on phytoplankton ecology, working e.g. on the utilization of satellite data for estimation of chlorophyll and calculations of primary production around Iceland. He will contribute to WP3 (tasks 3.1, 3.2, 3.3), and WP4 (tasks 4.1, 4.2, 4.3, 4.4).
Solveig R. Olafsdóttir, MSc, is a chemical oceanographer. Her main projects are time series measurements of nutrients and carbon system parameters and monitoring of nutrients in Icelandic waters. She will contribute to WP4 (tasks 4.1, 4.2).
Hedinn Valdimarsson, MSc, is a physical oceanographer and a senior scientist, responsible for the project of monitoring climatic variability in Icelandic waters. Main interests are circulation, climate and their effect on biota. He will contribute to tasks 3.1, 3.2 of WP3, and 4.1, 4.2 of WP4.
Dr Gudmundur J. Oskarsson is a research scientist at MRI-HAFRO (since 2006). His main focus is on stock assessment of herring beside various ecological and biological researches on herring and other pelagic fish species. He will contribute to 5.2. of WP 5.
Droplaug Olafsdottir, CandScient, has been working on feeding ecology of marine mammals and bluefin tuna since 1996, In 1999-2005 she supervised a programmefor experimental fisheries for bluefin tuna within the Icelandic EEZ, that included research on feeding of the bluefin tuna in the area. She will contribute to Task 5.2 of WP 5.
Höskuldur Björnsson, MSc, has been working on multispecies modelling, survey data, gear technology, and annual assessment of marine resources since 1992. He will contribute to tasks 5.2 and 5.3 of WP5.

B2.2.7. Sea Fisheries Institute in Gdynia (MIR)
The Sea Fisheries Institute in Gdynia (MIR) founded in 1921 is the oldest marine research institution in Poland. The Sea Fisheries Institute is divided into five scientific departments: Department of Fish Resources, Department of Fisheries Oceanography and Marine Ecology, Department of Processing Technology, Department of Food and Environmental Chemistry and Department of Fishery Economics. There are also two other departments: Plankton Sorting and Identification Center in Szczecin and the Gdynia Aquarium. MIR also acts in an advisory capacity for the Ministry of Agriculture and Rural Development. The MIR conducts research mainly on the Baltic Sea fishery resources but also in other seas. The overall tasks of MIR fit closely to the ICES Strategic Plan and to the majority of the priorities for scientific research in support of Common Fishery Policy of the EC (e.g. scientific bases of integrated fisheries management). The Institute is a member of EFARO, which associates main governmental institutions carrying out applied research on behalf of sea fishery and aquaculture. MIR is also responsible for a national implementation of EC DCR, participates at the moment in six projects funded by EC and six national projects. Our Plankton Sorting and Identification Center in Szczecin is a world unique facility working under 35-year lasting Poland (MIR) and US (NOAA-NMFS) Joint Studies Agreement contributing to the development of ecosystem-based approach in the United States and Poland as well as in the large marine ecosystems around the globe.

Role in EURO-BASIN
MIR will contribute to WP-4 by description of the species/size/sex/stage structure of the zooplankton/copepod community necessary to study mortality, egg production and feeding processes and to WP-5 by application of multispecies production models and difference models for stock assessment.

Description of PIs involved in the project
Dr. Jan Horbowy is the head of the Department of Fishery Resources at the Sea Fisheries Institute in Gdynia. In 1994-96 he chaired ICES Working Groups dealing with Baltic stocks assessment. Since 1995 he has participated in Advisory Committee for Fishery Management (ACFM) work as Polish member, chairing several review and advice drafting groups. In 2000-2005 he was member of Editorial Advisory Board of Archive of Fishery and Marine Research. He has worked on fish stocks assessment, fishery management, ecological modelling, statistical modelling. These activities covered both Baltic fishery and deep-sea resources. He participated in several EC founded projects, and he was national co-ordinator in STORE, BECAUSE and EFIMAS. J. Horbowy would work on application of multispecies production models and difference models for stock assessment in WP-5.
Dr Dariusz Fey is a team leader responsible for the research on early life history of fish and zooplankton ecology at the Dept. of Oceanography, SFI. He has been working on environmental factors affecting larval fish growth and survival for over ten years. He will contribute to the WP-4 by supervising processing of zooplankton samples by the staff of the SFI Plankton Sorting and Identification Center in Szczecin.

B2.2.8. Plymouth Marine Laboratory (PML)
PML is an International Centre of Excellence in Marine Science & Technology and a Collaborative Centre of the UK Natural Environment Research Council. PML carries out innovative and timely fundamental, strategic and applied research in the marine environment from the uppermost reaches of estuaries to the open ocean. The research at PML is highly relevant to UK and international societal needs and has at its core the mission to contribute to the issues of global change and sustainability. It is an independent, impartial provider of scientific research in the marine environment, with a focus on understanding biodiversity and ecosystem function, which is critical to providing solutions in terms of measures of ecological sensitivity, biogeochemical cycling, pollution and health, scaling biodiversity and forecasting the role of the oceans in the Earth System. It has centres of expertise providing skills and knowledge, which are leading in their respective fields internationally, particularly in molecular science, development and application of novel technology, marine systems modelling and satellite remote sensing. The PML modelling group has over 18 years specialist experience of interpreting and quantifying marine system function and its relationship with the physical environment by developing mathematical models and promoting coupled complex models as a methodology for heuristic and predictive studies. PML leads the NERC QUEST_Fish project which is investigating how climate change will affect the potential production for global fisheries resources, linking climate change scenarios, the ecosystems and bio-economics and societal vulnerability assessment. PML has been at the forefront of international zooplankton research for over 20 years.

Role in EURO-BASIN
PML will lead the integrative modelling (WP6) and will contribute to the ensemble of past and future ecosystem states and lead the biogeographical analysis. The bio-economic modelling of North Atlantic fish resources (WP7) is also led by PML who will coordinate the assessment of the impacts of climate change, fisheries management and market developments, on the productivity, dynamics and services of North Atlantic fish commodities. PML will also contribute field sampling, shipboard experiments and analysis of gene expression to investigate the plasticity of vital rates of *Calanus helgolandicus* (or *Calanus finmarchicus*) over its entire distribution range in the Atlantic to WP3.

Description of PI's involved in the Project.
J. Icarus Allen is Head of Science for Biogeochemistry at the Plymouth Marine Laboratory and leader of PML's core strategic research Oceans 2025 Theme 9 programme, 'Next generation marine models'. He has been involved in and acted as principle investigator for 30 national and EC scientific projects, including coordinating the FP7 MEECE integrated project. His primary expertise is in marine ecosystem modelling and ecosystem response to climate change. He has over 60 ISI listed publications.
Manuel Barange is Director of the IGBP-SCSOR-IOC core project GLOBEC (Global Ocean Ecosystem Dynamics), PI of the NERC-funded QUEST_Fish project, and Chair (2010-2012) of the ICES Scientific

Committee. He also coordinates the ICES-PICES Working Group on Forecasting Climate Change Impacts on Fish and Shellfish (WGFCCIFS), and a past member of the European Commission FP7 Advisory Group for Environment (including Climate Change). His expertise is in physical/biological interactions, fish and fisheries ecology, assessment and management, and in linking natural and socio-economic sciences in the study of global change impacts on marine ecosystems. He has published over 60 peer-reviewed publications. **Pennie Lindeque** is a NERC band 5 open-ended appointment at PML. She has 14 years experience working in the area of molecular biology and marine invertebrates. She has experience in many areas of molecular techniques both DNA and RNA, including PCR, quantitative PCR, primer design, cloning, sequencing and microarray analysis. In the last 5 years she has been associated with 3 NERC grants as CoI and PI, 1 EC Framework VI Network of Excellence and 1 EC Framework VI Policy-orientated research programme. She has published 12 peer-reviewed publications and has been invited to talk about her research as a key-note speaker at international meetings and to teach on a Marine Genomics/MARBef Summer course.

B2.2.9. School of Environmental Sciences, University of East Anglia (ENV, UEA)

The ENV-UEA holds the highest possible rating in the UK Research Assessment Exercise (RAE). Particularly, ENV is a world leading research institute in climate change studies and geosciences (e.g. through the Climatic Research Unit and Tyndall Centre for Climate Change Research). ENV has a strategic alliance with the Centre for Environment, Fisheries and Aquaculture Sciences (CEFAS), a leading research institute in fisheries and environmental science. The positions at both ENV and CEFAS held by W. Cheung (PI) facilitate the access and usage of long-term fish and environmental datasets maintained at CEFAS. Such datasets are important for the proposed project. Besides, all necessary facilities and support services are in place in ENV. ENV is very well equipped in terms of the computing hardware, software and technician support necessary for successful completion of this research.

Role in EURO-BASIN

UEA will lead WP 7, Task 6.2. W. Cheung will focus on using simulation models to predict past and future changes in distribution and production of key fish stocks in the North Atlantic based on climate change projections. Specifically, W. Cheung will work with Simon Jennings (CEFAS) to develop models that integrate existing species-based models with size-based models in predicting distribution and production of fish stocks. This will provide outputs to Task 6.3 for bio-economic modelling of fish communities in the North Atlantic.

Description of PI involved in the project:

Dr. William Cheung is Lecturer in Marine Ecosystem Services in ENV, UEA which is a joint appointment by UEA and CEFAS. He works on assessing impacts of fishing and climate change on marine ecosystems and their goods and services. He developed novel modelling approaches to project changes in distribution ranges and potential fisheries catch of over 1,000 species of exploited marine fish and shellfish. These approaches form part of the theoretical and analytical background for Task 6.2 of this proposal. W. Cheung works on various interdisciplinary research projects with global collaboration networks in China, Australia, USA and Canada.

B2.2.10. National Environmental Research Institute, University of Aarhus (NERI)

Department of Marine Ecology, National Environmental Research Institute, University of Aarhus is a high ranking research department providing data, knowledge and the scientific basis for environmental policy and decisions pertaining to nature and the marine environment. Key competences are within structure and functions of marine ecosystems, interactions between land, atmosphere and the sea, physical and ecological modelling, biological oceanography, basic and applied biogeochemistry and ecotoxicology. Research areas include fjords and coastal regions, estuaries, and open sea enviroments around Denmark and in Arctic waters. Department of Marine Ecology has been partner and/or coordinator of a large number of finalized and ongoing EC research projects. Staff members comprise about 70. Bo Riemann is Director of Department of Marine Ecology.

Role in EURO-BASIN

NERI will participate in WP 4 (T4.2, T4.4, T4.6). The overall objective of this WP is to quantify the key *in situ* processes controlling the flow of carbon and energy, within and between trophic levels in the North Atlantic basin. The main field activities will be performed during the spring bloom at high temporal resolution to investigate match mismatch of the bloom with higher trophic levels and the sedimentation and carbon sequestering during the important event.

Description of PIs involved in the project

Dr. Eva Friis Møller, Ph.D. (2004), Department of Marine Ecology, National Environmental Research Institute, Aarhus University. Biological oceanographer working on plankton ecology, especially zooplankton, in laboratory, field and modelling studies. 15 published scientific papers, 4 submitted. ISI citations analysis 1.december 2009: # items = 15; total cites 171; h-index = 8. She will contribute to WP4.

Senior scientist Stiig Markager, Ph.D., Department of Marine Ecology, National Environmental Research Institute. His has done research in aquatic ecology since 1988 working with ecology and physiology of phytoplankton, bio-optics and the bio-geochemistry of dissolved organic matter. The last 13 years as senior scientist at NERI with focus on eutrophication in marine areas and modelling of marine systems. Adjunct professor at University of Copenhagen in plankton ecology and modelling. He has been PI and coordinator on a number of projects over the last 10 years, e.g. one on the 3. Danish Galathea Expedition around the earth. ISI citation analysis 30. November 2009: # items = 38; total cites 886; h-index = 16. He will contribute to WP [2 and 6].

B2.2.11. Institute of Marine Research, Bergen, Norway (IMR)

The Institute of Marine Research undertakes research on marine resources, the marine environment and aquaculture. The principal objective of the Institute is to provide scientific advice in the above areas to the authorities, industry and society as a whole. The Institute of Marine Research is answerable to the Ministry of Fisheries, and its duties are to:

- monitor and carry out research on life, the environment and interactions among living organisms in coastal waters and the ocean
- generate new and updated knowledge of marine resources of importance to fishing and aquaculture
- develop technology and greater biological understanding as the basis of rational, future-oriented fishing and aquaculture industries
- offer advice to the authorities and industry regarding management of the marine environment and its resources
- disseminate the results of research in order to promote the interests of the fishing and aquaculture industries and of society as a whole

The work of the Institute is primarily concentrated on the ecosystems of the Barents Sea, the Norwegian Sea and the North Sea, and the Norwegian coastal zone. With a staff of about 600, the Institute of Marine Research is the largest marine research institution in Norway, and in many of its areas of research it plays a leading role at international level. Most of its activities are based in Bergen, but the Institute also has a department in Tromsø and research stations in Matre and Austevoll near Bergen, as well as in Flødevigen near Arendal. The Institute operate four large research vessels.

Role in EURO-BASIN & Description of PIs involved in the project

Dr. Geir Huse has a background in fisheries biology and has worked with developing spatial models of fish and zooplankton dynamics. Publications: 30 papers in peer review journals, 3 book chapters. He has contributed to several EC projects and has acted as a project leader of three projects funded by the Research Council of Norway. Presently he is leader of the research programmeEcosystem and stock dynamics at the Institute of marine Research. Expertise & interests: individual-based modelling of fish behaviour, fish migrations and population dynamics; application of neural networks and genetic algorithms. Huse will contribute mainly to Tasks 3.6, 5.1, 5.3, 6.3.

Dr. Webjørn Melle has a background in fisheries and marine biology, 23 years experience at IMR in plankton research, and more than 30 papers in peer review journals, 4 book chapters. His main interests are in zooplankton ecology, zooplankton acoustics and sampling methodology, fish migration and feeding ecology, and general assessment of lower trophic levels. He has lead several RCN funded projects, and he has been chief scientist of several expeditions to Arctic, Antarctic and Northern Seas. His national and international representations include: member of ICES WG on Zooplankton Ecology; member of ICES WG on Northern Pelagic and Blue Whiting; member of ICES Planning Group on Surveys of Pelagic Fishes in the Norwegian Sea; former member of ICES Advisory Committee on Marine Environment; former Programme leader of Ecosystem Norwegian Sea – “Mare Cognitum”; Member of Norwegian Core Group for MAR-ECO, Census of Marine Life; Member of steering committee CmarZ; Census of Marine Life; Member of SCOR WG 125 on Global Comparisons of Zooplankton Time Series. Former Head of Plankton Research Group at the Institute of Marine Research. Melle will contribute to Tasks 3.2, 4.2., 4.4 and 5.1.

Dr Richard Nash is a research scientist at the Institute of marine Research (IMR, Norway). Prior to October 1st 2004 he was a senior lecturer at the University of Liverpool's Port Erin Marine Laboratory (1988-2004). Education: BSc Marine Biology, University College Swansea, UK; PhD Fish Ecology, University of Glasgow, UK. He has mainly worked in the area of fish biology and ecology, concentrating on flatfish and herring and processes that control their recruitment. Whilst in the UK most of his work has concentrated on the Irish Sea with some work in the North Sea. He was a member of the ICES Herring Assessment Working Group (1989-2004) and is currently a member (and co-chair) of the ICES Working Group on Recruitment Processes and a member of the NAFO Working Group on Reproductive Potential. He is current partaking in a couple of EC projects. The WESTHER programme looking at stock discrimination in western herring stocks and is the co-ordinator of the Liverpool contribution. RASER programme examining the reproductive potential and an evaluation of the stock characteristics for recovery. The principal species are cod and hake. Dr. Nash will contribute to Task 5.1.

Dr Svein Sundby is Dr. philos and principle oceanographer at Institute of Marine Research. His research focus is on responses of physical processes and ocean climate fluctuations on marine ecosystems. He has worked in arctic and boreal ecosystems as well as in upwelling systems in the Southern Hemisphere. Sundby has authored more than 150 reports and publications. He has been involved in the planning of international climate change and marine ecology research programmemes: Together with Professor Brian J. Rothschild, University of Massachusetts, he initiated and developed the Cod and Climate Change programmeunder the International Council for the Exploration of the Sea (ICES) in the early 1990s. Sundby was a member of the Scientific Steering Committee under SCOR that developed the Science and Implementation Plans for the IGBP programmeGlobal Ocean Ecosystem Dynamics (GLOBEC). He has been chairman and member of a number of working groups and steering committees within the ICES, and has been member of referee and standing committees for marine research programmemes in US and Canada. He has been a programmedirector for three intern research programmemes at the Institute of Marine Research, and presently group leader in the Bjerknes Centre of Excellence for Climate Research. In spring 2002 he became member of a newly established science steering committee that develops an integrated IGBP programme(OCEANS) on global change, biogeochemical cycles and ecosystem dynamics. Dr. Sundby will contribute to Tasks 4.2 and 4.4.

B2.2.12. Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), France

IFREMER is a public body created in 1984, and is the only French research organisation with an entirely maritime remit. It operates under the joint auspices of three Ministries: Higher Education and Research, Agriculture and Fisheries, and Ecology, Sustainable development and Infrastructure.

Being involved in all marine science and technology domains, IFREMER has the capability of solving different problems with an integrated approach. IFREMER's scope of action can be divided into four main areas, each of them including different topics as described hereunder:

1. Understanding, assessing, developing and managing ocean resources (knowledge and exploration of the deep sea; contribution to the exploitation of offshore oil; understanding ocean circulation in relation with the global change; sustainable management of fishery resources; optimisation and development of aquaculture production)
2. Improving knowledge, protection and restoration methods for the marine environment
3. Production and management of equipment of national interest
4. Helping the socio-economic development of the maritime world

Role in EURO-BASIN

IFREMER will lead WP 5 and contribute to WP8. They will focus on the role and the spatial coupling of blue whiting and mackerel and lower trophic levels and on modelling of blue whiting past and future population dynamics in the Western approaches. They will also contribute to the developpment of an indicator approach to ocean management.

Description of PIs involved in the project

Dr Verena Trenkel (WP 5 leader) has been working on wildlife and fish stock assessment models in a single and multi-species context as well as the indicator approach to fisheries management for over fifteen years. She has recently participated in the EC projects Fisboat and Image on survey based single species stock assessments and community indicators for the ecosystem approach and is currently involved in the Deepfishman projet on deep-water stock and ecosystem management. She has published over 40 papers and participates in the ICES working group on Fish Ecology.

Dr Marie-Joëlle Rochet has research interests in the fields of fisheries and quantitative ecology. She focuses on the changes in demographic traits of fishes as a consequence of fishing. She developed research and co-ordination of several groups in the field of indicators of fishing impacts on fish populations and communities, with a special attention to size-based indicators. This was recently extended to evaluating, selecting and using indicators for an ecosystem approach to fisheries management. She also involved in developing qualitative and quantitative ecosystem models for predicting the impact of fishing and other drivers on exploited fish communities.

Laurent Berger is an acoustic engineer with a large experience in hydroacoustics systems applied to the detection and quantification of fish resources. He worked for the development and testing of the ME70 multibeam echosounder that equips the IFREMER RV Thalassa. He is the IFREMER leader for the development and use of the processing software MOVIES+ and MOVIE3D. He is also an active member of ICES working group on fishery acoustics (WGFAST).

A **postdoc** (to be hired) will work on analysing survey data (acoustic and trawl data) to determine the relationship between small pelagics, in particular blue whiting and mackerel and layers of plankton.

B2.2.13. Sir Alister Hardy Foundation for Ocean Science (SAHFOS)

The Sir Alister Hardy Foundation for Ocean Science (SAHFOS) (see www.sahfos.ac.uk) is an international charity that manages the Continuous Plankton Recorder (CPR) Survey, a basin-scale plankton monitoring programme operating in the Atlantic, Arctic, Pacific and Southern Oceans. Surveys are carried out monthly and have done so since 1931. It represents the most extensive broadest scale plankton biodiversity survey in the world. Monthly surveys are carried out on some 30 routes across the Atlantic, Arctic, Pacific and Southern Oceans. The survey is funded primarily by the UK (NERC & Defra) but also receives funding from Canada, Ireland, France, Portugal, Netherlands and USA.

Role in EURO-BASIN

SAHFOS will participate to WP1 and WP3. In WP1 SAHFOS will provide information on the surface distribution of key jellyfish species through molecular analysis of CPR samples. Taxonomic and molecular analysis of jellyfish species collected during cruises (WP3) will be used to build up a database of DNA sequences to interpret the CPR jellyfish samples. Using its extensive database SAHFOS will contribute in WP3 to the analysis of the basin-scale distribution and predictive habitat models of key zooplankton species. They will also lead task T3.1 which focus on the retrospective analysis of the distribution of key species.

Description of PIs involved in the project

Dr Claudia Castellani is a Research fellow. She has over 15 years experience on zooplankton ecology, taxonomy and physiology. She has participated to large UK NERC funded scientific projects on plankton such us Plankton Reactivity in the Marine Environment (PRIME) and Marine Productivity. She is currently working on several projects on molecular taxonomy and geographical distribution of copepod species. She has also been conducting controlled laboratory experiments and eco-physiological field research on marine zooplankton species. Dr Castellani will contribute to task T3.1, T3.2 and T3.5 of WP3.

Dr Priscilla Licandro is a Research Fellow at SAHFOS, with over 15 years experience in plankton ecology and taxonomy. She is currently PI on the Defra contract 'The Continuous Plankton Recorder Survey: Fisheries Investigations' MF1105. She has got skills in numerical analysis that she has applied to analyze meso- and large-scale temporal and spatial patterns in marine communities and populations. PL is experienced in the taxonomy and ecology of medusae and siphonophores. PL has been contributing to a few ICES (WGZE, SGRECVAP, ICES SGWRECC) and SCOR (SCOR WG 130) working groups and she is currently involved in the FP7 Project MEECE. In EURO-BASIN PL will be involved in tasks T2.2 in WP1, and tasks T3.1 and T3.2 in WP3.

Dr Richard Kirby Dr Richard R Kirby is a molecular biologist with over 20 years experience.

Currently, RRK is a Royal Society University Research Fellow at the University of Plymouth. RRK has over 20 years molecular biology experience and he pioneered the genetic analysis of Continuous Plankton Recorder samples and he works on questions in plankton ecology, predominantly.

In EURO-BASIN RRK will be involved in tasks T2.2 in WP1 and tasks T3.2 in WP3.

B2.2.14. Institut de Recherche pour le Développement (IRD)

IRD is a French public research institute that has been working in Southern countries for over sixty years. It operates under the joint authority of the French ministries responsible for research and overseas development. IRD researchers address major development challenges regarding environment, sustainable development of living resources, social studies and health.

The "Exploited Marine Ecosystems" (EME) Joint Research Unit, leaded by Philippe Cury, is working on the ecosystem approach to fisheries and aims to contribute to the emergence of a global governance of living resources. One of its main objective is to study the impact of global changes on the governance and exploitation of marine resources, and to study possible scenarios of their evolution with integrated models and empirical analyses in response to exogenous environmental and economic changes. The searchers of this research unit present the following main skills : integrated deterministic models, trophic webs and parameter estimation by data assimilation techniques,fisheries bioeconomics and resource exploitation. They work on several large marine ecosystems: upwelling ecosystems in the Benguela and Humboldt currents, pelagic ecosystem of the Indian Ocean.

Role in EURO-BASIN

IRD will be involved in WP 7, lead by Manuel Barange.

Description of PIs involved in the project

Dr Christian Mullon has developed several integrated models relating ecological and economic features of large ecosystems such as the inland Delta of Mali. More recently, he has developed a global model of the supply chain from small pelagic fisheries to fishmeal and fish oil markets.

He is responsible (under supervision of Manuel Barange) for Task 7.3. He will be in charge of the integrated model of the North Atlantic fisheries using a similar approach and tools (network economics) with the aim (1) of exploring the effects of scenarios of climate changes and economic globalization, (2) of building tools of consensus building in the perspective of a common governance of the North Atlantic basin.

B2.2.15. CNRS, Centre National de la Recherche Scientifique, France

Two Joint Research Units (JRUs) of the CNRS at the European Institute of Marine Sciences (CNRS) in Brest will contribute to EURO-BASIN, the Laboratoire des Sciences de l'Environement Marin (LEMAR) and the Laboratoire de Physique des Océans (LPO). LEMAR, in association with the Institut de Recherche pour le Développement (IRD) and the University of Brest (UBO), is a laboratory composed of biologists, chemists, and physicists working together to detail and then model marine systems. LEMAR researchers investigate (i) the physics and biogeochemistry of the marine environment, (ii) the response of coastal ecosystems to global change, and (iii) the biology of these interactions and adaptations. LPO , in association with IRD, IFREMER, and UBO, conducts process studies, numerical models, field studies and data analysis that increases our knowledge of the functioning of the oceans. LPO scientific objectives focus on (i) understanding the processes controlling ocean dynamics from the sub-mesoscale to the scale of the ocean basin, (ii) quantifying the role of the ocean (especialy thermohaline circulation) in the climate change, and (iii) exploring processes controlling exchange between the open ocean and the continental margins.

Role in EURO-BASIN

CNRS will participate in WP2 and WP6. In WP2, by conducting lab experiments and by coordinating a multi-institute mesocosm experiment, LEMAR will investigate the impact of phytoplankton, bacterial, zooplankton, and biominerals on the formation, decomposition, and sinking velocity of aggregates of particulate organic carbon. In WP6, LEMAR and LPO will conduct the basic basin-scale simulation by coupling a regional model to the PISCES ecosystem model and using APECOSM to focus on the fate of carbon in the meso pelagic layer in light of higher trophic levels controls and feedbacks between climate and fisheries. This group will also participate to the validation, comparison and ensemble simulations planned in EURO-BASIN.

Description of PIs involved in the project

Dr. Laurent Mémery is currently the director of LEMAR. He models ocean circulation, biogeochemical cycles, and marine ecosystems, with an emphasis on the impact of small and medium scales at regional and basin-scales. He will contribute in tasks 6.1, 6.2, 6.3 and 6.4 of WP6.

Prof. Christina de la Rocha investigates processes controlling the fraction of primary production exported to depth. She will help lead WP2 and oversee task 2.1.

Dr. Anne Marie Tréguier, P.I. of the DRAKKAR modelling project, working on the dynamics of the ocean from the mesoscale to the global scale using the NEMO platform.
Dr. Olivier Aumont has developed the PISCES biogeochemical model of the ocean that is part of NEMO and a component of the Earth System model of IPSL. He will contribute to tasks 6.3 and 6.4.
Dr Brivaëla Moriceau studies links between phytoplankton physiology, aggregate composition, and fluxes of carbon, silicon, and other nutrient elements to the deep sea. She will contribute to task 2.1
Dr Herwig Stibor specializes in using mesocosms to explore ecological interactions. He will oversee the successful set-up of the mesocosm experiment proposed in task 2.1.
Mr. Claude Talandier is an engineer in numerical ocean modelling. He develops ocean configurations based on the NEMO platform.
Ms Manon Le Goff is a techician at LEMAR. She will assist with the mesocosm experiment outlined in task 2.1.
Ms Anne Cécile Blaizot, a PhD student supervised by L. Mémery, will model ocean circulation and ecosystem structure in the North Atlantic. She will contrinute to tasks 6.1 and 6.3 of WP6.

B2.2.16. University of Strathclyde, Department of Mathematics and Statistics (USTRATH)

Role in EURO-BASIN
Strathclyde University will lead on WP 8 Task 8.2 which is concerned with developing metrics of food web structure and function in European sea regions. The motivation of the work is to support the international effort to elaborate on the Good Environmental Status descriptors enshrined in the Marine Strategy Framework Directive. The Task will involve comparative food web analyses, building on the well established concept and methodology of ECOPATH. Strathclyde will also contribute to WP 5 Tasks 5.2 and 5.3, which deal respectively with quantifying the predation on mid-trophic levels by herring, blue whiting and mackerel, and with developing models of these pelagic predators aimed at quantifying climatic and fisheries population impacts. The Strathclyde input will focus on developing a spatial size-structured model of blue whiting driven by output from coupled physical/biological ecosystem models. The Department of Mathematics and Statistics has established international excellence in theoretical ecology (Prof W.S.C. Gurney, Dr D. Speirs, and Dr S. Webb) and statistical population modelling (Prof. G. Gettinby, Prof E. McKenzie). Strathclyde is a partner in the Marine Alliance in Science and Technology Scotland (MASTS), a pooling initiative linking 10 universities, institutes and government laboratories launched in November 2009.

Description of PIs involved in the project
Prof. Michael R. Heath will take up the MASTS Research Chair in Fisheries Oceanography in the Department of Mathematics and Statistics in January 2010. Formerly a senior researcher at Marine Scotland Science, he has developed and led research on nutrient and plankton dynamics in Loch Linnhe, driven by the Scottish Government policy need to understand the impacts of fish farm nutrient impacts on sea loch ecosystems. He has researched climatic effects on zooplankton, involving deep sea sampling programmemes, and participated in two EU-funded research projects culminating in a central role on the UK-GLOBEC programmeon zooplankton dynamics in the Irminger Sea. He has worked on shelf-sea studies of the factors affecting larval cod and haddock growth and survival, including individual based modelling of fish larvae. More recent work includes research on cod and sandeel population structure issues, ocean-basin-scale plankton population dynamics, and coastal eutrophication problems, and changes in the food web structure of the North Sea. Ongoing work includes modelling climate change and fishing impacts on North Sea food web productivity, and the population structure of cod in European waters. He is a member of the GES-4 Task group supporting the MSFD, which is specifically concerned with food web status. Professor Heath will lead in WP 8 Task 8.2, and contribute to WP5 Subtask 5.2.2 and Subtask 5.3.2.
Dr. Douglas C. Speirs was appointed lecturer in Marine Resource Modelling in the Department Mathematics and Statistics at the University of Strathclyde in 2007. He has worked on diverse problems in theoretical ecology in terrestrial and aquatic systems, including spatial modelling of the marine copepod *Calanus finmarchicus* as part of UK GLOBEC. In partnership with Marine Scotland Science (MSS), Prof. M.R. Heath, and Prof W.S.C. Gurney he has developed multi-species length-structured models focused on cod and its immediate ecosystem neighbours. Ongoing work includes implementing such models in Operational management Procedures. He is subject editor of *Ecology*, on the editorial board of *Journal of Biological Systems*, and regularly reviews for *Mathematical Biosciences, ICES Journal of Marine Science, Marine*

Ecology Progress Series, *Limnology & Oceanography*, *Deep Sea Research*, Princeton University Press, NERC, the US National Oceanic and Atmospheric Administration (NOAA) and the US National Science Foundation (NSF). He sits on the steering group the Strathclyde Marine Institute, and on both the Modelling and the Fisheries Joint Research Themes of MASTS. Funded projects include *Spatially-Resolved Ecosystem Models for the Assessment of Fisheries Dynamics* (2008-2011), *Population structure of cod around the UK: scale, mechanisms and dynamics* (2008-2010), and a he is a collaborator in *A Testable High-Resolution Ecosystem Model for Inshore Waters* (2009-2011, W.S.C. Gurney PI). Dr. Speirs will lead Subtask 5.2.2 and contribute to Subtask 5.3.2 in WP 5, and contribute to WP 8 Task 8.2.

B2.2.17. CEFAS

is an Executive Agency of the UK Department for Environment, Food and Rural Affairs (Defra). It is a multidisciplinary scientific research centre specializing in aquatic science, monitoring and assessment. The organization employs over 550 staff at two laboratories, and provides its services to a broad range of UK and international public and private sector clients. CEFAS has become established as the home of the UK Marine Climate Change Impacts Partnership (MCCIP); a 'flagship' programmethat is supported by the devolved administrations of England, Scotland, Northern Ireland and Wales. The organization plays a leading role within the International Council for the Exploration of the Seas (ICES) as well as OSPAR, STECF, ICCAT and the IWC. In addition, CEFAS staff play an active and important role in many EC and national research initiatives, including: 'RECLAIM' on climate change and fisheries, 'UNCOVER' on mechanisms of fish stock recovery, 'BECAUSE' on interactions between key fish species, and 'CLAMER' on public perception of marine climate change. CEFAS played a key role (case-study leader for European shelf-seas) within the EC Network of Excellence, 'EUR-OCEANS'.

Dr John K. Pinnegar is a senior scientist and programmeDirector for Marine Climate Change at CEFAS, with overall responsibility to provide leadership across the organisation's climate-related portfolio. Dr Pinnegar's research interests include, the impact of climate change on marine animal populations, marine food-webs and ecosystem modelling, marine scenarios, marine protected areas, bioeconomic modelling. Dr Pinnegar regularly provides advice to the UK government on multispecies fisheries issues, climate change and ocean acidification. He is a current co-chair of the ICES Working Group on Multispecies Assessment Methods, as well as an honorary lecturer at the University of East Anglia. Dr Pinnegar is lead-scientist on the DAPSTOM initiative, which is an ongoing project to make predator-prey and fish diet information available to the wider scientific community through a web-based data portal. Within EURO-BASIN Dr Pinnegar will primarily contribute to WP5, and specifically work on predator-prey linkages (via blue whiting) in the Celtic Sea. He will also contribute to WP1, through support and further development of the DAPSTOM data portal.
Prof. Simon Jennings is a senior scientist and leading researcher at CEFAS as well as Chair of Environmental Sciences at the University of East Anglia. Prof Jennings' scientific interests include, food-webs, macroecological theory, ecosystem indicators and fisheries management. His research has contributed directly towards the development of an 'ecosystem approach' to marine environmental management' in Europe, and Prof Jennings is a key advisor to the UK government on fisheries and marine conservation issues. Prof. Jennings is Science leader for the 'Ecosystem Interactions' Thematic Area within CEFAS (108 staff, £7.9 million income). In 2007 he chaired an expert group developing indicators to support fisheries management in Europe (on behalf of the Scientific Technical and Economic Committee for Fisheries (STECF) of the European Commission). He was also chair of the International Council for the Exploration of the Sea, Advisory Committee on Ecosystems (ICES, ACE) (UK representative 2001-2003, elected Chair 2004-2006). Within EURO-BASIN Prof Jennings will primarily contribute towards WP7 ('Bioeconomic modelling of N. Atlantic fish resources'). The primary focus will be on the development of models that predict the future distribution and production of key fish stocks based on climate change projections.

B2.2.18. Individual Participant: Bodø University College (BUC)

is an academic institution of graduate and post-graduate studies and research. During 2009 a formal application to become Norways 8th full University was sent in and validation is expected spring 2010. BUC is located 67, 17° N with the Atlantic sea shelf located only (100 km from land) providing ideal locations for the study of the North Atlantic sea basin. The Faculty of Biosciences and Aquaculture (FBA) is one of the leading academic environments within fisheries, marine ecology and fish farming in Norway. Being located on the seaside, Bodø offers a perfect environment for studies within ecology, aquaculture, marine sciences and natural sciences. In addition to campus facilities the faculty owns a 5000m^2 marine research station equipped with state of the art laboratories. The latest 3,6M € investments in new equipments will be completed by the end of 2009 providing the Faculty with one of Europe's most modern marine research stations. The Marine Ecology Group (MEG) focuses on field-based marine ecological research, in particular the coastal environment. The major emphasis is on processes, which increasingly involve human impacts. General areas of research are physical and biological oceanography of fjords and coastal waters, special studies on production and quality of marine algae, zooplankton, fisheries resources, as well as molecular biology.

Role in EURO-BASIN

BUC will chair the WP3 in EURO-BASIN, supporting the field work by arranging the set-up of the large scale surveys and contribute on the large scale and mesoscale studies data analysis and synthesis. BUC will also use its facilities, and provide technical support locally at BUC in particular the planned molecular genomic studies to be swiftly carried out. It will also provide labour input to the project by its current staff relevant for the research identified.

Description of PIs involved in the project

Professor Kurt Tande is Dr. philos in marine biology in 1992 at the University of Tromsø, is currently employed at Bodø University College (BUC). He has extensive experience in copepod ecology, as well as modelling vertical distribution, growth, survival of lower trophic organisms. He also has experince from modelling after working together for several year with Dag Slagstad, and have recently been involved in studying the effect of advection and tide on the distribution of plankton in fjords (Mare Nor) and on the North Norwegian shelf (OMEX). Has been working together with Dr. Meng Zhou, UMASS, USA, on using the ADCP and SCANFISH LOPC SEABIRD platform, and are currently sharing a PhD (with Zhou) and one Master student on the use of LOPC, application of biomass spectrum theory, and ADCP analysis. He has served as co-ordinator of TASC in MAST III (1993-97), acted as Pro-Dean at the Norwegian College of Fishery Science (UiT) for three years, and is currently acting as Head of the Marine Ecology Group at BUC.

Professor Ketil Eiane is a marine ecologist specializing in population biology of fish and zooplankton. Carried out his PhD in the TASC program, and has been working on the University of Svalbard (UNIS) for 6 years, and is currently holding a professor position in Marine Ecology at the University College of Bodø. His contribution in the project is through his expertise in ecology and he will participate in: supervision, ecological investigations, data analysis, and development of ideas and applications. Will contribute to Task 2, 3, 4 of WP3.

Dr. Sunnje Basedow is currently affiliated to the University of Tromsø as a young scientist, and had extensive practise from sea-going research, laboratory experimentation, and analyses of large data sets from Scanfish LOPC-CTDF. Dr. Basedow will contribute to Task 2, 3, 4 of WP3.

Professor Galice Hoarau has extensive experience from using modern molecular techniques such as spatial modelling (Ecological Niche Modelling), transcriptomics (qPCR) and genomics (genome scans, AFLPs & microsatellites) to disentangle the ecological (range shift and phenotypic plasticity or modulating gene expression) and evolutionary response (selection for the most adaptive genotypes) both in fish species and makroalgae Will contribute to Tasks 4 in WP3 and Task 5 in WP4

B2.2.19. Uni Research

NB: As of November 2009, 'UNIFOB AS' became 'Uni Research'. We are updating this information with the EC.

Uni Research AS is the University of Bergen's main instrument for externally funded research. Uni Research AS' objective is to advance research and other activities normally associated with research, and of essential interest to the University of Bergen. Uni Research researchers have in particular proven experience to link marine observations (including mesocosm studies, autonomous systems, and deep sections) with models (from process to global scale 3-D models). The Bjerknes Centre for Climate Research (BCCR) in Uni Research is an international leader in high latitude climate research, and a key institution for information on climate change for politicians, industry and the public.Uni Research has participated as coordinator and principle investigator in a series of EC and national projects in the fields of climate, ocean biogeochemistry and ecosystem research.

Role in EURO-BASIN

Uni Research will focus on understanding the strength and variability of the biological carbon pump in the North Atlantic and Nordic Seas. They will be responsible for the carbon dioxide system measurements during the EURO-BASIN expedition to the Norwegian Sea in Task 2.2. They will analysis historical and new datasets from combined cruise, mesocosm studies to provide new information on the quantity and the quality of the biological pump. Uni Research will lead Task 2.3 *Time series analysis of the biological carbon pump at high latitudes.*

Description of PIs involved in the project

Dr. Richard Bellerby: Senior Researcher at the BCCR and Associate Professor at the Geophysical Institute, University of Bergen. He has 17 years experience as a biogeochemist researching carbon cycle-ecosystem-biogeochemical coupling and climate change. PI on several ecosystem-biogeochemistry projects (EU CARUSO, EIFEX, and NFR CABANERA) and coordinator of the NFR SOBER and MERCLIM projects, WP leader and SSC member on EC FP7 MEECE and PI on EPOCA. SSC member and WT leader of the EC COST 735 working group and project manager and WT leader of the IPY project BIAC. He is leader of the BCCR research team on *Ecosystem Response and Feedback to Climate Change*. He is a member of the SCOR/SCAR *Expert Group in Oceanography and the ICED* Scientific Steering Committee. He has published over 50 peer reviewed scientific papers.

Dr. Are Olsen:Senior Researcher at the BCCR. He has 10 years experience as a biogeochemist with research focussed on ocean uptake and accumulation of carbon dioxide. He is the Principle Investigator on two biogeochemistry projects (NFR A-CARB and CARBON-HEAT), a member of the SOCAT (Surface Ocean CO2 Atlas) global coordination group, and was a regional PI for the recently completed CARINA data synthesis effort .

Prof. Truls Johannessen: full professor at Geophysical Institute and the BCCR, in chemical oceanography at the University of Bergen. Johannessen research experience studying marine climates, geochemistry, oceanography and earth systems. He is a SSC member in a number of international programmes under JGOFS, SCOR and IOC. He is the author of more than 70 scientific paper. He has been involved in several EU-project: including ESOP, IMCORP, CAVASSOO, TRACTOR and CARBOOCEAN.

B2.2.20. Instituto Español de Oceanografía (IEO)

IEO is an organization belonging to the Ministerio de Ciencia y Tecnología of Spain specifically devoted to RD activities in the ocean, including multidisciplinary oceanography, marine geology, marine pollution, fisheries and aquaculture, and the assessment to the Spanish Government on marine policies (i.e. fisheries and environmental aspects). These studies are carried out under the coordination of International Commission of Organizations, such as the COI, ICES, ICCAT, NAFO, CECAF, OSPAR, etc, in which IEO participates actively and, in most cases acts as the state representative. The human resources and the infrastructure available (regional oceanographic centres, research fleet, aquaculture facilities) is adequate to carry out multidisciplinary research. The IEO is involved in the promotion of co-operation in marine research at the regional, national and international levels through training oceanographers and disseminating oceanographic knowledge. The IEO works in all oceans from the Arctic to the Antarctic. The IEO maintains long term observational projects aimed at the study of the oceanography of the Atlantic Ocean, its ecosystems and pelagic resources, such as the programme RADIALES, http://www.seriestemporales-ieo.net). In EURO-BASIN the IEO will be represented by the research group on Plankton Ecology and Biogeochemistry (EPB) from its Oceanographic Centre in A Coruña.

Role in EURO-BASIN

IEO will lead task T4.3 (Trophic pathways) and will participate in T4.2 (Field Observations) and T.4.1 (Historical data analysis) in WP4 (Trophic Flows: Production and controls). The participant team will focus on the determination of stable C and N isotope signatures in plankton to determine the role of key species and functional groups in transfer of biomass and carbon within the marine food web. These results will also contribute to the objectives of task T4.6 (Trophodynamics modelling) by providing estimates of trophic positions and of their variability.

Description of PIs involved in the project

Dr. Antonio Bode has a permanent position as staff researcher at IEO since 1991. He is currently leading the time-series project RADIALES and has been the leader of research projects aimed at the study of pelagic food webs using stable isotopes. He has experience in studies of nitrogen and carbon cycling in a range of oceanic ecosystems, from the coast to the deep-ocean and from polar to tropical regions. He is currently leading the IEO research group on Plankton Ecology and Biogeochemistry (EPB). In EURO-BASIN he will lead Task 4.3 and will assisted by laboratory technicians and PhD students.

B2.2.21. CLS: Collecte Localisation Satellite (France)

CLS is a subsidiary of CNES (French Space Agency) and IFREMER (French Research Institute for Exploration of the Sea). CLS operates the ARGOS data collection and location system and offers a wide-range of ARGOS-based services. Through its large Space Oceanography Division (SOD) (over 65 oceanographers and remote sensing specialists) CLS is also very active in the field of operational satellite oceanography. CLS/SOD develops (a) ground processing systems for various satellite oceanography missions and (b) operational ocean models through its contribution to the French operational oceanography programme MERCATOR. CLS/SOD is one among the major partners of the European project “MyOcean”, an implementation project of the GMES Marine Core Service, aiming at setting up a new European service to monitor and forecast the oceans. CLS is responsible of the sea level TAC (Thematic Assembly center) thanks to 20 years of experiences in processing, validation and disseminating satellite altimetry data. CLS is also responsible for cross-cutting system engineering and data management and information systems.

Inside SOD, CLS has developed a new programmefor Marine Ecosystems Modelling and Monitoring by Satellites (MEMMS) to contribute to a better understanding of how marine ecosystems function, under the influence of both human activities and climate-environmental variability. It also provides useful tools for ecosystem-based management and sustainable exploitation of marine resources.

Role in EURO-BASIN

CLS will leads basin-scale Mid-Trophic Level hindcast and forecast simulations (Task 6.1.3 and Task 6.3.3). The tasks include model parameterization using acoustic data (WP1) and data assimilation techniques, and production of grazing and detritus fields from MTL functional groups that will be used to test sensitivity of the carbon cycle models to top down impacts. In WP5, CLS will develop an application of SEAPODYM model to North Atlantic Albacore tuna, using fishing data (WP1) for parameter estimation of the model using maximum likelihood approach. Hindcast and forecast simulations will be conducted to investigate the impact of both fishing and climate on the tuna population dynamics and their prey consumptions.

Description of PIs involved in the project

Dr Patrick Lehodey holds a PhD in Marine Biology. He joined the Oceanic Fisheries Programme (OFP) of the Secretariat of the Pacific Community (Nouméa) and became the Principal Fisheries Scientist of the OFP tuna ecology/biology section in 2002. He joined CLS in 2006, to lead the Marine Ecosystem Modelling component of MEMMS. He is the main contributor to the development of a spatial numerical model (SEAPODYM), coupled off-line to physical-biogeochemical ocean models and integrating knowledge on Mid-Trophic Level organisms and biology and ecology of tuna. Patrick Lehodey was a member of the Scientific Steering Committee of GLOBEC and is now the co-chair of GLOBEC/CLIOTOP (Climate Impacts on Oceanic Top Predators) programme.

Dr Inna Senina completed a PhD degree in Mathematical Sciences at the Rostov State University (Russia). Her thesis topic was mathematical modelling, extinction risk assessment and prognosis of harvested fish population dynamics. In April 2004, she became Assistant Researcher for the Pelagic Fisheries Research Programme at the University of Hawaii (USA) starting collaboration with Patrick Lehodey. She joined the MEMMS team in 2007 under a EUR-OCEANS post-doc grant to contribute in the modelling of fish population spatial dynamics. Then, she was recruited in CLS and is responsible for parameters optimization with reaction-diffusion-advection models that are used to predict dynamics of prey and predators pelagic species in SEAPODYM.

B2.2.22. Swansea University, Department of Pure and Applied Ecology (SWANSEA)

The Department of Pure & Applied Ecology at Swansea University is a new grouping headed by Prof. Kevin J Flynn. It brings together expertise in diverse areas of ecology. Interests merge studies of traditional (pure) ecology with applied ecology, the use of ecological concepts and knowledge to advance sustainable human endeavour and improve our environment.

Our work in pure ecology ranges from theoretical aspects making use of mechanistic models, through experimental micro- and mesocosms, to work in large artificial wetland habitats and research conducted in the wild (tropical, UK, polar). Much of this work is associated with understanding the dynamics of trophic processes (notably plankton, fish, turtles, seabirds), including impacts of climate change.
Applied work ranges from invasion ecology, the identification and exploitation of novel compounds found in nature in organism-organism interactions (e.g. predator-prey, parasites), exploitation of whole organisms for control of pests of socio-economic importance, through aquaculture, fisheries, biofuels, livestock management, organism and ecosystem conservation, and environmental impact of marine renewable energy. Methods deployed include modelling, molecular, analytical (including advanced and stable isotope mass spectrometry), whole organism ecophysiology and behaviour, and deployment of highly complex animal-attached recording technology with satellite telemetry. Research facilities include the coastal research vessel *Noctiluca*, and the Centre for Sustainable Aquaculture Research (CSAR), which is one of the largest recirculatory marine aquaculture facilities in Europe.

Role in EURO-BASIN
SU will contribute to WP 3 and 4, and thence to 6. In addition to supplying an advisory input on phytoplankton interactions, the main contribution will use models to explore the transfer of nutrients between plankton trophic levels using stoichiometric (quality) and quantity descriptions. These models will develop from those already built. In addition, we will build in a parallel description of stable isotope fractionation to better interpret studies of stable isotope natural abundance as applied to food webs and trophic analysis. The mechanistic models will also act to test the behaviour of the simpler models (more appropriate for placement in complex 3D whole ecosystem simulators) deployed elsewhere in the EURO-BASIN project.

Description of PIs involved in the project
Prof. Kevin J Flynn works on the construction and utilisation of mechanistic models of plankton. These models find applications in pure (theoretical) marine plankton ecology and also in the applied area of algal biofuels and in modelling work conducted in the Centre for Sustainable Aquaculture Research (CSAR), which is one of the largest water-recycling aquaculture facilities in Europe. The models constructed at Swansea contrast with those developed elsewhere in their mechanistic content and also in that a whole suite of models have been developed describing bacteria, phytoplankton, mixotrophs, microzooplankton and copepods. Prof. Flynn also works with experimental systems; an ongoing research project considers the impact of ocean acidification on phytoplankton growth.

B2.2.23. Institute of Marine Sciences – Middle East Technical University (IMS-METU):
IMS is located on the Mediterranean coast of Turkey, near Erdemli. It is a part of the Middle East Technical University (main campus is in Ankara). The Institute established in 1975 has four main disciplines: (1) Physical Oceanography, (2) Chemical Oceanography, (3) Marine Biology and Fisheries, (4) Marine Geology and Geophysics. The Institute carries out research (both observational and theoretical) on the Eastern Mediterranean, Aegean, Black Seas as well as the Turkish Straits System. The main research foci are impacts of pollution, nutrient dynamics, primary production, phytoplankton, zooplankton, fish population dynamics, acoustical methods in fisheries science, topography and structure of sub-bottom sediments and rocks, application of remote sensing to oceanography, and circulation dynamics. The Institute owns a well-equipped research vessel called R.V. BILIM. Some major international projects contributed in the recent years are: Monitoring of the basic oceanographic variables in the Turkish Seas, Compilation of the National Oceanographic Data Inventory, Ecosystem Modelling as a Management Tool for the Black Sea: A Regional Programme of Multi-Institutional Cooperation. (TU-Black Sea), Black Sea Ecosystem Processes And Forecasting / Operational Database Management, Multidisciplinary Analysis of the Caspian Sea Ecosystem (MACE), MFSTEP, MAMA, MERSEA and SEA-SEARCH, ARENA, a Pan-European Network for Ocean & Marine Data and Information Management, EUR-OCEANS, SESAME, ECOOP, MEECE, ODEMM, MYOCEANS. IMS-METU participates to GLOBEC, IMBER and SOLAS Programmemes.

Role in EURO-BASIN
IMS-METU, is responsible for providing new parameterizations of downward particulate organic carbon flux suitable for inclusion in numerical models and will contribute to collating existing information on the relationship between plankton community structure and transfer efficiency, Convection IBM parameterizations into NEMO, and medium and high resolution ensemble hindcast and forecast of the ecosystem of the North Atlantic.

Description of PIs involved in the project

Dr. Baris Salihoglu, joined to IMS-METU on January 2007 after his Ph.D in USA and post-doc in CNRS-France. Assistant Professor since June 2009. His research interests include studying processes controlling the food web dynamics and biogeochemical cycles, the role of micro- and mesozooplankton as a link between the first and the higher trophic levels, and the biogeochemical consequences of climate change. He has successfully developed an ecosystem model for the North Atlantic to investigate the nutrient and carbon cycling and export processes. Currently at IMS-METU his work focuses on understanding the functioning of the Black Sea ecosystem in terms of "trophic cascade control" and "regime shift" mechanisms using retrospective data analysis and an interdisciplinary modelling approach. He will be responsible of Task 2.4 of WP2 and Task 6.1.5 of WP6 and will contribute to Task 2.1.2 of WP2 and Task 6.2.2 of WP6.

Dr. Sinan Husrevoglu is currently a post-doctoral researcher at IMS-METU working on coupled ocean-ecosystem modelling of various coastal and shelf regions in the Mediterranean, Marmara and Black Seas. His research interests are in observational and modelling aspects of physical oceanography, model coupling (ocean, ecosystem, sea ice), regional operational and climate modelling, and data analysis. He will lead Task 6.2.2 of WP6 and contribute to Task 6.1.5 of WP6 and Task 2.4 of WP2.

Dr. Heather Cannaby had recently joined the physical oceanography group at IMS-METU as a postdoctoral research fellow. She has worked previously at the Irish Marine Institute investigating the impact of climate change on Irish marine systems and at the National University of Galway, Ireland where she supported the production and validation of operational model products for the NE Atlantic region. She has expertise in the analysis and statistical interpretation of climate data. Recent research activities have focused on establishing links between large-scale atmospheric teleconnection patterns and periodic variability in marine climate systems. She will contribute to Tasks 2.1.2 and 2.4 of WP2 and Task 6.2.2, and 6.1.5 of WP6.

B2.3 Consortium as a whole

EURO-BASIN requires a multidisciplinary approach to deliver answers to the EU-call. To do so the consortium is built up of the leading European institutes in the disciplines relevant for addressing the call. Within 5 of total 9 work packages (WP 2 to 5) the trophic cascade from lowest to highest trophic level and their interactions will be monitored, investigated and tested. Additionally two more WPs will use time series data from WP 1 in combination with data gained in WP2-5 for integrative (WP6) and bioeconomic modelling (WP7). All WP feed into the synthesis in WP8.

To address these scientific needs, institutions were chosen who could provide complementary knowledge and data required for analyses and modelling. A summary outline of all partners and their disciplines is given in Table 3. Detailed partner descriptions and the expertise of all participating scientists can be found within B2.2. The EURO-BASIN consortium comprises 23 partners including 7 from EC member states, (Germany, Denmark, UK, France, Italy, Spain and Poland) and three from associate countries (Norway, Turkey and Iceland). The partners represent a range of institutions from small to large and include universities and public research bodies

The criteria for the selection of partners was evidence of high quality science as well as that the partners represented key European experts in their science discipline. Partners were also selected based on their record in collaborative interdisciplinary research and their ablity to communicate working hypotheses, experimental set-ups, model structures and results across disciplinary boundaries. Futhermore, experience in international collaboration was a criterion. The team brings together expertise in marine ecosystem research across all trophic levels and modelling and has chosen high quality partners who participate and act as chairmen in International Programmes such as GLOBEC and IMBER as well as serving in several ICES Working Groups (e.g. Physical Biological Interactions; Multi Species Working Groups, Fisheries Recruitment, Zooplankton Ecology, Advisory Committee on Fisheries Management) and scientific Steering Committee under SCOR. Furthermore, PIs serve as chairs and participants in European Networks of Excellence such as EUROCEANS and Integrated projects such as CARBO-OCEANS, MERSEA, MYOCEAN, FACTS. Regional expertise, a criteria for partnership selection allows the team to cover the various case study regions (cruises, times series, etc) including knowledge of the regional management systems and capabilities of communicating with regional managers, interest groups and the public.

Table 3: A summary of all partners and their key expertise.

No.	Short	Expertise	WPs	Key Scientists

	name			
1	UHAM	Co-ordination, Time Series Analysis, Biochemical Ecology, Trophic Interactions, Fisheries Science, Ecosystem Modelling, Process Modelling, Systems Analysis	2,3,4,5,6,8,9	St John, Backhaus, Möllmann, Temming
2	UNI-HB	Time Series Analysis/Data management	1	Pesant
3	DTU-AQUA	Time Series Analysis, Biogeochemistry, Biochemical Ecology, Trophic Interactions, Fisheries Science, Process Modelling	1,2,4,5,8	Köster, MacKenzie, Visser, Vinther
4	Tecnalia-AZIT	Time Series Analysis, Trophic Interactions, Fisheries Science, Ecosystem Modelling, Process Modelling	3,5	Irigoien, Cotano, Chust
5	NERC	Time Series Analyses, Biogeochemistry, Ecosystem Modelling	1,2,6	Sanders, Lampitt, Anderson
6	MRI-HAFRO	Time Series Analyses, Trophic Interactions, Fisheries Science, Process Modelling	1,3,4,5	Gislason, Petursdottir, Oskarsson
7	MIR	Time Series Analysis, Biogeochemistry, Trophic Interactions, Fisheries Science	4,5	Horbowy, Fey
8	PML	Time Series Analysis, Trophic Interactions, Ecosystem Modelling, Process Modelling, Bioeconomics	4,6,7,8	Allen, Barange, Lindeque
9	UEA	Time Series Analysis, Biogeochemistry, Ecosystem Modelling, Process Modelling, Systems Analysis, Bioeconomics	7	Cheung
10	NERI	Time Series Analysis, Biochemical Ecology, Genomics, Trophic Interactions, Ecosystem Modelling, Process Modelling	4	Nielsen, Markager, Møller
11	IMR	Time Series Analyses, Biogeochemistry, Trophic Interactions, Fisheries Science, Ecosystem Modelling, Process Modelling	1,3,4,5,6	Huse, Melle, Nash, Sundby
12	IFREMER	Time Series Analysis, Trophic Interactions, Fisheries Science, Ecosystem Modelling, Process Modelling	5,8,9	Trenkel, Rochet, Berger
13	SAHFOS	Time Series Analyses, Trophic Interactions	1,3	Castellani, Licandro, Kirby
14	IRD	Time Series Analysis, Trophic Interactions, Fisheries Science, Ecosystem Modelling	7	Mullon
15	CNRS	Time Series Analyses, Biogeochemistry, Trophic Interactions, Ecosystem Modelling, Process Modelling	1,2,6	Mémery, de la Rocha, Tréguier
16	USTRATH	Time Series Analysis, Fisheries Science, Ecosystem Modelling, Systems Analysis	5,8	Speirs
17	CEFAS	Time Series Analysis, Fisheries Science, Process Modelling, Systems Analysis, Bioeconomics	5,7	Pinnegar, Jennings
18	BUC	Time Series Analysis, Biochemical Ecology, Genomics, Trophic Interactions, Process Modelling	3,4	Tande,Eiane, Basedow, Hoarau
19	Uni Research	Time Series Analysis, Biogeochemistry, Process Modelling	2	Bellerby, Olsen, Johannessen
20	IEO	Time Series Analysis, Trophic Interactions, Process Modelling, Bioeconomics	4	Bode
21	CLS	Time Series Analyses, Fisheries Science, Ecosystem Modelling, Process Modelling	1,4,6	Lehodey, Senina
22	SWANSEA	Time Series Analysis, Biogeochemistry,	4	Flynn

		Biochemical Ecology, Trophic Interactions, Fisheries Science, Ecosystem Modelling, Process Modelling		
23	IMS-METU	Time Series Analysis, Biogeochemistry, Ecosystem Modelling, Process Modelling	2,7	Salihoglu, Husrevoglu, Cannaby
24	UPMC	Time Series Analysis, Biogeochemistry, Biological Samples Data Rescue	1	Lars Stemann

EURO-BASIN will stay open for widening the scientific participation, e.g. with respect to cooperation with projects emerging from parallel calls, already running projects or new up-starting initiatives. EURO-BASIN will furthermore place emphasis on i) employment of young researchers including dedicated contributions to education and supervision, ii) integrating top scientists from new EC countries, and iii) hiring top female scientists within the project.

B2.3.1 Sub-contracting

The consortium proposes to sub-contract a number of minor activities in order to access proprietary data or to perform specialized data access tasks. **The subcontractors do not perform scientific analyses.** Activities are not core to the programme's success yet their extremely low cost/benefit ratio significantly increases the cost-effectiveness of the project by adding value to the final synthesis. In addition, these subcontracting tasks will make available, and exploitable, historic datasets available to the broader scientific community.

i) EC Associated Countries & International Cooperation Partner Countries
UNI-HB proposes to subcontract the Flanders Marine Institute (VLIZ) and the International Council for the Exploration of the Sea (ICES) for the service of **transforming key historic field data from reports into in exploitable electronic formats** for reanalysis by participants in WPs 3 4 and 5 to perform retrospective analyses on abundance and biomass of plankton and fish species (WP1, Task 1.3.4) and fisheries catch and effort (WP1, Task 1.3.6).

Flanders Marine Institute (VLIZ)
VLIZ is a non-profit public research institution (Belgium) and will **provide access** to the EURO-BASIN project the international OBIS community (EurOBIS, US-OBIS and CanOBIS) thereby **providing historic biogeographic abundance data**. UNI-HB (through WP1) will provide VLIZ with funds for data digitization activities. UNI-HB and WP1 will in return share EURO-BASIN-collected biogeographic data, subject to agreement by data providers. The datasets will support activities in WPs3-5 and be delivered by Month 16. The subcontract is part of University of Bremen (UNI-HB) budget (under Workpackage 1), will cover staff time at cost, and amount to € 40k.

The International Council for the Exploration of the Sea (ICES)
ICES coordinates and promotes marine research on oceanography, marine environment, marine ecosystems, and on living marine resources in the North Atlantic, and is uniquely placed with access to historical fisheries datasets from the North Atlantic Basin. ICES are best qualified to efficiently provide datasets in exploitable format to the EURO-BASIN programme. **ICES will provide data** to be used in WP 5 and will be provided by Month 16. The subcontract is part of UNI-HB budget (under Workpackage 1), will cover staff time at cost, and amount to € 40k.

IMI Ireland
The Marine Institute is the national agency responsible for Marine Research, Technology Development and Innovation, and a regional expert in small pelagic fish. **IMI** will be subcontracted by WP5 as an expert in blue whiting spatial/temporal distribution across shelf waters, to **contribute proprietary historical data** on that species in support of spatial population modelling (Task 5.1.2 Spatial structure in small pelagic fish, Atlanto-Scandic herring, blue whiting and mackerel). The data compilation costs are part of WP5 and amount to € 20k.

Polar Research Institute of Marine Fisheries and Oceanography PINRO Russia

PINRO has access to, and will supply in exploitable electronic formats, **a proprietary and unique historic time-series on mackerel catch data** from the commercial Russian fleet in the Nordic Seas in 1985-2010. Changes in distribution between years and through the season (June-August) can then be mapped by EURO-BASIN participants and hypotheses of N-S and E-W changes will be tested. Patterns will be related to bottom up control through environment and food. Alternative explanations, such as fishing behaviour due to regulation, fish quality or market price, will be qualitatively investigated through contact with pelagic skippers from the fleet. The results will be compared to results from pelagic trawl surveys.
This subcontract study will be delivered by Month 24 and will make a substantial contribution to Task 5.1.2, and understanding of mackerel migration in a dynamic environment. The subcontract costs are part of WP5 and amount to € 30k.

ii) Non-EC Associated Country/ non ICPC countries (International Cooperation Partner Countries)

Faroe Marine Research Institute (FAMRI-HAFRO), Faeroe Islands
Contracting for existing information on ocean climate and its influence on the plankton dynamics in the North EasterNorth Atlantic (Hátún et al. 2009a) at FAMRI-HAFRO, is a cost-effective way for obtaining compilations of historic datasets from the NE Atlantic shelf waters on mackerel spawning stock dynamics, and will be highly complimentary to services provided by PINRO (Russia).

FAMRI-HAFRO will, as a service, will provide **proprietary compilations of existing electronic datasets** related to spatio-temporal spawning stock dynamics of mackerel, including i) hydrographic data from the comprehensive NISE dataset (Hátún et al. 2009b; Nilsen et al. 2008) ii) existing output from a realistic numerical general ocean circulation models (Hátún et al. 2005a; Hátún et al. 2005b) and iii) satellite based observations of sea surface height, sea surface temperature and chlorophyll concentrations. The subcontract will make a substantial contribution to Tasks 5.1.2 and be delivered by Month 24. The costs are part of WP5 and amount to € 30k.

B2.4 Resources to be committed

Mobilisation of the critical mass of resources
EURO-BASIN is proposing an ambitious workplan to improve the knowledge base on marine ecosystems and their response to climate and anthropogenic driving forces, and to develop predictive tools to resolve the impact of ecosystem drivers on marine resources and their management. The project mobilizes the critical mass of resources required (personnel, indirect costs, equipment, finances and consumables) required for success. The size of the EURO-BASIN consortium, including 23 highly competent partners with 75 PIs, illustrates the capacity required to implement a project of this complexity. It includes leading European scientists with significant experience and expertise in marine ecosystem, coastal and basin wide modelling, and resource management. The proposed coordination and workpackage structures will ensure that resources are fully and efficiently integrated into a coherent project.

Financial Planning
The financial planning will be under the guidance of the expert financial mangement team at UHAM. A detailed breakdown of each partner's expenditure (personnel, indirect costs, equipment etc.) will be prepared for each year of the project. These will be monitored as the project progresses to ensure any under or over expenditures are identified and rectified. The estimated spending profile by WP and by year is shown in table 5, which indicates an even spending profile, with a maximum in year 2 when all the WPs are active. Table 6 shows the projected breakdown of spending profile of each beneficiaries EC contribution by WP.

Table 4: Estimated breakdown of the spending profile in EURO-BASIN of the EC contribution K Euro) per workpackage per year

	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	WP 7	WP 8	WP 9	Total	% of Budget
Yr 1	309035	140123	119052	264920	263561	292722	169329	66374	154908	1780024	25,4
Yr 2	130011	283762	304761	348070	373205	313076	159247	82603	177804	2172539	31,1
Yr 3	45291	304712	240665	229831	255855	283342	65269	102550	162204	1689718	24,2
Yr 4	39000	224780	105780	150161	180943	250639	68976	120765	213082	1354126	19,4
Total	523337	953376	770258	992982	1073564	1139780	462820	372292	707998	6996407	100

Other activities**:** Costs are requested under the category of 'other activities' for workpackage 9. These are essential to the success of EURO-BASIN and will be used to disseminate the RTD results of the project to the users of its results (e.g. Policy makers, advisory boards, research managers, management bodies etc. at both national and European level). These costs are 130.4 K euro, constituting 1.9% of the budget and will deliver the following:

• Strategies, frameworks and tools to transfer knowledge acquired during EURO-BASIN to user communities
• Two Summer Schools (partially funded) to transfer expertise to the next generation
• Coordination of user inputs to EURO-BASIN through meetings of a User Group
• Facilitate knowledge transfer to the research domain (training workshops) at the science/society interface (free open access to all research output); and 4) beyond academia (press office for public and media)

Workshops*:* EURO-BASIN will ensure the transfer of knowledge and integration of ideas, through a series of joint workshops between work packages. When possible these will be timed to coincide with the annual project meetings. For those that lie outside of this time window, UHAM will hold a budget (~3% of the WP budget WP 1 to WP 8, a total of 189 K euro) to organize the workshops pay travel and subsistence costs. The workshops are identified as milestones.

Table 5: breakdown of the spending profile in EURO-BASIN of the EC contribution Euro beneficiary per workpackage.

The consortium will be co-financing EURO-BASIN for example,

- **PML** will contribute National funding from 'Oceans 2025' theme 9 – "next generation ecosystem models" providing i12 MM per year in years 1 and 2 to support basic model development. The value of this support is ~ 250 K Euro.
- Additionally **PML** will make available the supercomputing time required for the project modelling and forecasting activities with about 250 K Euros.
- One winter spring cruise of 45 days **by UHAM** to assess the impacts of deep convection on the dynamcs of the spring bloom and interactions with carbon flux and higher trophic level production. Calculated value 450 K Euro.
- **NERC** will provide national funds of ~ 200 K Euro supporting EURO-BASIN with MMs
- Two transatlantic cruises of at least 45 days length funded by **IMR** and **UHAM** with a calculated value of 1125 K Euro and several process studies in the North Atlantic (approx. 120 d and 720 K Euro) plus **IMRs** regional long term sampling with small vessels (over 400 d, approx. 576 K Euro) will support sampling and monitoring processes EURO-BASIN (see table 7).
- Two Summer schools will highlight the EURO-BASIN expertise, and will be co-funded by **GIS Europole Mer/IMBER** who can potentially bid for CNRS Thematic Schools grants (up to 20 k Euros).
- **IFREMER** will continue to make all EURO-BASIN funded research publications freely available and archived at ARCHIMER open access repository for up to two years after the programme.

Table: 6 Planned cruises for EURO-BASIN covering the period from 2011 to 2014.

No	Area	Time	Objective	Vessel	Duration	Costs € k	WPs
	Dedicated to EURO-BASIN						
1	Disko Bay	2012/13/14	Spring bloom	Porsild	Feb-June (daily)	144	3, 4,5
2	Godthaab	2012/13/14	Biological oceanography	Ouzm Masik	Jan-Dec (daily)	432	3,4,5
3	West Coast Greenland	2012	Multidisiplinary	Dana	June, 30 days	90	2,3,4,5,
4	North Atlantic	2012	Multidisiplinary, from physics to fish	Meteor	45 days	450	2,3,4,5,
5	PAP (NABE)	2012	BGC lower TL	UK vessel	30 days	90	2,3,4
6	Trans-Atlantic	2013	Multidisiplinary, from physics to fish	Meteor	45 days, spring-early summer	450	2,3,4,5,
7	Trans-Atlantic	2013	Multidisiplinary, from physics to fish	G.O. Sars	45 days, Spring-early summer	675	2,3,4,5
8	NE Norwegian Sea (Svinøy)	2012	Multidisiplinary, from physics to fish	G.O. Sars	20 days, 4 seasons	n.a.	2,3,4,5
9	North Atlantic	2012	Multidiciplinary from physics to fish	Bjarni Sæmundsson	7-10 days, May	60	2,3,4,5
10	North Atlantic	2013	Multidiciplinarhy from physics to fish	Bjarni Sæmundsson	7-10 days, May	60	2,3,4,5
11	Western Norwegian Sea	2012	Frontal studies, fish-zooplankton	G.O.Sars	7 days, May	60	5
	Ships of opportunity						
1	International Ecosystem Survey in Nordic Sea	2011-2014	Acoustic pelagic fishing (herring and blue whiting)	Five vessels	Appr. 30 days each, April-June	n.a.	3/5
2	Internatinoal Ecosystem Survey NW of the British Isles	2011-2014	International Blue Whiting Spawning Survey	Five vessels	Appr. 20 days each, March-April	n.a.	3/5
3	Western and southern areas	2013	Mackerel and horse mackerel surveys	Nine vessels	14-35 days each, May-June	n.a.	3/5
4	North Sea	2011, 2014	Mackerel egg surveys	Two vessels	Appr. 20 days each, May-June	n.a.	3/5
5	Norwegian Sea	2011-2014	Summer Ecosystem Studies	Four vessels	Ca 20 days each, July-August	n.a.	3/5

Furthermore, activities in EURO-BASIN will be supported by existing information acquired from national or regional modelling, observational and experimental programmemes. Existing data will be provided by the partner institutions, without cost. EURO-BASIN will, as far as possible, incorporate knowledge and information from complementary ongoing projects and cooperative programmes. This includes synthesising results from former and ongoing EC research projects. The effort required to interlink EURO-BASIN with these related activities, e.g. in form of informal clusters, will be covered by partners regular funds for travel as EURO-BASIN funding is only sufficient for support of project related workshops. Similarly, dissemination of participant specific project results is expected to happen at own expense when going beyond the dissemination plan outlined in WP9.

The majority of the requested budget is being spent on personnel costs (50.8%) and indirect costs (39%), while few resources are spent on consumables. The budget for travel and workshops is 3% of the budget, because EURO-BASIN will need a range of workshops in order to maximise synergies and feedback between Work Packages and sub-tasks. In WP9 the budget for organizing user group meetings is 15K Euro. We also request 51.6 K Euro to fund two advanced summer school to train the next generation of scienttists and three training workshops to tranfer technical expertise.

Equipment: There is no large equipment to be purchased with the requested money.

Consumables**:** The major consumable costs are for the experimental work (WP2,3,4 and 5) totalling 337K Euro, required by UHAM, UNI-HB, Tecnalia-AZTI, NERC, MRI-HAFRO, PML, UEA, IMR, IFREMER, SAHFOS, IRD, CNRS, USTRATH, CEFAS, BUC, Uni Research, IEO, SWANSEA and IMS-METU. This covers laboratory consumable materials, Standard CO2 gases, carbon reference materials, chemicals, spare parts for instruments, and a microarray assays for the studied organisms.

B3. Impact

B3.1 Strategic Impact

B3.1.1 How EURO-BASIN contributes towards the expected impacts listed in the work programme.

EURO-BASIN activities are situated in the FP7 Cooperation Work Programme 2010: Environment (including climate change) under Cooperation Theme 6; Activity 6.2: Sustainable management of resources; Sub-Activity 6.2.2 Management of marine environments: *Area 6.2.2.1 Marine resources;* ENV.2010.2.2.1-1 North Atlantic Ocean and associated shelf-seas protection and management options.

In answer to the call EURO-BASIN will *improve the knowledge base on marine ecosystems of the North Atlantic as well as establishing how they are impacted upon by both anthropogenic and natural forcing and how anthropogenic forcing and global change feedback on North Atlantic ecosystems and on their capacity to provide services. Secondly EURO-BASIN will provide input to governmental and non-governmental actors in the development of innovative tools and strategies for the protection and the sustainable use of the sea and its resources, in the perspective of the ecosystem approach to ocean management*.

EURO-BASIN will reinforce the knowledge base of the impact of global changes on the North Atlantic marine ecosystems and contribute to a better ocean management. This involves informing policy makers at national, EC and global level, other stakeholders and the public at large. The project will generate data, analysis and models for implementing the ecosystem approach to fisheries and ecosystem management in an integrated way considering future changes in production characteristics driven by basin-scale climate events, which require adaptive integrated ocean management strategies.

EURO-BASIN will provide new data, analyses and simulation tools to understand and project the population structure and dynamics of broadly distributed, and biogeochemically (diatoms vs. microbial loop players) and trophically important plankton (genus *Calanus*) and fish species (tuna, herring, mackerel and blue whiting). The project will assess feedbacks to and from the climate system and marine ecosystems via quantifying the effect of fisheries exploitation patterns and climate change on the dynamics of the Biological Carbon Pump. Furthermore, EURO-BASIN will develop methods to consolidate and integrate long-term observations from EC and international databases for modelling and prediction of the Atlantic Ocean ecosystem and related services. Finally, the project will push forward the development of the marine ecosystem approach, through the assessment and development scientific ecosystem management options and models, thus contributing to the protection of marine ecosystems and of their capacity to provide expected goods and services. To these ends EURO-BASIN will:

- Integrate existing databases in the EC Canada and the US, develop new databases and perform perform retrospective statistical analyses based on the assembly of new databases and integration of existing databases in the EC Canada and the US and thus contribute to the goals of the European Marine observation Network **EMODNET**
- Undertake targeted field and laboratory experiments as well as perform modelling studies to investigate the impacts of climate change, and other drivers, n ecosystem structure and functioning, thus addressing the first major research topic 'Climate change and oceans' defined by the **European Strategy for Marine and Maritime Research**,
- Implement the modelling tools necessary to provide integrated end to end modelling including a range of feedbacks between drivers and ecosystem on both the physiological and population scale. Such information is necessary for the implementation of the **WSSD (2002) Maximum Sustainable Yield Approach** to be implemented in the revised **Common Fisheries Policy** (CFP) in 2012 and reached by 2015,
- Simulate with quantified uncertainties the response of marine ecosystems to climate and exploitation drivers, being a prerequisite for the **Precautionary Approach to Management** as central principal of the CFP and other European directives,
- Assess the role of harvesting and climate on the efficiency of the biological pump thus providing feedbacks to climate; being cornerstone knowledge for the **future European Integrated Policy on Climate Change**,
- Provide a modelled ensemble assessment of the future dynamics of ecosystems and key species status for the development of adaptive management strategies and plans, being both central for the revised CFP and the implementation of the ecosystem approach through the **Marine Strategy Framework Directive (MSFD),**
- Assess the economic ramifications of climate change and harvesting patterns in terms of carbon sequestration and fisheries commodities, thus addressing the objectives of the **Integrated Maritime Policy for the European Union,**
- Assess existing and proposed management frameworks, e.g. the CFP and MSFD, for applicability in the open North Atlantic in a situation of climate change.

In support of the **European Marine Observation and Data Network** (EMODNET), EURO-BASIN will contribute to the consolidation of existing, but fragmented initiatives to assemble primary data in order to facilitate access to primary data for public authorities, maritime services, related industries and researchers via data management and integration activities within EURO-BASIN thereby supporting the goals of EMODNET and its proof of concept through contributing preparatory actions.

EURO-BASIN is in support of the **European Marine Strategy, which requires the development regional conservation,** and management plans by defining long term regional ecosystem objectives each with a suite of indicators to achieve and maintain good ecological status of these systems. The **Marine Strategy Framework Directive** (MSFD) throws down a significant challenge to the European Marine Science Community. It requires assessments of integrated status of marine waters as well as issue-based aspects, and advice on the integrated response of the system to the combined impact of human activity as environmental pillar of the Integrated Maritime Policy for the European Union. This is a serious departure from the past and requires a significant response from the scientific community in terms of overview and cross-disciplinary synthesis of data and analysis. EURO-BASIN is in support of the **European Marine Strategy,** by defining long term regional ecosystem objectives each with a suite of indicators to achieve and maintain good ecological status of these systems. Project activities fit closely with the framework of the Good Environmental Status (GES) descriptors in particular three of the first four of the 11 GES descriptors, which require scientists and managers to adopt an integrated view of the biological structure and function of marine ecosystems. These are as follows:

- Biological diversity is maintained, recognising that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions, a concept fully implemented in WP3 of EURO-BASIN.
- Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. The first part of the descriptor is already implemented in the European fisheries management system, however, it is clear these are sensitive to productivity changes in fish stocks and ecosystems and thus alternatives need to be developed (WP8). Similarly, population age and size compositions indicative of healthy stocks need to be defined for fish stocks addressed in the WP5.

- All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity. Dynamics of marine food webs are central focus of EURO-BASIN and consequently the project will deliver substantial knowledge for definition and testing food web indicators in WP2 and WP4-6.

The MSFD puts focus on achieving good ecological status and focusing the ecosystem approach to fisheries management on not compromising good ecological status, but does not consider the wider definition of the ecosystem approach according to the commission communication COM (2008) 187) 'The role of the CFP in implementing an **ecosystem approach to marine management'** ensuring as well goods and services from living aquatic resources and being in line with the Integrated Marine Management (COM (2007) 575). Independent which of the definitions is implemented, the proposed project will contribute to both settings. More generally, the concept of defining indicators of good ecological status inclusive limit values under global change will be tested by applying scenario forecast of ecosystem dynamics under various climate scenarios specifically to isolate the response to management measures. This will help to develop the concept of adaptive indicators as basis for adaptive management systems and will identify related research needs. With respect to the wider definition of the ecosystem approach according to COM (2008)187) on the economic consequences of fisheries management measures will be evaluated within WP7.

The FAO Code of Conduct for Responsible Fisheries (1995) stipulates that counties should ensure implementation of and respect for conservation and management measures and to improve research and scientific knowledge. Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources for future generations in the context of food security, poverty alleviation and sustainable development. These goals also concern all living aquatic species, including species other than target species. Decisions should be based on the best scientific advice available, while the absence of scientific information should not be used as a reason for failing to take conservation measures. The **precautionary approach** needs to be applied both in identifying indicators and indicator values of good ecological status and in testing these with respect to sensitivity against the state of the ecosystem they are supposed to characterize and robustness against trends in drivers supposed to have no impact on the respective indicators. To this end, activities in WP 8 contribute significantly to the development of indicators in support of the Code of Conduct for responsibility of Fisheries.

The objective of the EC **Common Fisheries Policy** is '*to provide for sustainable exploitation of living aquatic resources and of aquaculture in the context of sustainable development, taking account of the environmental, economic and social aspects in a balanced manner*' (Council regulation 2371/2002). The CFP does not set priorities for these objectives and, while direct references are made to adopting a precautionary and an ecosystem approach, it is not clear how this relates to economic and social conditions. (Green paper on the Reform of the Common Fisheries Policy – COM (2009)163). However, the EC does not perceive this as an obstacle: '*the economic and social viability of fisheries can only result from restoring the productivity of fish stocks. There is, therefore, no conflict between ecological, economic and social objectives in the long term*' (Green paper 2008). EURO-BASIN by addressing the dependence of fish stock productivity of some of the world's largest and economically most valuable fish stocks on drivers partly out of human control, such as climate change and species interactions, will investigate whether the expectation of the EC commission that management can restore (tuna) and sustain these fish stocks (herring, mackerel, blue whiting) in the long term is realistic. Additionally, EURO-BASIN will elucidate the potential consequences of failure to achieve this objective on marine ecosystem structure and functioning by estimating the gains and losses in goods and services such as fisheries yields and carbon sequestering including economic costs through bio-economic modelling.

With respect to ecological sustainability UNCED (1992) defined the overarching objective as maintenance of the reproductive capacity of the living resources to ensure sustainable exploitation. In contrast WSSD 2002 is more ambitious and agreed on the objective to restore stocks to levels that can produce the **Maximum Sustainable Yield** (MSY) at the latest by 2015. Besides the implementation of the ecosystem approach, the MSY approach is the second ecological pillar of the revised CFP to be implemented in 2012 (Green paper on the revision of the CFP 2009). This poses, however, a specific problem: even when implementing the MSY approach through target fishing mortalities leading to stock sizes producing the MSY (COM (2006) 360), these target fishing mortalities are not necessarily sustainable under changing environmental conditions and thus, the concept needs revision and furthermore it needs embedment in the ecosystem approach, e.g. should consider effects of fisheries on food web structures not to violate indicators of good ecological status as defined by the MSFD. This requires: i) close monitoring of resources, ii) assessment of their productivity and iii) development of predictive capabilities to allow for management, economic and social adaptation. EURO-BASIN will improve our predictive capabilities based on spatially explicit coupled physical, biogeochemical, ecosystem and fisheries models, and it will allow drawing conclusions on future monitoring and assessment procedures to provide the necessary scientific advice for management.

In the EC Council decision of 8 June 1998 on the ratification of the Agreement for the implementing of the provisions of the UN Convention on the Law of the Sea of 10 December 1982 on the **conservation and management of straddling stocks and highly migratory fish stocks**, it is stated that coastal states and states fishing on the high seas shall:

i) Adopt measures to ensure long-term sustainability of straddling fish stocks and highly migratory fish stocks and promote the objective of their optimum utilization,
ii) Ensure that such measures are based on the best scientific evidence available and are designed to maintain or restore stocks at levels capable of producing maximum sustainable yield,
iii) Apply the precautionary approach,
iv) Assess the impacts of fishing, other human activities and environmental factors on target stocks, and species belonging to the same ecosystem, associated with or dependent on the target stocks;
v) Adopt management measures for these species to maintain or restore populations above levels at which their reproduction may become seriously threatened. EURO-BASIN will provide necessary scientific knowledge on highly migratory stocks in the North Atlantic; specifically tuna being under sever exploitation pressure.

With respect to the enhanced **regional focus** of the revised CFP, EURO-BASIN will contribute with scientific results and advice on future monitoring and assessment systems for the open North Atlantic. This geographical area which will need specific attention by the commission as EC member states are not necessarily focused on this area in their activities, even when assuming that Iceland joins the EU. For fisheries management negotiations with none EC member countries, e.g. Norway, Russia, Faroe Islands, Greenland, an enhanced engagement in open ocean science supporting policy is required, especially in view of difficult negotiations on fishing rights for stocks with largely changed distribution and production patterns lying ahead, as example we refer to negotiations with Iceland on mackerel fisheries in 2009.

B3.1.2 The International Dimension.

EURO-BASIN contributes to the **International Geosphere-Biosphere Programme** (IGBP) in relation to the **Integrated Marine Biogeochemistry and Ecosystem Research** programme (IMBER). The chair of IMBER writes "*Your proposal aims to understand the interactions between biogeochemistry and ecosystems and food web structure and function. This aim is closely aligned with the IMBER Science Plan which has an overall focus on the integration of our knowledge of biogeochemical cycles and food webs. The proposed project is specifically closely aligned with Theme 1 of IMBER which is "Interaction between Biogeochemical Cycles and Marine Food webs*". Your proposal would contribute new knowledge to each of the issues identified in Theme 1 of IMBER. These are "*Transformations of organic matter in marine food webs*", "*Transfer of matter across ocean interfaces*" and "E*nd to end food web and material flows*". "*There are also clear contributions that would be made from the proposed research into Theme's 2 and 4 of IMBER*"

EURO-BASIN follows the concept of the FP6 NoE EUR-OCEANS developing biogeochemical and ecosystem understanding to further the modelling capacities necessary to predict the impacts of climate change and resource exploitation on marine ecosystems. The ecosystem dimension of EURO-BASIN characterises the proposed project as in line with the programme Global Ocean Ecosystem Dynamics (GLOBEC), the IGBP core project responsible for understanding how global change will affect the abundance, diversity and productivity of marine populations. This program terminated as of 1. January 2010 and has been integrated within IMBER.

EURO-BASIN will contribute significantly to the fostering of research **interactions between the USA Canada and the European Union**. Activities inside EURO-BASIN will be performed in close collaboration with US and Canadian partners (see support letters in Appendix 1). This collaboration occurs on the scientific level, via joint cruises, experimental and modelling activities; through programme management with the establishment of an International Programme office. Furthermore to ensure optimized research and communications activities between the respective partners a Joint US Canada EC steering committee will be established, whose mission is to ensure the optimal integration of research activities. Research activities will be achieved in close collaboration with similar initiatives in the US and Canada with specific activities mapping on to the WPs comprising EURO-BASIN (see section B3.1.3).

B3.1.3 Synergies with other programmes.

The scientific objectives addressed by EURO-BASIN follow the International BASIN programme; see International Science Plan 2008 (GLOBEC report 27). The Science Plan is an outcome of a series of international workshops, partly financed by a FP6 Specific Support Action BASIN, coordinated by UHAM. EURO-BASIN in its approaches and methodology follows the International Science Plan closely. The core questions posed in section B.1.1.2 have been modified slightly to better reflect the FP7 call text, but overall EURO-BASIN is the natural progression from the International BASIN and the Specific Support Action into the European scientific implementation.

B3.1.3.1. Collaborations and Synergies with the US

Discussions between DG-RTD and NSF and between EC scientists and US have focused on climate change, ocean acidification, and marine ecosystems of the North Atlantic with a clear focus on the International BASIN Science Plan. On the NSF website, links directing interested US researchers to the International BASIN web site (http://web.pml.ac.uk/globec/structure/multinational/basin/basin.htm) for more information and to ensure that NSF funded proposals linked to EURO-BASIN will be produced (see annex 1 for letters of intent). In 2010 and beyond, NSF is anticipating supporting U.S. scientists engaged in collaborative environmental research with European scientists in conjunction to European Commission Programmes, particularly in the areas of climate effects on ocean ecosystem dynamics, carbon and geochemical cycles, ocean acidification. Stating that "There may be opportunities and resources for targeted announcements in these areas (e.g. to link specifically with EC calls for proposals in their Framework Programme)", but they also expect that many of the successful collaborations will develop as investigator-initiated proposals submitted to their regular 15 August and February target dates (http://www.nsf.gov/geo/oce/programmes/biores.jsp#Cooperative). Communication with US researchers has been on going and an expression of interest by the US community as well as a number of US scientists are included in Appendix 1. Many of these letters clearly state that, proposals will be developed for the aforementioned NSF calls to fund interaction with EURO-BASIN.

US Projects and Programmes identified as relevant to EURO-BASIN by the US community.

- NERACOOS: North-eastern Regional Association of Coastal Ocean Observing Systems (http://www.neracoos.org/) – A NOAA IOOS funded association for ocean observing between New York and Nova Scotia, which includes both U.S. and Canadian scientists.
- MACOORA: Mid-Atlantic Coastal Ocean Observing Regional Association (http://www.macoora.org/) – A NOAA IOOS funded association for ocean observing between New York and Virginia.
- OOI: Ocean Observatories Initiative (http://www.oceanleadership.org/programmes-and-partnerships/ocean-observing/ooi/) – A NSF funded programme of science-driven sensor systems to measure the physical, chemical, geological and biological variables in the ocean and seafloor. Specific to BASIN, there are sites on the northeast U.S. continental shelf and in the Irminger Sea.
- NOAA/CPO: Climate Programme Office - (http://www.oco.noaa.gov/) - Builds, sustains, and coordinates a global climate observing system with a wide variety of assets in the North Atlantic including U.S. contributions to the Global Drifter Programme, support for high density XBT lines across the North Atlantic, and pCO2 measurements on NOAA and merchant vessels.
- NOAA FATE: Fisheries And The Environment (http://fate.nmfs.noaa.gov/) – Improves single species and ecosystem assessments across the US. There are several projects in the North Atlantic including habitat modelling of fishery species, integrative modelling focused on cod recruitment, and work examining the dynamics of Atlantic herring. A number of other relevant proposals were recently submitted to the 2010 funding call.
- BCO-DMO: Biological and Chemical Oceanography Data Management Office (http://www.bco-dmo.org/) – Supports the scientific community through improved accessibility to ocean science data. The BCO-DMO provides continuing curatorship for the US GLOBEC and US JGOFS data repositories as well as several others, which are highly relevant to the EURO-BASIN programme.
- CAMEO: Comparative Analysis of Marine Ecosystem Organization (http://cameo.noaa.gov/) - A partnership between the NOAA and NSF that supports fundamental research to understand complex

dynamics controlling ecosystem structure, productivity, behaviour, resilience, and population connectivity, as well as effects of climate variability and anthropogenic pressures on living marine resources and critical habitats. There are currently two funded projects and a funded post-doc that are relevant to the EURO-BASIN programme as well as several submitted proposals that are under consideration for funding in 2010.

- NOAA/NEFSC: The Northeast Fisheries Science Centre (http://www.nefsc.noaa.gov/) – Responsible for the assessment, conservation and protection of living marine resources within the northeast United States' Exclusive Economic Zone (water three to 200 mile offshore). There are a number of activities relevant to EURO-BASIN including fishery and oceanographic observing programmes (trawl survey, EcoMon, SOOP-CPR), data integration and management activities, measurements of vital rates and habitat, trophic and food web modelling, population modelling, and a wide variety of bio economic modelling and ocean management activities. Most of the programmes are ongoing.
- US GLOBEC: US Global Ocean Ecosystems Dynamic Programme (http://www.usglobec.org/) - a multi-disciplinary research programme that examines the potential impact of global climate change on ocean ecosystems. The Georges Bank / NW Atlantic GLOBEC Programme was one of three national level programmes which was funded during the 1990’s. The national programme is now in a Pan-synthesis phase with several funded projects working in the North Atlantic that are highly relevant to the EURO-BASIN programme.
- CINAR: Cooperative Institute for the North Atlantic (http://www.whoi.edu/page.do?pid=30715) - Conducts and coordinates cutting-edge research engaging both NOAA and academic scientists to enable informed decisions by NOAA for sustainable and beneficial management of the North-Western North Atlantic shelf ecosystem. There are numerous activities underway by CINAR members that are relate to the EURO-BASIN programme
- COML: Census of Marine Life (http://www.coml.org/) – An international effort to assess and explain the diversity, distribution, and abundance of life in the oceans. As part of COML, a programme was established in the Gulf of Maine; the goal of this regional programme is to advance knowledge of both biodiversity and ecological processes over a range of habitats and food-chain levels, from plankton to whales
- BATS: Bermuda Atlantic Time-Series Study (http://bats.bios.edu/) – A funded programme south of Bermuda that maintains deep-ocean time-series, with a focus on the importance of biological diversity in understanding biological and chemical cycles and in particular the Biological Carbon Pump.
- NOAA OA: Ocean Acidification – Under the Federal Ocean Acidification Research And Monitoring (FORAM) Act of 2009, NOAA will initiate a new programme in 2010 that is aimed at understanding the effect of increasing CO_2 in marine systems with an emphasis on resource species and ecosystem structure and function. In the North Atlantic, there will be observing, experimental, and modelling components. These activities are currently in the planning stage and work will begin during 2010.
- MVCO: Martha’s Vineyard Cabled Observatory (http://mvcodata.whoi.edu/cgi-bin/mvco/mvco.cgi) - The MVCO provides real-time data and virtually unlimited power transmission that enables continuous scientific study of complex and dynamic biological, physical, geological, and meteorological processes that occur in the coastal ocean off southern New England.
- AMOC: Atlantic Meridional Overturning Circulation (http://www.atlanticmoc.org/) – Funded by US CLIVAR, the AMOC programme seeks to understand Atlantic Meridional Overturning Circulation (AMOC) and its relationship to sudden climate change. There are numerous field and modelling efforts underway all in the North Atlantic. There are also links to a number of international activities.

Table 7. US Programmes of relevance to EURO-BASIN: WP synergies

US Programme (see links to programmes in Appendix)	WP 1 (Data & Retrosp.)	WP 2 (Carbon cycling)	WP 3 (Habitats & Rates)	WP 4 (Trophic Flows)	WP 5 (Living resources)	WP 6 (Integr. Modelling)	WP 7 (Bioecon Mod)	WP 8 (Ocean Mgmt.)
NERACOOS	X	X	X			X		
MACOORA	X		X			X		
OOI	X							
NOAA/CPO	X	X			X		X	
NOAA FATE	X		X	X	X	X		X
BCO-DMO	X							
CAMEO	X		X	X	X	X		X
NOAA/NEFSC	X	X	X	X	X		X	X

US GLOBEC	X		X	X	X	X		
CINAR	X	X	X	X	X	X	X	X
COML	X		X					
BATS	X	X		X				
NOAA OA		X	X		X			X
MVCO	X	X		X				
AMOC	X					X		

B3.1.3. 2 Collaborations and Synergies with Canada

Strong links are established with University and Government Agencies in Canada (see letters of support in Annex 1). Letters outline the potential linkages with EURO-BASIN. They identify not only research interactions and researchers to link with, but also the funding available to the researchers in support of EURO-BASIN activities. As stated by the Department of Fisheries and Oceans "We are excited by the opportunities offered by collaboration with the EURO-BASIN programme and we are pleased to outline here possibilities for participation of the Department of Fisheries and Oceans Canada (DFO). They state, "*A major priority for Atlantic Canada is to describe and understand coupled ocean and shelf processes in order to assess and predict the impact of climate variability and climate change on marine ecosystems and exploitable resources. This is obviously in agreement with the overarching aim of EURO-BASIN and provides a solid basis for cooperation. Under that umbrella, we are pursuing a number of initiatives that could become contributions and we list them within their letter in Annex 1 under the major components of the BASIN Science Plan*". Furthermore they state "*We will participate in efforts to further develop the North American component of BASIN such as a proposed open workshop to be hosted by our U.S. colleagues. We look forward to collaborating with the EURO-BASIN programme and are pleased to discuss matters further at your earliest convenience."* These statements clearly indicate the Canadian interest in a close collaboration with EURO-BASIN in order to complement own research initiatives in the North Atlantic.

B3.1.3.3. Collaborations and Synergies within the EC

To achieve its goals, EURO-BASIN will closely cooperate with national (member states) and international (EC) programmes. On national level, cooperation will be organised with i) existing science projects targeting regional seas and specific tasks of the EURO-BASIN work programme and ii) ongoing monitoring activities with the specific aim of using existing surveys, conducted e.g. in relation to the EC Data Collection Framework, as sampling platform and to get access to routinely collected data. The relatively high level of co-financing of the project by partners is indicative of the close interconnections envisaged (e.g. see value of cruises performed at no cost to EURO-BASIN Table 7).

With respect to collaboration with anticipated and ongoing EU programmes (see listed of relevant projects below), a close cooperation with upcoming projects under the joint call "The Ocean of tomorrow: Joining research forces to meet challenges in ocean management" will be established. These projects have the goal of improving our understanding and the predictive capacity on; how marine ecosystems respond to a combination of natural and anthropogenic factors; how rapid environmental changes will affect the full range of goods and services provided by the oceans; which measures could be developed to mitigate or adapt to these changes. Research in these projects is cross-thematic, integrating different marine and maritime research domains. Thus, these projects are scientifically complementary to EURO-BASIN, as they cover social and economic disciplines as well as other industry sectors, such as transport and energy, while EURO-BASIN focuses mainly on natural sciences. Finally projects under the joint call are geographically complimentary. ENV.2010.2.2.2-01 "Quantification of climate change impacts on economic sectors in the Arctic" targets areas north of EURO-BASIN research area, with limited overlap in the Sub-Arctic, while ENV.2010.2.2.2-02 "Vectors of changes in ocean and seas marine life, impact on economic sectors" targets regional shelf seas. However, both projects cover impact of global change on ecosystem structures (e.g. biodiversity) and function (e.g. food chains) and thus close cooperation is mandatory.

EURO-BASIN will interact with and utilise results of other FP7 research projects, such as the end to end ecosystem model toolbox developed within MEECE, which will be adopted to open North Atlantic waters. Similarly, EURO-BASIN will benefit from operational oceanographic work ongoing within MyOCEAN. Food web processes with focus of the role of pelagic fish are studied within FACTS, however targeting regional seas rather than the North Atlantic. HERMIONE is designed to advance our knowledge of the functioning of deep-sea hot spot ecosystems, e.g. seamounts, coral water reefs, submarine canyons related to key drivers of change including climate change, human impacts and the impact of large-scale episodic events. Although the focus is more on benthic ecosystem components in well-defined sensitive ecosystems, driving forces considered are partly similar warranting cooperation. With respect to ecosystem management, EURO-BASIN will cooperate closely with the EraNet project DEFINELT working on concepts to introduce the MSY approach to the EC fisheries management, while the project JAKFISH considers possibilities to integrate knowledge and data from industry into assessments, inclusive communication to stakeholders. EURO-BASIN will furthermore contribute to the process of FP6 marine NoEs durable integration by close cooperation with the new project FP7 project ENV.2010.2.2.1-3. EURO-BASIN sees the NoE successor as a platform for discussing and disseminating project results into the larger scientific community, but also to contribute to the identification of future research needs.

Cooperation with the aim to communicate EURO-BASIN project results and identified future research needs is envisaged with the FP7 project MARCOM+ "Towards an Integrated Marine and Maritime Science Community", which has the objective to develop a new governance model for marine and maritime research based on consensus among the marine and maritime sectors. Its Science and Policy panels will be used as forum for discussing and reviewing EURO-BASIN results of cross-sectorial and policy relevance. EURO-BASIN will further contribute to the new overarching marine ERANET SEASERA "Towards integrated European marine research strategy and programmes", specifically to its regional North Atlantic component, mostly with input on future North Atlantic research needs, inclusive research infrastructure.

Participants in EURO-BASIN are involved with the following EC programmes thus creating close links between scientific activities and ensuring the flow of information between the consortiums.

- FP7 MEECE (funded 2008-2012): Marine Ecosystem Evolution in a Changing Environment) http://www.meece.eu/, Coordinator PML (leader of WP6 and WP7 in this proposal).
- EUROCEANS Consortium on Ocean Ecosystem Analysis, www.eur-oceans.eu, and its FP7 successor on 'FP6 NoEs durable integration' (2010-2012).
- EraNet MariFish project DEFINELT (funded 2009-2012): Developing fisheries management indicators and targets – Coordinator: DTU-AQUA (co-leader of WP5 and WP8 in this proposal).
- EraNet MarinERA project ECODRIVE (funded 2009-2012): Ecosystem Change in the North Sea: Processes, Drivers, Future Scenarios.
- FP7 FACTS (funded 2010-2013), Forage Fish Interactions – Coordinator DTU-AQUA.
- FP7 HERMIONE (funded 2009-2012): Hotspot Ecosystem Research and Man's Impact on European Seas – Coordinator NERC_NOCS.
- FP7 JAKFISH (funded 2008-2011): Judgment and knowledge in fisheries involving stakeholders (2008-2011) – Coordinator CEFAS.
- FP7 Joint call Ocean of tomorrow (ENV.2010.2.2.2-01): Quantification of climate change impacts on economic sectors in the Arctic.
- FP7 Joint call Ocean of tomorrow (ENV.2010.2.2.2-02): Quantification Vectors of changes in ocean and seas marine life, impact on economic sectors.
- FP7 Coordination actions (ENV.2010.2.2.1.3) to support FP6 NoEs durable integration.
- FP7 SEAS-ERA (funded 2010-2012): Towards integrated European marine research strategy and programmes.
- FP7 MARCOM+ (funded 2010-2014) 6.2. 'Sustainable management of resources', Coordinator ICES
- FP7 Joint call Ocean of tomorrow: Quantification of climate change impacts on economic sectors in the Arctic (2010-2014).
- FP7 EUROSITES (funded 2008-2011): Integrated European network deep-ocean observatories. Coordinated by NERC_NOCS (Co-leader of WP2 in this proposal).
- FP7 MyOCEAN (funded 2009-2012): Operational Oceanography and Data dissemination, www.myocean.eu.org/
- FP7 OPENAIRE (funded 2009-2012): Open Access Infrastructure for Research in Europe, www.openaire.eu

B3.2 Dissemination and Management of Intellectual Property

There are no problematic issues anticipated in dealing with intellectual property rights. All knowledge and tools generated by the EURO-BASIN Consortium will become publicly available at the end of the project. Partners will retain intellectual property rights to any foreground knowledge that they have mobilised for the use of the project, with the exception of the subcontractors.

B3.2.1 Management of Knowledge and Intellectual Property

The EURO-BASIN consortium agreement will spell out and identify foreground and the provisions for intellectual property safeguards to the foreground generated by the project. The project will invoke article 29 of the grant agreement Access rights to foreground for policy purposes and transfer of ownership of foreground for policy purposes and transfer of ownership of foreground. (Specific to environment research) which states:

1. The project will ensure that protocols and plans for data collection and storage are in line with Community Data Policy (Inspire Directive).

2. The community Institutions and Bodies have access rights to programme foreground for the purpose of developing, implementing and monitoring environmental policies. Such access rights shall be granted by the beneficiary concerned on a royalty-free basis.

3. Where programme developed foreground will no longer be used by the beneficiary nor transferred, the beneficiary concerned will inform the commission. In such case, the commission may request the transfer of ownership of such foreground to the community. Such transfer shall be made free of charge and without restrictions on use and dissemination.

B3.2.2 Ownership and protection of foreground

Foreground shall be the property of the beneficiary generating it. In case of a joint invention, design or work made by two or more beneficiaries, each of the beneficiaries concerned shall be entitled to use the joint foreground as they see fit, providing 45 days prior notice is given to the joint owners and fair and reasonable compensation is provided.

Publication of Knowledge*:* A beneficiary shall provide the other beneficiaries and the Commission with 30-days prior notice of any planned publication on its foreground and, if requested, with copy of relevant publication data. This shall be done through the Coordinator who is responsible for obtaining the approval. Any contractor may publish Knowledge generated by another beneficiary or any background of such other beneficiary, only with the other beneficiary's prior written approval. Any beneficiary may object to the publication within fifteen calendar days from receipt of the request, if it considers and can reasonably show that the protection of its own legitimate interests could be adversely affected.

Dissemination of Knowledge after the end of the Project*:* Each beneficiary has a duty to disseminate the project knowledge in accordance with the contract.

Data policy: Through WP 1, the EURO-BASIN Consortium will where possible follow the spirit of the Community data policy, as described in the INSPIRE directive The data policy of the project will be based on the recognition that "The timely, free and unrestricted international exchange of oceanographic data is essential for the efficient acquisition, integration and use of the ocean observations gathered by the countries of the world for a wide variety of purposes including the prediction of weather and climate, the operational forecasting of the marine environment, the preservation of life, the mitigation of human-induced changes on the marine and coastal environment, as well as for the advancement of scientific understanding that makes this possible."

The EURO-BASIN Consortium will apply rigorous metadata quality control (see WP 1 'Data Management and Integration', Table 1.3d) and will provide all rescued historic data either via the public-access data portal PANGAEA (www.pagaea.de) and/or open access publications in the Earth System Science Data Journal (www.earth-system-science-data.net). With EURO-BASIN-generated data the widest dissemination policy will be adopted by the project (subject to a two year embargo), aiming to provide free access to the project results e.g. through the User Advisory Group, programme webpage and EU-funded projects on data dissemination (EC FP7 MyOCEAN) and research open access archiving (EU FP7 OPENAIRE). However, that aim will be weighed against the pre-existing policies of beneficiaries.

In terms of commercial exploitation the consortium contains a number of the beneficiaries (e.g. PML, NERC-POL, CEFAS, Tecnalia-AZTI-Tecnalia) have internal commercial departments. These groups will be encouraged to exploit the knowledge base and tools developed by EURO-BASIN, within the constraints of the foreground and access rights protection defined by the consortium agreement.

B3.2.3 Dissemination

Spreading scientific excellence in research

EURO-BASIN will spread scientific excellence through publication of results in high ranking scientific journals, meetings and conferences. It will spread scientific excellence by employing and training the best available young researchers, following the best practices of the partner institutes. Finally, to positively influence the education of the next generation of scientists, EURO-BASIN will co-fund and actively provide input to two summer schools in Month 24 and Month 44, i.e. a one- to two-week event where young researchers (Ph.D. students and early postdoctoral researchers) gather for theoretical lectures, practical exercises and/or computational case studies relating to key topics connected to the EURO-BASIN research programme. The products of the summer school will be the training of young scientists and a web-based collection of course presentations and other materials (hand-outs, reprints, video recordings where possible).

Spreading scientific excellence to stakeholders, policy makers and society

The EURO-BASIN Consortium aims to adopt Special Clause 39 (EC, Aug 2008) which states that:
'*In addition to Article II.30.4, beneficiaries shall deposit an electronic copy of the published version or the final manuscript accepted for publication of a scientific publication relating to foreground published before or after the final report in an institutional or subject-based repository at the moment of publication.*
Beneficiaries are required to make their best efforts to ensure that this electronic copy becomes freely and electronically available to anyone through this repository:

- immediately if the scientific publication is published "open access", i.e. if an electronic version is also available free of charge via the publisher, or

- within 6 months of publication (in full agreement with publishers' embargoes).'

As a result the EURO-BASIN Consortium proposes to publish two open access Special Issues on data, and be one of the first to actively invest in archiving all of its research publication in the Archimer (IFREMER) open access repository, so that all scientific output of the programme is freely available and accessible by stakeholders, policy makers and society at large only 6 months (publishers' embargo) after publication. This will include all synthesis and recommendations output by WP 8 Advancing Ocean Management, that directly concern socio-economics and policy formulation for ocean management under climate and anthropogenic pressure. The User ABdvisory Group will guide targeted dissemination of key recommendations and synthesis.

Engaging with the Public

Outreach is a generic effort to connect to outside organizations, groups, specific audiences or to the general public and media. Outreach within the context of EURO-BASIN will be achieved using the Press Office and the website as a means to contact experts on issues of direct socio-economic interest.

B4. Ethical Issues

Informed consent: All participants, including principle researchers, stakeholders and end users, will engage in the project on a voluntary basis. Participants will be informed of the procedures applied in the project and the necessary conditions on publishing results. Where necessary, authors will be provided the opportunity to check any reports containing produced by them data.

Data protection issues: The collection and use of personal data will be avoided in the EURO-BASIN Consortium. In the case of using interactive websites for the purpose of supporting necessary consortium activities, the participants/visitors/users will be informed of the procedure for protecting personal data and no permanent record of webusers' IP addresses will be kept by the consortium.

Appropriate procedures will be applied to securing confidentiality of information that is not meant to be disclosed. These will be set out in the consortium agreement among partners, which will also specify a procedure for the resolution of potential conflicts.

Use of animals and embryonic stem cells: The EURO-BASIN programme does not involve use of animals or human embryonic stem cells.

ETHICAL ISSUES TABLE 8

	Research on Human Embryo/ Foetus	YES	Page
*	Does the proposed research involve human Embryos?		
*	Does the proposed research involve human Foetal Tissues/ Cells?		
*	Does the proposed research involve human Embryonic Stem Cells (hESCs)?		
*	Does the proposed research on human Embryonic Stem Cells involve cells in culture?		
*	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	

	Research on Humans	YES	Page
*	Does the proposed research involve children?		
*	Does the proposed research involve patients?		
*	Does the proposed research involve persons not able to give consent?		
*	Does the proposed research involve adult healthy volunteers?		
	Does the proposed research involve Human genetic material?		
	Does the proposed research involve Human biological samples?		
	Does the proposed research involve Human data collection?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	

	Privacy	YES	Page
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?		
	Does the proposed research involve tracking the location or observation of people?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	

	Research on Animals	YES	Page
	Does the proposed research involve research on animals?		
	Are those animals transgenic small laboratory animals?		
	Are those animals transgenic farm animals?		
*	Are those animals non-human primates?		
	Are those animals cloned farm animals?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	

	Research Involving Developing Countries	YES	Page
	Does the proposed research involve the use of local resources (genetic, animal, plant, etc)?		
	Is the proposed research of benefit to local communities (e.g. capacity building, access to healthcare, education, etc)?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	

	Dual Use	YES	Page
	Research having direct military use		

	Research having the potential for terrorist abuse		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	

B5. Consideration of gender aspects

The EURO-BASIN Consortium is aware that the European policy of equal opportunities between women and men is central to the Treaty of the European Union, and will seek to eliminate gender inequality.

The EURO-BASIN consortium includes approximately 70 European researchers, of which 25% are women at senior scientist and PI level, and will provide an equal opportunity for women in the recruitment of a female Project Manager for the Consortium.

While recognising that EURO-BASIN has no control over the employment policy of the beneficiaries, the coordination team commits to monitoring and promoting equal female participation by keeping statistics about, employment, participation in conferences and other training activities, and ensuring that this information is disseminated to the consortium, and is available to all relevant bodies including the EC.