ANR	Programme STRA	Réservé à l'organisme gestionnaire du programme N° de dossier : ANR-08-STRA-03 Date de révision : décembre 08
	Document de soumission **B**	**Edition 2008**

Acronyme	**AMPED (Aires Marines Protégées pour Espèces qui se Déplacent beaucoup)**
Titre du projet *(en français)*	Évaluation d'aires marines protégées comme outil de gestion pour espèces marines migratoires à haute valeur économique
Titre du projet *(en anglais)*	Evaluation of Marine Protected Areas as a management strategy for valuable migratory marine resources

Les pages seront numérotées et l'acronyme du projet devra figurer sur toutes les pages du document en pied de page. Un sommaire du document est bienvenu

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1. Programme scientifique et technique/Description du projet

1.1 Problème posé *(1/2 page maximum)*

Marine Protected Areas (MPA) are rapidly developing into an important part of the management of fish stocks and the protection of marine biodiversity because of their potential to protect entire functioning ecosystems and improve fishery harvests. Historically, MPA have been directed towards the protection of coastal marine species with a sedentary adult phase because individuals remain inside reserves and are protected from anthropogenic disturbances. Nevertheless, the politics and science of MPA are moving beyond these limits, and there is increasing interest in and pressure for the use of marine reserves as part of the management and conservation strategy for mobile demersal and pelagic species. These species and their ecosystems present special biological, economic and governance challenges for the use of MPA. Because mobile species are likely to move out of reserves, it is widely expected that MPA will offer less protection and benefits to these species. However, the life histories of mobile marine species are often complex, involving a variety of migratory behavior patterns. This spatio-temporal complexity offers the hope that reserves that protect particular life-history phases or critical habitats along migratory routes will offer benefits to these species. Nevertheless, the negative consequences of fishing effort displacement may outweigh protection benefits if fishing mortality increases outside of reserves.

In the absence of scientific study of how the complex spatial dynamics of mobile marine species affects MPA functioning, there is a great risk that ineffective management decisions will be taken based on existing knowledge relating to sedentary species and/or terrestrial management. This project addresses this urgent need through a comprehensive examination of the problem from a variety of complimentary angles, including (i) the collection of basic empirical data needed to understand the movement and interactions of fish species, (ii) the development and use of several spatially-explicit MPA models, including individually-based, single-species, ecosystem and bio-economic approaches, to test competing strategies (MPA and other forms of management) against a variety of fish life-history types, and (iii) the examination of the governance implications of large scale marine reserves in national and international waters. We apply these methods in three different systems, the Gulf of Lions, South Africa and the Indian Ocean, that contain high-value and/or important by-catch species with different movement behavior. All three areas have expressed a strong interest in pursuing a science-based examination of the potential effects of MPA. Through this comprehensive study, we aim to provide the information that management authorities need now while the topic of MPA for demersal and pelagic species is relatively young and critical decisions have yet to be made.

1.2 Contexte et enjeux du projet *(1 à 5 pages maximum)*

1.2.1 Economic, social and governance contexts

The three systems we propose to study, the Gulf of Lions in France, the Agulhas Bank and Benguela Upwelling System of South Africa, and the Indian Ocean (see Fig. 1), have been chosen because they all possess important industrial fisheries of mobile pelagic and demersal species that have strong social and economic connections in their respective regions. For example, bluefin tuna, anchovy and hake fisheries are the most value landings in the Gulf of Lions, with hake and anchovy representing a total direct input to the region of 100 million €, as well as innumerable indirect inputs. This activity makes up an important part of the economy of local port communities (e.g., Sète and Port-Vendre). Similarly, the shelf along the coast of South Africa hosts some of the world's most productive fisheries, with an annual net fisheries revenue of approximately 280 million €. Hake, anchovy, sardine and lobster fisheries represent an important source of local economic activity that many coastal communities depend upon, as well as of export revenues. Finally, the tuna fisheries of the Indian Ocean are major, high-value international efforts with a yearly catch of over 1 million tons. They include a significant EU and French component (40% of the purse seine fleet; yearly catches in the Indian Ocean over 100.000 tons, at a landing value of over 100 million €), with a large industrial fishing fleet and its associated economic environment based in Concarneau. Furthermore, the spillover effects for local Indian Ocean economies are very important. Fishing licenses account for a large share of coastal state incomes (e.g., around 1% of the Seychelles GDP), and fishing activity is a major part of the economy. In the Seychelles Is., the whole tuna industry represents some 14 to 17% of the employment, one third of the GDP and nearly all export revenues (Seychelles Central Bank).

Despite this economic activity, all three areas are threatened in one way or another. Globally, tuna fisheries have experienced long term increases in their total catches, but these are mainly due to major improvements in technology that have masked significant declines in the biomass of tuna stocks. The Indian Ocean is no exception to this pattern (e.g., Polacheck 2006). The rapid industrialization of both the European (French and Spanish) purse-seine fishery and the Asian and European (Japanese, Taiwanese, Indonesian, Spanish, Portuguese) longline fishery, as well as the development of many artisanal regional fishing fleets, threatens the longterm productivity of these ecosystems. Most tuna stocks in the Indian Ocean are now estimated by the Indian Ocean Tuna Commission (IOTC) to be either fully exploited or close to being overfished. However, this fishery is still highly profitable and the size of the fishing fleet continues to grow, worsening problems with significant overcapacity of the fleet. This overcapacity of tuna fleets threatens the conservation of tuna stocks, as well as the structure and functioning of the pelagic ecosystem through removal of top predators and significant losses due to by-catch.

Similarly, the trawling fishery for hake on the continental shelf in the Gulf of Lions, which has been relatively stable over long time periods, is now potentially threatened due to increased capture by deeper-water gillnet and longline fisheries of larger, highly-fecund individuals. These larger individuals along the shelf edge have long been thought to be the source of the stability of these fisheries due to their high fecundity and inaccessibility to trawl fishing, thereby providing a natural refuge for the population. However, increased take of large individuals could remove this natural refuge, thereby threatening all three fisheries. Very similar patterns of increased diversification of fishing techniques may be the source of recent declines in the hake fisheries of South Africa. Therefore, in both regions there is concern about the sustainability of current fishing activity and managers are looking for ways to avoid potential fishery collapses.

MPA have been suggested by managers, scientists and politicians as potential solutions to some or all of the threats these systems face. For example, there is an ongoing effort in South Africa led by the South African National Biodiversity Institute (SANBI) to extend an existing coastal MPA network to include deeper water reserves for demersal and pelagic species, as well as for the protection of essential habitat areas and non-target, by-catch species. This effort is based primarily on the spatial description of marine habitats, which complements the population and ecosystem perspectives to be developed in this study (see Section 1.4 and Appendix D for more details). Similarly, at a recent symposium on high-seas governance of marine biodiversity (Monaco, March 20-21, 2008), MPA were repeatedly mentioned by presenters as a major component of future management activities. Nevertheless, the motivation for these reserves was largely based on very limited scientific knowledge derived from experience with coastal MPA and terrestrial reserves. In the absence of scientific study, we run the real risk of doing what has been creatively called “faith-based fisheries” management (Hilborn 2006), i.e., management based on beliefs instead of concrete scientific results. In this study, we hope to fill this knowledge gap.

1.2.2 Scientific context

The management of marine resources is currently going though a period of rapid evolution. Only a couple of decades ago, the vast majority of fisheries management decisions consisted solely of effort-based controls and were based exclusively on single-species approaches to understanding the dynamics of marine populations. Today, however, increasing anthropogenic pressures from fishing, pollution, climate change and other human activities demand an ever widening set of tools for maintaining the productivity and the economic and social values of these systems. Management approaches now include a wide variety of techniques, such as conventional fishing effort controls, ecosystem approaches, spatial management, and the use of economic forces and stakeholder participation programs (e.g., see review in Clark 2006). While these techniques offer the hope of successfully managing marine ecosystems so that they can continue to play their vital economic, social and cultural roles, they also present a significant challenge to the scientific and management communities. In the rush to fix existing problems and confront future demand for marine resources, there is the real risk that poor management decisions will be made based on incomplete or non-existent scientific data regarding the effects of these new techniques (e.g., Hilborn 2006).

Marine protected areas (MPA), zones where all or some human activities are forbidden for a (generally) indefinite period of time, have played an important part in this revolution in marine management (see reviews in Sale et al. 2005, Field et al. 2006, Sumaila et al. 2007). While less than a few percent of the world's coastal oceans and far less of the total ocean surface were protected as little as a decade ago, there are currently many national and international efforts to build significant MPA networks around the world (e.g., the Port-Cros declaration in 2007 to build an extensive network of MPA in the Mediterranean; and IUCN 2003). By reducing anthropogenic pressures in an area through the prohibition of human activity, it is hoped that entire marine ecosystems can return to a more "natural" state (e.g., higher abundances, bigger sizes and increased diversity of species) and that marine biodiversity can be protected from the negative evolutionary and ecosystemic effects of fishing and other human influences. Furthermore, export of juvenile and/or adult individuals from reserve areas to surrounding fished areas has the potential to provide economic benefits to fisheries (Gell & Roberts 2003, Hastings & Botsford 2003).

This explosion in interest in MPA has been accompanied by an equally rapid increase in scientific research on the biological, economic and social consequences of implementing MPA. There is currently substantial scientific evidence that most existing MPA have a higher density of fished species in terms of biomass and number of individuals (Halpern & Warner 2002, Halpern et al. 2003). There is also more limited experimental evidence that MPA benefit nearby fisheries (Roberts et al. 2001, Gell & Roberts 2003, Russ et al. 2004). The theoretical literature in general indicates that MPA can benefit severely overfished species (e.g., Quinn et al. 1993, Kaplan & Botsford 2003, White & Kendall 2007), though the extent of those benefits will depend on a number of factors, such as connectivity between reserve and non-reserve areas through movement of individuals (e.g., Kaplan 2006), changes in the amount and spatial distribution of fishing effort after reserve implementation (e.g., Smith & Wilen 2003, Sanchirico et al. 2006) and the life history and movement patterns of the fished species (e.g., Gaylord et al. 2005, Walters et al. 2007, White & Kendall 2007).

Though there has been ample recent scientific research on the effects of MPA, this research has overwhelmingly concentrated on coastal species that are relatively sedentary as adults. The vast majority of existing MPA are coastal, due in part to the logical analogy between coastal marine ecosystems, such as estuaries, kelp forests and coral reefs, and nearby terrestrial ecosystems and the terrestrial reserves that protect them. Furthermore, residency among fish species is generally associated with reef structures and other features common to coastal waters (e.g. mangroves, sea grass beds). Sedentary species are most likely to benefit from reserves because individuals spend their entire lifetime inside MPA, thereby being protected from anthropogenic pressures throughout their adult lives. In contrast, continental shelves and slopes are often characterized by sediments forming vast relatively featureless plains. In these deep habitats, where most of the valuable commercial stocks are found, fish are generally more mobile, often displaying ontogenic movements from shallow to deep water. As a result, reserve implementation and associated scientific research have naturally concentrated on those species and habitats that are most likely to receive benefits from MPA, namely coastal zones.

While there is a solid body of theoretical and experimental literature supporting the use of MPA for a variety of coastal sedentary species, few studies to date have examined the effects of MPA on mobile and pelagic species that are expected to move in and out of reserves one or more times during their lifetimes. This is an obvious gap in the study of MPA effects, as the vast majority of valuable demersal and pelagic species that are exploited on an industrial scale are neither sedentary nor coastal. Mobile species that cross reserve borders may be subject to fishing pressure while outside the reserve. Empirical evidence indicates that fishers may respond to MPA implementation by "fishing the line" (i.e., fishing on or near the border of the reserve; see, e.g., Gell & Roberts 2003) and/or intensifying fishing pressure outside of reserves, thereby potentially capturing most individuals outside reserves and reducing the effectiveness of the MPA. Furthermore, recent modeling work integrating adult dispersion into MPA models has found that even relatively minor movement of adults (compared to the size of a reserve) can substantially reduce the protection an MPA offers to a population (Walters et al. 2007).

Despite these caveats regarding the use of MPA for mobile species, there have recently been a number of calls to use large marine reserves as part of the management strategy for commercially important and by-catch species that move considerably over their lifetime (e.g., IUCN 2003, Greenpeace 2006, Sumaila et al. 2007). These species typically, though not exclusively, inhabit demersal ecosystems along the outside of the continental shelf or pelagic ecosystems in open waters. The large size of the proposed reserves is in part a response to the movement capabilities of these species. However, the reserve size and location necessary to obtain a certain biological or economic benefit from a mobile fish species has not been examined even in well-studied fish populations.

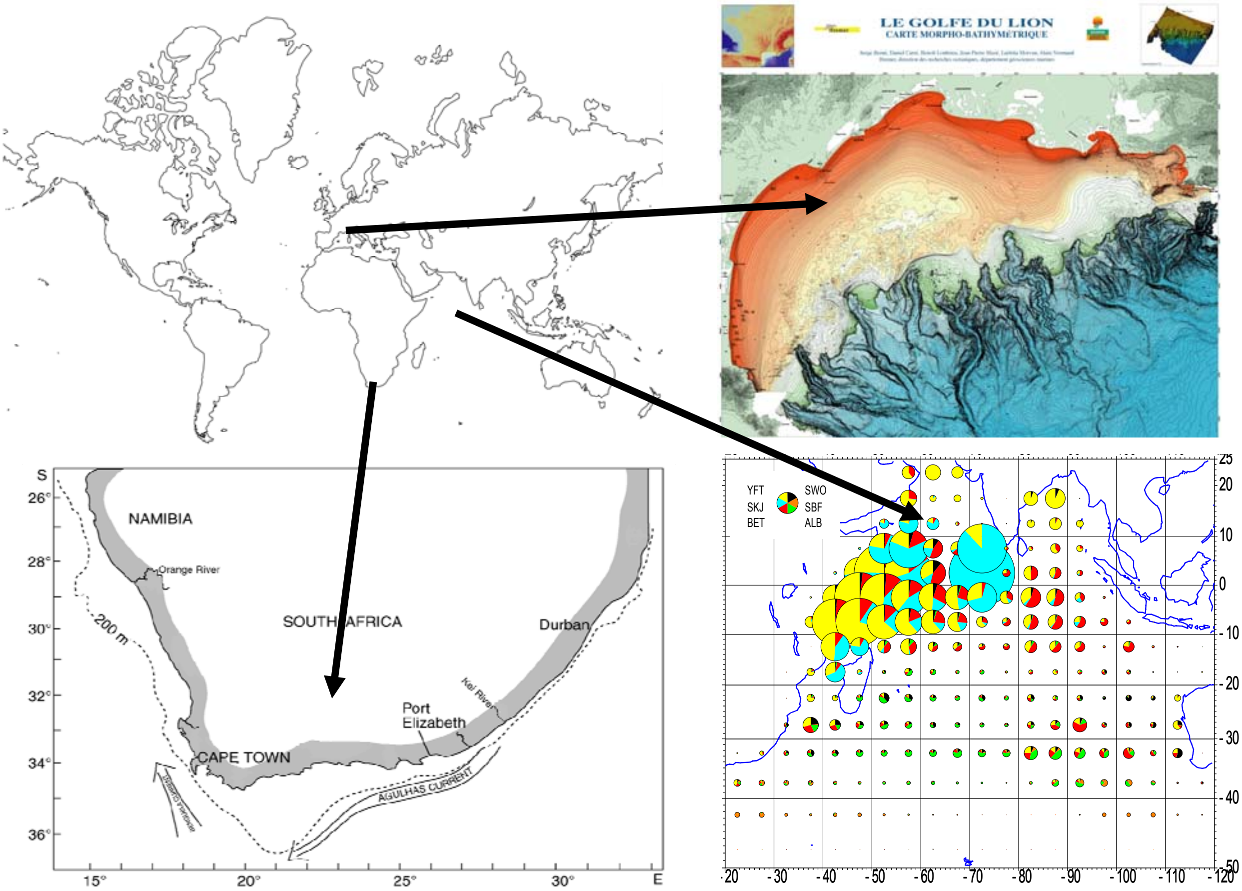
Furthermore, the movement of pelagic and demersal fish species is generally complex, often involving specific ontogenic or migratory behavior for juvenile development, to take advantage of prey resources or for reproduction. For example, hake are widely believed to move into deeper waters as they grow older (Ferraton 2007, Methratta & Link 2007) and the largest, most reproductively active individuals are generally found along the shelf edge. Tuna species are known to make long distance foraging migrations, as well as to congregate at specific locations for mating, where they are often the target of intense fishing pressure (Hassani & Stequert 1991, Block et al. 2005). These movement patterns change the accessibility of the species to anthropogenic pressures in space and time, suggesting that MPA might be designed to protect particular phases of the life cycle (e.g., juveniles) and, therefore, provide benefits even to mobile species. However, in the absence of careful study regarding the nature of the movements themselves and modeling work examining how protection affects the dynamics of these species, it is difficult, if not impossible, to predict the consequences of MPA, large or small, for these species.

Large MPA for mobile species also pose additional implementation and governance issues. The habitats of mobile species often cross multiple jurisdictional boundaries, thereby necessitating coordination among a number of different governments and fishing industry partners for a MPA plan to be effective. Furthermore, many pelagic fisheries operate partially or entirely in international waters outside of all economic exclusion zones (EEZ). In international waters, management requires multi-lateral agreement among nations and enforcement of fishing restrictions is particularly challenging. Though existing Regional Fisheries Organizations (RFO) may be capable of mandating high-seas MPA, careful reflection is needed to determine if high-seas MPA are feasible given the difficulties of enforcement and current levels of illegal, unregulated and unreported (IUU) fishing activity. Furthermore, there may be significant economic consequences to closing areas to fishing when many fishing fleets are already at overcapacity. In this context, a number of conferences and workshops have been held recently on high-seas governance and management (e.g., Monaco 2008, Nice 2008), but international agreements or standards for implementing open-ocean MPA are still lacking.

Despite insufficient information regarding the effects of MPA on pelagic and demersal species and the challenges involved in their implementation, the existing political climate suggests that the use of MPA for these species may advance rapidly (e.g., IUCN 2003). Managers are striving to find new ways to respond to the management challenges that marine resources face. Based on existing successes with MPA in coastal ecosystems, there is pressure to extend their use to other areas. Therefore, there is an urgent need to fill the information gap and provide a concrete scientific understanding of the consequences of MPA implementation for these species. This study addresses this need by examining the problem using a number of different biological, economic and legal approaches. We aim to provide information that can directly contribute to marine management in our three areas of work, the Gulf of Lions, South Africa and the Indian Ocean, as well as build a general and widely applicable framework for understanding and predicting the effects of MPA on mobile species.

Figure 1

Maps of study areas included in this project. Clockwise from upper left corner, the panels show: (1) a world map with three study areas indicated by arrows, (2) a map of Gulf of Lions with depth contours indicating shelf edge and deep-water canyons that are habitat for large mature hake, (3) map of Indian Ocean with total tuna catches indicated by size of circles and color indicating species, and (4) a map of South African coastline with shelf edge indicated by dashed line and dominant flow features indicated with arrows.



1.3 Objectifs et caractère ambitieux/novateur du projet *(1 à 2 pages maximum)*

The overall objectives of this project are to describe how different types of fish movement behavior will affect the functioning and effectiveness of a network of MPA, and to apply this knowledge to the analysis of the potential effects of MPA in three specific regions (see Fig. 1): (1) the Gulf of Lions, France, (2) the Agulhas Bank and Benguela Upwelling System, South Africa, and (3) the Indian Ocean. The proposed research uses a mixture of empirical and modeling approaches to enhance our fundamental understanding of how movement behavior interacts with spatial management efforts, and to provide specific recommendations vis-à-vis the MPA processes in each of the three regions regarding the consequences for fishery harvests, by-catch species and the maintenance of marine biodiversity of implementing a MPA network (e.g., the optimal size and location of MPA, comparison with other management approaches, etc.). This information is essential to providing timely advice regarding how MPA networks will perform, and to determining whether or not other methods of limiting or modifying human impacts on marine ecosystems, such as temporal fisheries closures and fisher by-in programs, are more effective.

This project can roughly be divided into four main conceptual sections that together contribute to the overall objectives described above:

(1) Targeted empirical studies of the spatial and ecosystem dynamics of marine populations
(2) Compilation and synthesis of existing data on the spatial distribution of fish habitats, movement behavior, trophic interactions, and the impacts of fishing
(3) Development and application of a variety of MPA modeling approaches to the dynamics of mobile species and the fisheries that depend on them
(4) Examination of the implications for governance of implementing larger MPA for mobile species in national and international waters.

The targeted empirical studies will focus on enhancing our understanding of the spatial distribution of marine habitats, the movement patterns of target species, and the trophic dynamics of pelagic and demersal species in South Africa and the Gulf of Lions. We have chosen a specific set of experimental studies that are designed to complement existing knowledge of these systems. This additional information will provide key data to making accurate and believable predictions about the effects of spatial management measures on these systems.

Data compilation and synthesis efforts will provide modeling efforts with the essential information necessary for accurate parameterization, as well as identify initial priority areas for conservation. Though much data organization has already taken place in the study areas, additional analysis and meta-analysis will be necessary to combine disparate datasets into accurate, spatially-explicit databases needed to assess the effects of fish movement. As this data compilation will undoubtedly be useful to a variety of studies outside the context of this project, we expect that this effort will provide an invaluable resource to managers and scientists and will significantly enhance the overall value of the project.

Our approach to understanding the effects of adult fish mobility on the dynamics of marine populations with MPA consists of using a wide variety of complimentary modeling frameworks to look at the problem from different perspectives. The goals of this effort are to understand the consequences of movement for MPA effectiveness, and to place this knowledge in the wider contexts of marine life histories, larval dispersal, trophic dynamics, fisheries economics and alternative fisheries management approaches. We plan on comparing results from individually-based models (IBM), classical single-species models, ecosystem models and bio-economic models of MPA. These different approaches provide different levels of accuracy in the description movement behavior, as well as in other aspects of the dynamics of marine populations and fisheries. This variety will be invaluable to understand in detail how movement interacts with spatial management efforts, as well as overall ecosystem functioning. Furthermore, this modeling effort will provide a concrete analysis for each of the three study areas of the efficacy, size and spacing, and optimal siting of MPA. Results will include analyses for population persistence, fisheries yield and ecosystem functioning of several MPA plans, as well as comparisons with management alternatives.

MPA implementation is a contentious issue that generally involves difficult compromises between governing bodies, fishers, environmental groups and scientists. As described above, the probable sizes and locations of MPA for mobile pelagic and demersal species are likely to make implementation in this context especially difficult. The goals of looking at MPA for mobile species from juridical and governance points of view are to compare governance issues with those of better-studied coastal MPA, to recommend solutions to any barriers to MPA implementation, and to see how remaining barriers are likely to affect the potential extent, functioning and governance of MPA for mobile species. It is important to point out that this effort is not separate from the scientific examination of MPA effects described above. Understanding governance issues is essential to identifying the biological, economic and political trade-offs that will determine the final extent and goals of any MPA network.

1.3.1 Innovative character of project

The innovative nature of this project derives from both the topic studied and the extent and variety of approaches used. Despite the fact that a number of proposals for large MPA for demersal and pelagic species exist or are in progress, little is known about how adult mobility in marine species will affect the functioning of MPA networks or how to incorporate mobility into the design of MPA networks. Existing predictions of the benefits of MPA for mobile species are almost exclusively based on simple analyses that do not incorporate the full complexity of the spatial dynamics of mobile species and cannot be supported from biological and economic points of views. This study will significantly enhance our understanding of the consequences of MPA for these species, and provide urgently needed recommendations to managers and politicians so that effective decisions can be made.

Furthermore, the diverse group of approaches, points of view and geographical contexts that will be used in this study has rarely been brought together to address the effects of MPA in a comparative framework. The three areas of study provide a variety of different movement patterns and levels of spatial population connectivity, as well as major differences in the trophic structure, fisheries economics and governance issues. The modeling approaches to be used each focus on different aspects of the overall system, and include species, ecosystem and economic points of view. This diversity enhances our ability to see the global consequences of adult mobility on MPA functioning, but also represents a challenge to project participants to work in a collaborative and inter-disciplinary fashion. Beyond the context of mobile species, the comparisons generated in this study between the different modeling approaches will be extremely useful for determining if and in what form models will enter into future spatial marine management and assessment efforts.

1.4 Positionnement du projet *(1 page maximum)*

1.4.1 Position of Project Relative to Context

While this study diverges from most previous MPA studies that have focused on coastal species, there are a number of previous and ongoing research and management efforts that are complimentary to this project. In general, our approach to these efforts has been to build links with them through shared collaborators or participation of project leaders on the steering committee of this project. Below is a list of relevant projects:

Name	Relevance	Shared collaborators
MADE (EU, '08-'10)	By-catch mitigation in Indian Ocean. MPA one of methods considered.	Francis Marsac, Patrice Guillotreau, Laurent Dagorn (steering committee)
AMPHORE (ANR, '08-'10)	Coastal / estuarine MPA indicators. Nursery habitats for mobile species examined, modeled.	Raymond Lae (steering committee)
PAMPA (Ag. AMP, '08-'10)	Workshops to develop indicators / standards for MPA implementation and management.	Dominique Pelletier (steering committee)
GAUIS (ANR, '08-'10)	Linking governance strategies of coastal MPA with ecosystem indicators.	Christian Chaboud
IOC MPA Proj. (FFEM, '06-'09)	Develop integrated MPA plan for Indian Ocean countries in IOC. Habitat mapping and description.	Dennis Etienne (steering committee)
OMPA (SANBI, '07-'09)	Offshore MPA plan for South Africa. Habitat mapping and description.	Colin Atwood
CODYSSEY (EU, '02-'07)	NE Atlantic cod stocks, including potential of MPA for management of these mobile stocks.	
Greenpeace MPA map ('06)	Map of proposed world MPA network based on MARXAN habitat analysis. 40% in MPA.	
Port-Cros Declaration ('07)	Establishes goal of representative MPA network in Mediterranean	
Agence des AMP ('07-)	French agency charged with implementation and management of MPA	

Additional information on these projects and their relevance is provided in Appendix D.

1.4.2 Position relative to the Systerra call for proposals

This project is directly relevant to all of the major themes and characteristics described in Sections 2.1 and 2.2 of the call for proposals. Sub-Themes 1.5, 2.2, 3.2, 3.3 and 4.2 are especially pertinent to this project. Fisheries are an essential part of the human food chain. Like other parts of that food chain, current rates of human resource exploitation have placed significant pressures on fish populations and the ecosystems they inhabit (see Section 1.2.1). Consequently, finding innovative ways to maintain or increase fisheries yields while at the same time assuring ecosystem functioning is an essential part of sustainable development and human food security (Theme 1). MPA have the potential to be a valuable tool for achieving these goals, but only if the consequences can be accurately assessed and incorporated into MPA designs. Contributing to this effort is one of the central goals of this project. Furthermore, the scientific study of the complex interactions between animal movement, human behavior and MPA is fundamental to elaborating conservation policies, as well as to creating exploitation strategies that make human needs compatible with sustainability of natural ecosystems. Our project incorporates a variety of different approaches and perspectives to effectively tackle this complexity (Theme 2). Finally, MPA is central to the new forms of marine management (Theme 3). Our study incorporates economists and legal experts to understand the role human response plays in shaping the impacts of this new management approach.

1.5 Description des travaux : programme scientifique et technique *(10 pages maximum)*

In addition to organizational and synthesis Work Packages (WP0 & WP5, respectively), this project consists of four central Work Packages (WP) associated with the four conceptual sections described in Section 1.4: (1) targeted empirical studies to enhance our understanding of the spatial and ecosystem dynamics of marine populations, (2) compilation, integration and synthesis of existing data on the spatial distribution of fish habitats, trophic interactions, movement behavior and life histories, (3) development and application of a variety of modeling approaches to the dynamics of mobile species and the fisheries that depend on them in the presence of an MPA network, and (4) examination of the implications for governance of implementing larger MPA for mobile species in national and international waters. These WP are further divided into individual "tasks" corresponding to specific goals or milestones towards completion of that WP.

Detailed descriptions of WP follow. The following abbreviations are used throughout the text (in addition to partner acronyms): Gulf of Lions (GL), South Africa (SA), and Indian Ocean (IO).

WP0. Organization of the Project

The wide range of topics and study areas included in this proposal necessitate strong and active organization. In addition to an overall project organizer, one senior project participant has been identified for each of the three study regions for additional organizational responsibilities (Mellon – GL; Attwood – SA; Marsac – IO). Together, these four individuals will ensure the timely completion of the WP. Furthermore, a steering committee, including fishery industry representatives and members of other MPA projects, is included in the project to bring in outside advice and concerns regarding the project direction, and to maintain strong links with interested parties (see Section 1.8).

Methodology and Work Program

The principal organizational elements of the project will be 3-4 day annual project workshops, beginning with a kickoff meeting shortly after project initiation. All major project participants, including members of the steering committee, will be expected to participate at these meetings. In addition to basic project organization, meetings will be essential to organization of major project milestones, such as the symposium discussed in Task 5.2 and the special volume of publications in Task 5.3. Three of the meetings will be held in Sète, while the fourth will be in SA to enhance the connection with that part of the project.

In addition to annual meetings, we expect to maintain a project web page that includes a number of web-based resources to facilitate exchange of ideas (e.g., a wiki, web forums, data exchange facilities). This web page will be supported by the EcoScope, an IRD effort to build a platform for data distribution and presentation. Furthermore, regular web-based conference calls among major project participants will be used between annual project meetings to maintain the project focus and ensure continuous advancement.

WP1. Targeted Empirical Studies on the Spatial and Ecosystem Dynamics of Marine Populations

Though much is known about the basic dynamics of the species and ecosystems relevant to this study, this project presents a particularly auspicious location to complement existing knowledge with additional, targeted empirical studies. The empirical work in this project has been chosen to provide crucial information that will significantly improve our ability to model the spatial dynamics of target species and ecosystems.

Task 1.1: Tagging of mature hake and juvenile bluefin tuna in the Gulf of Lions

Hake and bluefin tuna are key top predators of the GL, as well as major commercial species for the French Mediterranean fisheries. The movement patterns of large hake are largely unknown within and around the GL (movement of juveniles was studied by IFREMER during a 2006-2007 tagging program). Knowledge of the movement of these large individuals is essential to accurately describing population connectivity in the modeling efforts in WP3. The GL is also a major feeding area for juvenile bluefin tuna (Royer et al. 2004), which is now an endangered species due to severe overfishing (Fromentin and Powers 2005). Identification and preservation of its key feeding grounds is critical.

We thus aim to study the spatial distribution and movements of mature hake and juvenile bluefin tuna in the GL through tagging experiments. This study gets at the heart of describing the movements of pelagic and demersal fish species and will be quite original because the tagging of these populations has seldom been attempted.

Methodology and Work Program

The conventional tagging (i.e. spaghetti tag) carried out in the GL on juvenile and young adult hake in 2006-2007 led to 6.5% of recovery rate. These young fish were caught on the continental shelf from 30 to 60 m depth. We propose to perform a new tagging experiment using conventional tags on adult hake which inhabit the deeper part of the continental shelf. These fish are known to have a diurnal vertical migration, being close to the surface at night and deeper during the day. Therefore, we will tag fish at night using fishermen boats with a pelagic trawl equipped with a cod-end specially designed to minimize mortality (Pontual et al 2003). We aim to tag about 1000 large hakes to get at least 50 recaptures using conventional Floyd tags. The tagging experiment will be announced in local newspapers and radio stations, and posters will be sent to fishermen organizations and fish markets. A reward of 50€ will be offered for each tagged fish including date and location of catch.

Because juvenile bluefin tuna are rather large fish (up to 30 kg and 1.3 m long), electronic tagging through pop-archival tags should be possible. These tags record external temperature, depth and light (to estimate daily geolocations, see e.g. Royer et al. 2005). They detach automatically from the fish after a pre-set time, reach the surface and transmit data via satellite. This information allows us to reconstruct the fish track and ultimately to understand fish habitat (by combining tagging information with environmental data). Pop-up archival tags have primarily been used with large bluefin tuna in the past. Together with a US team, IFREMER carried out an initial study for tagging juveniles in 2007 with success (recovering 10 of 11 tags with tracks from 13 to 142 days). However, the juveniles were tagged in November, a period when they usually leave the GL. We thus aim at tagging 10 juvenile bluefin tuna in late spring using sport fishers from Marseille (as we did with success in 2007). Our objective is to get the first map of juvenile bluefin tuna behavior and residency in the GL during their summer feeding season.

Task 1.2: Determination of size-specific hake reproductive activity

Knowledge of the timing and relative contribution of the reproductive activity of different size hake is essential to understanding the effects of spatial management efforts because of the different spatial use patterns of younger and older adult hake discussed in Task 1.1. We, therefore, propose in this task to determine (1) the seasonal cycle of reproductive activity as a function of size by measuring gonad maturity in the French trawler and gillnet catch, and (2) the catch and fishing effort of the gillnet fishery.

Methodology and Work Program

We will analyze monthly fish samples taken from the 2 main harbors concerned by the French hake fishery (Sète and Marseille) during the first two years of the project. The data collection will consist of (1) monthly measurements of hake gonad maturity as a function of size and sex from individual fish bought from fishers, and (2) quarterly data surveys carried out directly on board fishing vessels of fishing effort and location. This data will be compiled to produce a yearly size- and location-specific pattern of hake reproductive activity.

Task 1.3: Shelf habitat mapping in South Africa

Determining the spatial distribution of essential fish habitat through an analysis of bottom type and water depth is crucial to accurately modeling and predicting the effects of MPA implementation. Though data exists on SA fish habitats on the continental shelf (see Task 2.2), additional data collection in deeper water and along the shelf edge is needed. The shelf edge is an important habitat for reproductively mature hake. This information will significantly enhance our ability to make accurate spatial predictions, as well as be a valuable addition to ongoing SA efforts to identify priority sights for conservation.

Methodology and Work Program

A 500 KHz side-scan sonar will be used to measure bottom topography along the shelf edge. The boat and side-scan sonar will be rented through the Marine Geosciences Units (a division of the SA Council for Geosciences). We estimate that approximately 10 days of boat time will be needed to provide a useful compliment to existing data in critical habitat areas for SA hake. The spatial resolution of resulting transects will be varied by depth, with resolutions of up to 1 km in (relatively) shallow water and resolutions on the order of 5-10 km in deeper water along the outside edge of the shelf.

Task 1.4: Trophic structure from isotopic signatures in South Africa

Since the major commercial species in SA are top predators, their management is likely to have important ecosystem-wide effects. In order to evaluate the impact of MPA, the spatial pattern of trophic interactions in shelf waters in SA needs to be described in more detail. There are two distinct regions in this ecosystem: the west coast dominated by the seasonal influence of wind-driven upwelling, and the Agulhas Bank, influenced by warmer waters from the IO. The same major fish species occur in both regions, though many perform ontogenetic or seasonal migrations along the coast. Local trophic networks have different structures because not the same stages and abundances of species are present, and the levels of primary and secondary productions differ greatly. Describing these differences will increase the predictive power of ecosystem models used in this project.

Methodology and Work Program

Nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) stable isotopes are powerful tools for understanding marine food webs (e.g. Jennings et al. 2002). $\delta^{15}N$ increases by 2.5 to 4.5 ‰ from predator to prey, and therefore accurately estimates an organism's trophic level, while $\delta^{13}C$ provides clues to the ultimate benthic or pelagic origin of the food (Fry et al. 1999, Post 2002). Therefore, we propose to use these two quantities taken from samples from different components of the marine ecosystem (i.e., species of phytoplankton, zooplankton, fish, etc.) and from different locations in space to understand trophic interactions in this system.

The work program will rely on existing sampling efforts undertaken annually by SA Marine and Coastal Management. Samples include small pelagic (acoustic surveys of recruits on west coast in May, and of spawners on west and south coast in November) and demersal fish species (south coast in January, and west coast in September), and encompass the bulk of the biomass of commercial and non-commercial species. Sampling for this project will occur in two different seasons in three consecutive years (2009 to 2011) in order to understand the effects of inter-annual environmental variations. To obtain the broadest "vision" of the trophic structure, food web isotopic baselines will also be sampled (i.e. phytoplankton and zooplankton, sediment organic matter and benthic invertebrates). In addition, the ten most important fish species in term of biomass will be collected at two different life stages in order to assess ontogenic trophic change.

WP2. Compilation, Integration and Synthesis of Life History, Trophic Interaction and Spatial Distribution Data

While there has already been significant organization of the spatial habitat distribution, life history and trophic interaction data necessary to identify priority areas for conservation and parametrize modeling efforts, some additional analysis will be necessary in all three study areas. The goals of these analyses will be to: (1) develop a consistent and accurate set of GIS layers describing the spatial distributions of relevant habitats, populations, and anthropogenic pressures; (2) estimate necessary life-history and trophic-interaction parameters (e.g., growth, reproduction and predation rates); and (3) use the reserve selection algorithm MARXAN (Possingham et al. 2000) to identify priority areas for protection as an initial parameterization and point of comparison for modeling efforts.

Task 2.1: Gulf of Lions

IFREMER has been studying main commercial fish species in the GL since the late 1950s through fisheries data and scientific surveys. However, this extensive dataset has been used almost exclusively in a single-species management context. The objective of this task is to integrate and synthesize the different sources of information that are available on demersal fish, small and large pelagics to get a ecosystem view of the GL, i.e. to determine the spatial distribution of key fish species, principal feeding and spawning zones, and trophic interactions.

Methodology and Work Program

For demersal species and small pelagics, we will use the data from the bottom trawl surveys MEDITS and the acoustic pelagic survey PELMED carried out since the early 1990s. For bluefin tuna, aerial surveys exist from 2000 to 2003. Extensive fisheries datasets will be used to estimate catch, size composition of the catch and fishing effort. In combination with satellite and oceanographic data, these datasets will be used to estimate principal feeding and spawning habitat areas of hake, anchovy, sardine and bluefin tuna. These spatial distributions will in turn be used to test the significance of coast/open-ocean and East/West gradients in fish density, fishing activity, etc. We will also map fish diversity and provide a first estimate of fishing pressure in the GL over the last decade.

Task 2.2: South Africa

In SA, much data organization has already taken place as part of previous ecosystem and species-specific work (e.g., Yemane et al. 2005, Travers et al. 2006, Fairhurst et al. 2007) or ongoing projects (e.g., OMPA; see Section 1.4.1 and Annexe D). Data organization efforts will concentrate on analysis of existing and newly obtained (e.g., Task 1.3) bottom topography transects to improve quality of maps of essential fish habitat.

Methodology and Work Program

From 1994 to the present, extensive acoustic data from pelagic fish surveys has been collected along the coast of SA. The surveys provide bottom topography over the entire SA shelf between the 30 and 250m isobaths. A data analyst will be employed to extract the habitat-type on each transect and to collate these positions into a GIS database of the shelf indicating rock structure, trawlable and untrawlable ground. This work will be augmented by other data sources (e.g. mining, port and shelf claim surveys) and data collected in Task 1.3 to extend coverage to the shelf edge.

Task 2.3: Indian Ocean

Fisheries data, as well as conventional tagging data, will be used in the IO and to calibrate the APECOSM model (see Task 3.4). A considerable dataset has been developed by project participants from the IRD (SARDARA) that includes all the tuna fishery data available from the tuna commissions over the whole historical fishing period (from ‘50s to present) with an appropriate spatio-temporal resolution (monthly 1-5 degree maps) and fleet stratification (per gear type and fishing country). Data organization for the IO will, therefore, concentrate on analysis of recent tagging data to estimate tuna movement patterns.

Methodology and Work Program

The recent IOTC (http://www.iotc.org) tagging program includes data from the 3 major tuna species (yellowfin, bigeye and skipjack). Almost 200,000 fish have been tagged and up to 20,000 have already been recovered. Our analysis will include estimates of mean spatial displacement, as well as identification of typical movement patterns and migratory routes from this dataset.

Task 2.4: MARXAN analysis to identify initial priority sites for MPA

MARXAN is a reserve design optimization program that uses simulated annealing to determine a set of areas that maximize protection of a group of habitats while minimizing a set of costs, such as total area or impact on human activities (Ball & Possingham 2000, Possingham et al. 2000). It is relatively easy to use and openly available. It has been the starting point for many MPA implementation plans, though it cannot estimate the true benefits of MPA because it does not include population dynamics. We will use it as a starting point and point of reference for our modeling work.

Methodology and Work Program

MARXAN is already in use in two of the study areas (SA and IO). In these areas, our work will simply extend coverage areas where needed. In GL, we will use MARXAN in the second (initial) and third (revised) years of the project to determine priority areas for conservation based on spatial maps of marine biodiversity and fishing identified in Task 2.1.

WP3. Comparative Approach to Modeling MPA

In this study, we propose to use a variety of different and complimentary MPA modeling approaches to examine at each level of the population structure, from individual to ecosystem, how mobility interacts with spatial management efforts to determine the final population dynamics. Each of the models focuses on a different aspect of the population dynamics, and each uses a different set of assumptions in describing the system. This breadth of approaches is necessary to fully understand the dynamics, as well as how model assumptions affect predictions of MPA consequences for mobile species, and the level of model complexity necessary to provide useful recommendations to managers.

Though for structural reasons this WP has been separated into several different tasks, we intend to thoroughly emphasize a comparative approach. As such, we have included a specific task on project integration and synthesis in Work Package 5 where inter-model comparisons are discussed (Task 3.6).

Task 3.1: Individual-Based Model (IBM) of South African hake

Individual fish likely differ significantly in their use and residency times in different habitat areas both with respect to other individuals and to the same individual at a different life stage (Ogden & Quinn 1984, Holland et al. 1996). An IBM (Grimm & Railsback 2005) is considerably more flexible and precise in its description of individual behavior than the alternative modeling approaches used in Tasks 3.2-3.5. Their ability to mimic animal behavior can be used to examine some of the simplifying assumptions inherent in conventional population models. We will use the IBM to test the effect of various MPA designs on SA hake and to determine if and how more traditional populations models (see Task 3.2) can be made to reproduce their behavior.

Methodology and Work Program

Though movement data are not available for SA hake, it is believed to have an ontogenic migration similar to that of GL hake. We will construct sets of plausible movement rules that mimic the ontogenic migration, as well as examine a range of behavioral patterns such as residency, ranging behavior, density-dependent movement, etc. We will use a fine spatial resolution (see Task 2.2), allowing us to simulate the effects of individual trawl tracks, and to evaluate the effects of high resolution zoning, such as trawling lanes.

We will develop the basic IBM such that it will attain stability prior to the year 1900, and then apply fishing according to historical maps of trawl tracks. The model will be projected into the future, testing several management options. The model will not be able to simulate realistic quantities of individual hake (because of computational intensity), but rather a small number of representative hake will be monitored in the model, to assess the mortality profiles in different areas and across different ages, under each scenario.

Task 3.2: Single-species, bio-economic MPA models focused on movement dynamics

Context and Objectives

Single-species population models hold the middle ground between single-species IBM and ecosystem models. Age- and/or size-structured population models have been central to most model-based fisheries management efforts. Though they lack the detail or completeness of alternative models, their relative simplicity allows for direct evaluation of how core life-history parameters affect dynamics. They have been extended in a number of ways to include the spatial dynamics of MPA implementation (e.g., Mahevas & Pelletier 2004, Kaplan et al. 2006, Walters et al. 2007, Kaplan et al. *submitted*). Furthermore, there are effective approaches to incorporating economic factors into single-species MPA models (Smith & Wilen 2003, Sanchirico et al. 2006). Therefore, these models are ideal for examining the effects of fish mobility on MPA effectiveness.

The goals of this Work Package are to: (1) incorporate different fish movement behavior, such as home ranges, ontogenic migrations and reproductive/foraging migrations, into single-species MPA models, (2) apply these models in spatial context specifically to hake and anchovy/sardine in the GL and SA, (3) determine the impact of mobility on persistence and yield in an MPA network by comparing model results with different levels and types of mobility, (4) incorporate economics factors, such as effort displacement and discount rate, into model assessments, and apply resulting bio-economic model to the hake fishery in GL.

Methodology and Work Program

Work will begin with the extension of existing spatial MPA models (e.g., possibly, but not limited to, Kaplan et al. 2006) to include adult movement patterns. Uncertainty about movement behavior will be addressed through comparison of model results with different levels and types of movement. We will identify when population collapse occurs and when MPA improve persistence and/or yield. MPA designs considered will include those produced by MARXAN (Task 2.4), as well as designs targeted to protect juveniles or adults.

Economic considerations, such as effort displacement, fisher dropout and the discount rate, will then be integrated following the previously mentioned bio-economics approaches (e.g., Smith & Wilen 2003) and in collaboration with project economists. Of interest will be to understand why the hake fishery in the GL has been relatively stable despite large catches of juveniles, whether and how increased longline and gillnet activity will destabilize this population, and if MPA are an effective management strategy.

Task 3.3: Trophic dynamics of marine resources in South Africa and the Gulf of Lions

One of the potential strengths of ecosystem models is that they provide a platform for exploring the responses of marine food webs to multiple anthropogenic pressures and various management measures. In this task, we explore the effects of MPA on the structure and function of exploited ecosystems using two independent ecosystem models with different underlying assumptions: Osmose (Object-oriented Simulator of Marine ecOSystems Exploitation; Shin and Cury 2001, 2004) and Ecospace (Walters 1998, Walters et al. 1999). OSMOSE is a spatial IBM (see Task 3.1) that assumes predation is opportunistic and only based on the relative size of predators and prey, while Ecospace is an ecosystem model that assumes average predation rates between species. A common difficulty of complex ecosystem models remains validation of the simulation output. Comparing the results of different models may consolidate, refute or encourage discussion of the effects of MPAs.

The originality of the proposed work lies in:

- the exploration of multispecies and ecosystem effects of MPA using simulation models
- the use of diversified indicators in model outputs to evaluate the performance of tested MPAs (size-based, trophodynamics, biodiversity, spatial indicators)
- a comparison between two independent spatial ecosystem models to propose an envelope of possible responses of the ecosystem to MPA implementation.

Methodology and Work Program

Simulations of MPA scenarios and cross-comparison of model outputs will be undertaken in SA (UCT, IRD) and in GL (IFREMER, IRD). In SA, the non-spatial version of Ecospace, i.e. Ecopath-with-Ecosim (EwE) has already been use successfully (e.g., Shannon et al. 2004). The passage to Ecospace will require regional trophic interactions (see Task 1.4). Output from WP2 will be used to parameterize the Ecospace model of SA, with at least two subregions clearly distinguished.

In SA, OSMOSE has already been used to explore different fishing scenarios (Shin et al. 2004, Travers et al. 2006). The novel aspect here is that the model has recently been coupled with a biogeochemical model of plankton and a hydrodynamic model, which allows us to explore both climate and fishing effects on target populations. This will provide a more accurate description of the consequences of MPA for the dynamics of the entire system at the present time and under future climate scenarios.

In the GL, trophic interactions in the food web have recently been studied through analysis of stomach contents and isotopic analyses. Ecosystem modelling in GL will follow the outline of that in SA, beginning with an EwE model before proceeding to more complex Ecospace and OSMOSE models.

Task 3.4: Application of APECOSM to MPA for mobile species in the Indian Ocean

The ecosystem model APECOSM (Apex Predators ECOSystem Model; Maury et al. 2007a,b) is a spatially explicit numerical model of the basin wide dynamics of open ocean pelagic ecosystems with a special focus on tunas. The model integrates various physiological, behavioural and ecological processes on a variety of scales. Physical forcing, biogeochemical forcing and the effects of fishing are explicitely taken into account.

The objective of this task is to use numerical simulations with the APECOSM model to study the effectiveness of MPAs for conserving oceanic ecosystems while maintaining fishery yields and limiting interactions between industrial and artisanal fisheries. The criteria (size, location, timing) for MPA to meet fishery management goals will be determined. In particular, a method for defining adaptive MPA size and location (mobile reserves) will be developed and tested to deal with the seasonal and inter-annual variability of environmentally driven tuna movements.

Methodology and Work Program

The different tasks envisioned in WP8 are the following:

- Adapt and run the APECOSM model in the Indian Ocean north of 45° S for exploited tropical and temperate tuna community (skipjack, bigeye, yellowfin, albacore) using recent mean catches, fishing effort and environmental forcing. Run two simulations with and without fishing as a reference set of simulation (the base case).
- Systematically assess the effects of MPAs for a large number of sizes and locations considering partial and total fishing effort redistribution outside the MPA. Compare with the "reference simulations" to determine criteria for optimal MPA design.
- Based on criteria, develop method for automatic determination of a Mobile Adaptive Network (MAN) of MPA.
- Run the APECOSM model from 1951 to 2006 using observed fishing efforts, as well as available physical-biogeochemical ocean reanalysis (NEMO-PISCES). Validate against observed catches. To test MAN efficiency to manage tuna fisheries with contrasting environmental and fishing effort conditions, rerun simulation without catches inside MAN and for alternative assumptions of fishing effort redistribution.

Task 3.5: Development of coupled bioeconomic MPA model: Application to the Indian Ocean fishery

Bioeconomic modelling has already been successfully applied to large oceanic-scale tuna fisheries (Campbell 2000) and a spatial bioeconomic model exists for the western Pacific tuna fisheries (Campbell 2000, Bertignac et al. 2001). This model included 4 species (albacore, skipjack, yellowfin, bigeye), 4 fleet segments (purse-seiners, freezer long-liners, fresh long-liners, pole-and-line) divided into national fleets and fishing zones. The pattern of breeding, recruitment, migration mortality and age structure of the population was used to predict the amount of available resources per 5° square and per month. This task aims at developing the same model for the Indian Ocean, possibly at a finer temporal and spatial scale so as to simulate the economic effects of various scenarios regarding MPA policies.

Methodology and Work Program

Several sub-tasks will frame this economic contribution. First, we will collect catch and economic data of the various fleets fishing the major tropical species of the western Indian ocean area. In particular, the model will include a fishing effort component (segmentation by fishing unit types), a management policy component (opening and closing dates of the fishery, MPAs, etc.), a market component (prices, exchange rate, tariff duties) and an economic component (profitability, international payments for coastal states, etc.).

Next, we will adapt the Campbell (200) to the IO case and link the economic model to APECOSM with the introduction of economic forcing (space and time distribution of fishing effort, relative price levels between species followed by the skippers on FADs or free schools, fuel price changes affecting patterns of fishing). Finally, we will simulate the impact of policy measures, such as the time and/or spatial closures, on the level of fishing rent and the adaptive strategies of the different fishing fleets. The costs of implementation of the different policy measures will be explicitly estimated and included in the impacts of MPA.

WP4. Moving Beyond Coastal MPA: Implications for Governance

Implementing MPA for mobile species poses challenges to developing effective governance structures for their implementation and management and to understanding how these changes in governance will affect the behavior and impacts of interested parties. In this WP, we explore these challenges to governance through two different approaches: (1) a legal examination of the modifications to existing governance structures needed to implement high-seas MPA, and (2) an examination using game theory to understand how individuals and groups will respond to MPA implementation.

Task 4.1: Comparative approach to advancing the governance of high seas MPA

Since the 1970's, numerous mechanisms have been created for the protection of fishing resources in water under national jurisdictions. These governance models generally relate to one, perhaps two or three, species. However, ecosystem approaches and international management efforts are increasingly important. We proposes to look beyond the existing rules governing marine management at the national level (e.g., division into individual fisheries; marine extensions of terrestrial parks, such as the ïle de Crau-Port; the Parc de l'Iroise reserve founded in 2007; etc.) and the international level (e.g., Franco-Italian project to create a marine park at Bouches de Bonifacio) to determine what governance changes are needed to translate these models into spatial management frameworks for pelagic species, the fisheries that depend upon them (e.g., the French tuna fleet), and by-catch species (e.g., sharks, turtles, marine birds).

This work builds on a growing body of research, as well as a number of national and international conferences on high-seas goverance (e.g.,Monaco 2008). Our work will depend upon and be complimentary to the work of the French Agence des Aires Marines Protégées (e.g., their MPA projects in the Baie de Somme and the Baie du Mont Saint Michel), and on the work of the science committee which currently studies the creation of MPA along the edge of the continental shelf for marine mammals and cold coral reefs.

Methodology and Work Program

Central to our work will be a consideration of what new international collaborations or agreements are needed to define effective management frameworks for mobile species that incorporate the ecosystem approach to fisheries (EAF) and allow for spatial management measures. One key element to consider in the context of high-seas MPA is what type of legal mechanisms are needed to effectively police MPA and limit illegal, unregulated and unreported (IUU) fishing inside reserves.

The specific work program envisioned in this task is:

Year 1 : Analysis of the existing legal framework (conservation initiatives, national rules and international conventions, informal processes) to identify the rights and obligations weighing on the users of high-seas resources.

Year 2 : Identifying the major difficulties raised by the creation of high-seas MPA (e.g., freedom of navigation, seen as exclusive to the UN Convention on the Law of the Sea (UNCLOS), vs the protection of resources, seen as a common / international concern).

Year 3 : analysis of the lack of a competent authority at the global level to regulate the use of marine biodiversity and of the prospect for a new legal framework.

Task 4.2: Using game theory to model the response of economic agents to MPA

The strategic behavior of fishers or collective economic agents (countries) is a key factor for the success of MPA. Individual fishers may or may not comply with the conservation public policy. Their choice depends on the payoff, which is in turn related to the resource response to MPA **and** to the expected level of penalty if the poacher is caught. Such strategic behavior can be modeled through a repeated mixed game with infinite or finite time horizon. A second, related, question is the cooperation (or non cooperation) between countries sharing a common, mobile fish resource. Some countries may decide to cooperate to build a MPA network, thereby sharing costs and benefits from resource improvement. But there is a real possibility of free riding, whereby a country takes advantages of conservation efforts, but doesn't pay the costs. These effects can be considered a case of the fish war game (Levhari & Mirman 1980). Different factors may explain the strategic choice of a country: position on migration route of resource, fishing capacity, etc. In this task, we will explore these factors by applying game theory to MPA.

Methodology and Work Program

This task will be divided into the following steps:

- Estimate the payoff matrix for the reference case in the absence of MPA (e.g., from Task 3.5) calibrated using the average fishing rent among fishing nations and fleets.
- Simulate various scenarios of compliance after the implementation of MPA policies (using one representative vessel per fleet segment) and estimate the new distribution of profits for the ship owners and the coastal states selling access fees and supporting the cost of the conservation policy.

WP5. Synthesis of Results and Ensuring Project Impact

In this WP, we seek to ensure the long term impact of this project through active diffusion of the fruits of our labor in three important ways: (1) publication / diffusion of specific MPA recommendations and generic MPA modeling tools, (2) organizing a symposium on the topic of MPA and species mobility, (2) publishing a special volume of publications incorporating works from the entire project team, as well as selected experts in the field.

Task 5.1: Comparison and synthesis across project Tasks and Work Packages

Comparisons among the different approaches used in this project will be extremely important to taking full advantage of the breadth of the proposed research. Each of the biological, bio-economic and economic models resolves certain aspects of the dynamics, while poorly describing others. Model complexity is also a major challenge to integrating model-based MPA assessments into management decisions. Only by comparing several different modeling approaches, as well as integrating the real-world considerations advanced in the governance work package (WP4), can we understand the full effects of species mobility on MPA dynamics, as well as determine the level of complexity and detail necessary to capture essential aspects of the dynamics.

Methodology and Work Program

Though comparisons are expected to occur at multiple levels, there are several comparisons that are particularly relevant. IBM models provide a detailed description of individual behavior, but they are too cumbersome for management decisions. It is important to identify aspects of the IBM that are novel compared to traditional single-species models with probabilistic descriptions of behavior. Once identified, their importance will be assessed and modifications to the models of Task 3.2 will be attempted to incorporate these effects.

The ecosystem models to be used in Tasks 3.3 & 3.4 provide a detailed description of the trophic web at the expense of increased complexity and difficult parameterization. It is once again useful to identify how model results differ from the single-species approaches of Task 3.2. Furthermore, there exists the possibility of non-trivial effects due to the spatial separation and different trophic interactions of juvenile and adult phases. Identification of these effects is best achieved by comparing with single species results.

Economic models are often less favourable than biological models regarding MPA benefits (e.g., Smith & Wilen 2003). Therefore, it is important to compare results with and without economics to identify possible misleading conclusions from biological models alone. Results from the bio-economic modelling developed in Tasks 3.2 and 3.5 will be contrasted with results from purely biological approaches. Furthermore, the results from the application of game theory to fisherman observance of MPA regulations and its effects on effort redistribution after MPA implementation (Task 4.2) will be closely watched to assess limitations of MPA models that do not take these effects into account and examine ways to accurately integrate fisherman behaviour in MPA models. We envision an eventual coupling between the model developed in Task 4.2 and the models developed in Work Package 3, particularly those in the IO where enforcement of MPA regulations is likely to be a major challenge.

Finally, the legal perspectives to be developed in Task 4.1 provide an alternative and extremely important perspective on the challenges surrounding the development of offshore MPA. This perspective will be central to developing in our modeling efforts realistic proposals for MPA networks that take into account the limitations and opportunities posed by national and international frameworks for MPA governance.

Task 5.2: Development of specific recommendations and generic tools for MPA assessment

Though the modeling work described in WP3 will have important theoretical implications on the optimal size and location of MPA, the applied outcomes of this project will be particularly valuable for managers and industry. We will develop specific suggestions for each study area regarding the use and optimal placement of MPA, as well as identify modeling tools that have applications for MPA assessment outside the scope of this project.

Methodology and Work Program

Though recommendations and modeling tools will follow naturally from modeling work in WP3, we plan on facilitating access to our work through the online diffusion of a "DVD" containing relevant spatial information (e.g., GIS data layers), model results with recommendations for each study area, and software used to perform modeling work.

Task 5.3: Organization of a symposium on the scientific, management and governance implications of MPA for mobile and dispersive species

As evidenced by the recent interest in non-coastal MPA, we expect that their will be an active community of scientists, managers, industry officials, politicians and environmental groups considering how adult mobility and dispersal affect the utility and implementation of MPA networks. Therefore, we feel it will be appropriate to organize an international symposium on the topic in the fourth year of the project. We hope to bring together an interdisciplinary group to look at the topic from as wide a group of angles possible.

Methodology and Work Program

We expect to hold the symposium in the fourth year of the project with significant organizational activity in the third year of the program. Invited speakers will be selected based on nominations from project participants. We anticipate inviting eight speakers, two for each of four special sessions. Additional participants will be selected from response to an open call for abstracts. Abstracts will be solicited from a symposium website, as well as through mailing list circulation. We expect the symposium to last between from 2-4 days.

Though basic funds for invited speakers and initial symposium organization are included in the budget, we expect to solicit additional funds to increase symposium size and invite additional speakers via grants proposals to the IRD, Agence AMP, GLOBEC, etc.

Task 5.4: Synthesis of results in a special volume of publications

In order to ensure the impact and visibility of project results, we feel it is important to organize them into a special volume. Though publications resulting from this project will not be limited to this volume, we expect strong participation from the entire project team with representative publications from each WP and study region. Furthermore, a select number of invited contributors will be added to increase breadth and attractiveness of the volume.

Methodology and Work Program

The special volume will be organized during the third and fourth year of the project with publication expected towards the end of the fourth year. We plan on publishing in a respected international journal, such as Marine Ecology Progress Series, Ecological Applications, Deep-Sea Research II or Progress in Oceanography.

1.6 Résultats escomptés et Retombées attendues *(1 à 2 pages maximum)*

The most fundamental measure of the success of this project will be whether or not our results are useful to managers, the fishing industry and scientists involved in the selection and implementation of MPA for demersal and pelagic species, e.g., through consideration of our results during the MPA decision making process in the three study areas. To maximize the probability of this eventual applied impact, as well as to provide testable benchmarks for project achievements, we have chosen three concrete, public outlets for the results of this study (detailed in WP5 above): (1) online distribution of collected results and models with relevant recommendations for MPA implementation in the study areas, (2) organization of a symposium on MPA for mobile species, and

(3) publication of a special volume with representative results from all aspects of the study. These three public forums will provide a range of outlets for project results that will appeal to a wide audience, thereby maximizing our long-term impact.

In addition to these overall project benchmarks, each of the WP1-4 has its own expected results that will contribute to our knowledge of the interaction between species mobility and spatial management efforts. The targeted experimental work in WP1 of this project should contribute four concrete products: (1.1) an initial estimation of mature hake and juvenile bluefin tuna movement in the GL, (1.2) determination of the reproductive output of GL hake as a function of season and size, (1.3) bottom topography measurements over essential fish habitats along the SA shelf edge, and (1.4) an isotope-based determination of the trophic level of the majority of SA marine biomass. While each of these is quite valuable and will enhance modeling efforts, the mark-recapture study of large hake is particularly noteworthy in that tagging of large hake at night has never been attempted before.

Beyond the contribution to the parameterization of modeling efforts, the most obvious measure of the successful achievement of WP2 will be the initial determination of priority sites for conservation using MARXAN in Task 2.4. While we do not recommend MARXAN as the sole method of MPA selection, it is a well-known, recognizable product that is extremely useful to managers in the initial conception of an MPA network. MARXAN analysis will require the detailed spatial habitat and fishing activity maps produced in the other tasks of WP2.

The contribution of the modeling portion of this project will naturally be measured in terms of the utility of results for MPA management efforts. While each of the models will provide insight into a particular aspect of the system, the overall outcome of the effort will likely come in two forms: (1) a theoretical understanding of the consequences and importance for MPA functioning of different types of movement behavior that has wide applicability both inside and outside the three study areas, and (2) a concrete analysis of the value (relative to management alternatives), optimal location and optimal size of MPA in the three study areas for the different species and ecosystems targeted by this study.

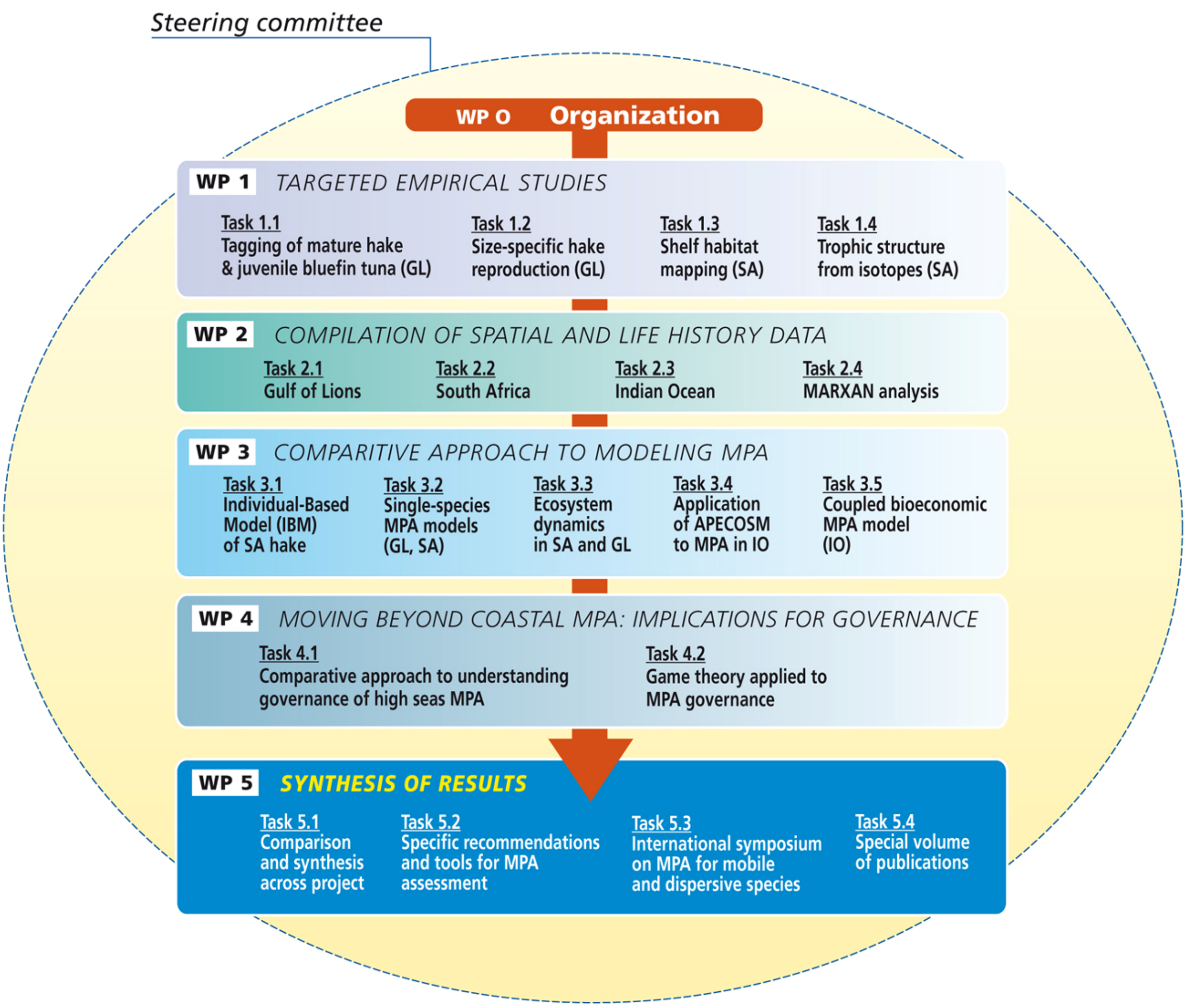
Finally, the governance aspect of this project (WP4) provides an interesting complement to the biological and economic work in the rest of the study. The insights drawn from this part of the study should have an immediate impact on MPA management efforts. Notably, the comparison between coastal and high-seas MPA governance will provide a concrete framework for developing open-ocean MPA plans, and the use of game theory to examine MPA compliance at an individual and an international level will be extremely useful to assessing the likely success or failure of such plans.

1.7 Organisation du projet

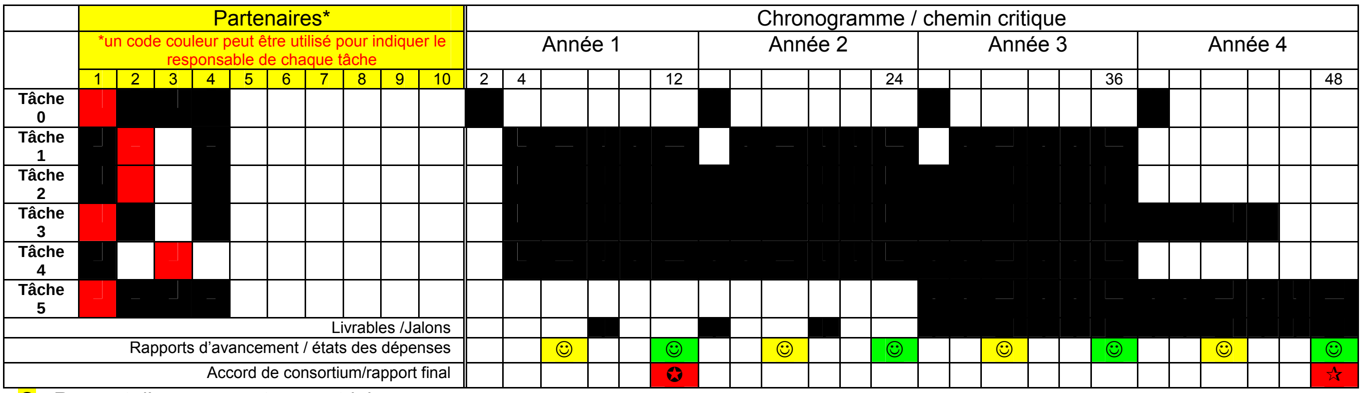
WP	Task	Description	Responsible Party	Other Participants
WP0	Overall	Organization	**IRD**: Kaplan	**IRD**: Marsac (IO) **IFREMER**: Mellon (GL) **UCT**: Attwood (SA)
WP1	Overall	Empirical studies	**IFREMER**: Mellon	
	1.1	Fish tagging GL	**IFREMER**: Mellon	**IFREMER**: Bourdeix, de Pontual, Fromentin, Metral, Mortreux,
	1.2	Hake reprod. GL	**IFREMER**: Jadaud	**IFREMER**: Bourdeix, Metral, Mellon
	1.3	Habitat map SA	**UCT**: Attwood	**UCT**: Hutchings, Sinclair, Analyst
	1.4	Trophic struct. SA	**IRD**: Le Loc'h	**IRD**: Shin, Technician **UCT**: Yemane, Shannon
WP2	Overall	Data compilation	**IFREMER**: Fromentin	
	2.1	GL	**IFREMER**: Fromentin	**IFREMER**: Cheret, Jadaud, Roos, Mellon, PhD student
	2.2	SA	**UCT**: Attwood	**IRD**: Le Loc'h, Shin, Technician **UCT**: Sinclair, Yemane, Shannon, Hutchings, PhD student
	2.3	IO	**IRD**: Fonteneau	**IRD**: Guillotreau, Marsac, Maury
	2.4	MARXAN	**IRD**: Kaplan	**IFREMER**: Mellon, Jadaud, Cheret, PhD student **IRD**: Maury, PhD student **UCT**: Attwood, PhD student

WP3	Overall	Modeling work	**IRD**: Maury	
	3.1	IBM SA hake	**UCT**: Attwood	**IRD**: Kaplan **UCT**: PhD student
	3.2	Single-species Model	**IRD**: Kaplan	**IRD**: Chaboud, Guillotreau, Maury, PhD student **IFREMER**: Mellon, Fromentin, Jadaud, Roos **UCT**: Attwood, PhD student
	3.3	Trophic model GL & SA	**IRD**: Shin	**IRD**: Le Loc'h, Postdoc **IFREMER**: Mellon, Jadaud, Roos, Fromentin, Postdoc **UCT**: Yemane, Shannon
	3.4	APECOSM IO	**IRD**: Maury	**IRD**: Marsac, PhD student
	3.5	Bio-econ. tuna IO	**IRD**: Guillotreau	**IRD**: Chaboud, Postdoc **CDMO**: Vallée
	3.6	Comparisons	**IRD**: Kaplan	Team effort
WP4	Overall	Governance	**CDMO**: Proutière-Maulion	
	4.1 4.2	High-seas MPA Game theory	**CDMO**: Proutière-Maulion **IRD**: Chaboud	**CDMO**: Beurier, Postdoc **IRD**: Guillotreau **CDMO**: Vallée
WP5	Overall	Synthesis	**IRD**: Kaplan	
	5.1	MPA assessment tools	**UCT**: Attwood	Team effort
	5.2	Symposium	**IRD**: Kaplan	Team effort
	5.3	Special volume	**IRD**: Kaplan	Team effort

Organigramme



Chronogramme



☺ : Rapport d'avancement semestriel

☺ : Rapport d'avancement semestriel + état des dépenses

✪ : Accord de consortium

☆ : Rapport de synthèse + récapitulatif des dépenses

Tableau des Livrables

TABLEAU des LIVRABLES et des JALONS (le cas échéant)			
Tâche	Intitulé et nature des livrables et des jalons	Date de fourniture ***nombre de mois à compter de T0***	Partenaire responsable du livrable/jalon
1. Targeted empirical studies of movement and trophic interactions			
	1.1. Completion of fish tagging in GL	24	IFREMER
	Description of movement based on tagging results	30	IFREMER
	1.2. Description of hake reproductive period in GL	24	IFREMER
	1.3. Completion of SA habitat mapping field work	18	UCT
	1.4. Completion of isotope analysis of SA ecosystem	36	IRD
2. Compilation of life history, trophic interaction and spatial distribution data			
	2.1. Initial parameterization for models in GL	12	IFREMER
	Final description of fish habitats and interactions, GL	36	IFREMER
	2.2. Initial parameterization for models in SA	6	UCT
	Final description of fish habitats and interactions, SA	30	UCT
	2.3. Initial parameterization for models in IO	6	IRD
	Final description of fish habitats and interactions, IO	24	IRD
	2.4. Initial MARXAN analysis for all three study areas	18	IRD
	Final MARXAN analysis including best habitat data	36	IRD
3. Comparative approach to modeling MPA			
	3.1. IBM results for SA hake movement	24	UCT
	3.2. Incorporation movement into single-species models	12	IRD
	Application of model to target species in SA	18	IRD
	Application of model to target species in GL	21	IFREMER
	Inclusion of economic factors in model	36	IRD
	3.3. Regionalized OSMOSE and Ecospace in SA	24	IRD
	Model comparison in SA	30	IRD
	Ecopath-with-Ecosim for GL	24	IFREMER
	OSMOSE / Ecospace for GL	36	IFREMER
	3.4. Running APECOSM MPA model for IO	18	IRD
	MPA assessment for IO using APECOSM	24	IRD
	Automatic Mobile Adaptive Network in APECOSM	30	IRD
	3.5. Economic model coupled to APECOSM	24	IRD
	IO economics analysis completed	36	IRD
	3.6. Comparitive model work focusing on three cases mentioned in Task 3.6 completed	42	IRD
4. Moving beyond coastal MPA: implications for governance			
	4.1. Analysis of existing high-seas governance frameworks	12	CDMO
	Recommendations of governance changes for high seas MPA	36	CDMO
	4.2. Completion game theory applied to MPA compliance	30	IRD
5. Synthesis of results and ensuring project impact			
	5.1. Publication of "DVD" with MPA analysis results	42	UCT
	5.2. Initial symposium site selection and organization	24	IRD
	Symposium on MPA for mobile species	42	IRD
	5.3. Publication of special volume with project results	48	IRD

1.8 Organisation du partenariat

1.8.1 Pertinence des partenaires

Each of the four partners in this project brings a special set of skills and interests to the effort. Despite this diversity, there is a strong common interest to study the effects of MPA on mobile species. One indication of the strength of this shared interest is that project members from each of the three study areas independently came to the conclusion that the study of offshore MPA was an urgent and important direction of research. In particular, project members C. Mellon (IFREMER, GL), C. Attwood (UCT, SA) and A. Fonteneau (IRD, IO), among others, have all been pushing the importance of studying the effects of potential MPA networks in their respective systems long before this project was born. This synergy between the different parties was a natural basis for building this project.

The project is lead by an interdisciplinary group of researchers from the Institut de Recherche pour le Développement (IRD) based in Sète, France. This group includes members of two Unité de Recherche (UR): ECO-UP focusing on comparative studies of exploited upwelling ecosystems (e.g., SA), and THETIS focusing on exploited tuna species of the Indian Ocean. Both these UR have a long history in their respective areas, including an expansive publication record (e.g., see CV of Y. Shin and O. Maury) and existing or prior long term attachments of researchers in the study regions. Furthermore, IRD Sète has been at the forefront of new approaches to fisheries management, with significant contributions to the ecosystem approach to fisheries. This group has recently been joined by the economists on the project, C. Chaboud and P. Guillotreau, as well as the project coordinator (see Section 1.8.3). These two highly-skilled economists (e.g., see CV of P. Guillotreau) are a valuable addition to both the laboratory and the project.

IFREMER has a long history in the field of marine science and is the major French marine research institute. The IFREMER group in Sète, France brings to the project detailed expertise in the fish species of the GL region. In particular, the team includes expertise in hake (C. Mellon and A. Jadaud), small pelagics (D. Roos) and bluefin tuna (J.M. Fromentin). Furthermore, the IFREMER team has strong links with regional management and fishing industry groups that will be invaluable in communicating and assuring the impact of project results.

The Université de Nantes brings to the project two experts in maritime jurisprudence, G. Proutière-Maulion and J.P. Beurier (Centre de Droit Maritime et Océanique, CDMO), as well as the economist Thomas Vallée. These individuals are experts in their field (e.g., G. Proutière-Maulion is the director of the CDMO; J.P. Beurier is an internationally recognized expert in his field with an extensive academic career, see CV) that add a unique dimension to the project. Furthermore, J.P. Beurier serves on an Agence des AMP scientific committee studying the use of offshore MPA to conserve marine resources, and, therefore, has intimate knowledge of the direction and challenges of MPA implementation in France and internationally.

The University of Cape Town (UCT) and Marine and Coastal Management (MCM) are two closely linked institutions that are regrouped in this project as a single partner (under the banner of UCT). The first is the premier university in SA, while the second is the central marine management institutes (the SA equivalent of IFREMER). Both have a long history of involvement with MPA science. C. Attwood in particular is a renowned expert in MPA with a publication history stretching back almost 20 years (e.g., Bennett & Attwood 1991). SA has one of the most highly developed coastal MPA networks in the world, and both institutions and their respective project members are directly involved in efforts to extend and enhance this network (e.g., OMPA project, see Section 1.4.1).

Steering Committee

In addition to the academic partners described above, the project includes a steering committee that will participate in annual project workshops, adding outside guidance and experience to the project. The committee includes representatives from the fishing industry, marine resource managers, and scientists leading other relevant MPA projects. Specifically, the members of the steering committee are:

- **Bertrand Wendling / Sa.Tho.An & AMOP**: Director of the leading fishermen organizations in Languedoc-Roussillon. These organizations represent commercial fishermen in the GL.
- **Michel Goujon / ORTHONGEL**: Director of the principal French organization of commercial tuna fishermen, including the IO fishing fleet.

- **Denis Etienne / Indian Ocean Commission (IOC)**: Leads the IOC effort to develop a MPA plan for IOC member countries, including the possibility of offshore MPA for the region. See Section 1.4.1 and Annexe D for more details.
- **Dominique Pelletier**: Head of PAMPA project (see Section 1.4.1 and Annexe D) and IFREMER expert on MPA.
- **Laurent Dagorn**: Head of the EU funded MADE project to study and mitigate impacts of by-catch on IO ecosystem (see Section 1.4.1 and Annexe D).
- **Raymond Lae**: Head of the ANR funded AMPHORE project to study MPA efficacy in five coastal reserves in the Mediterranean, Mauritania and Senegal (see Section 1.4.1 and Annexe D).

These experts will bring interesting and useful perspectives to the project, as well as assure the relevance of the project for industry.

1.8.2 Complémentarité des partenaires

The partners in this project have complementary skill sets that will be essential to the positive outcome of the project. In addition to the regional expertise represented by the different partners (e.g., IRD in SA and IO; IFREMER in GL; UCT in SA), the research direction of the partners varies significantly. IRD researchers on the project bring expertise in numerical modeling, economics and research in the developing world. This experience complements well the detailed biological knowledge and extensive field experience of the IFREMER researchers. Similarly, UCT and MCM researchers have applied experience with the use, implementation and management of MPA. Finally, the jurists and economists of the CDMO/U. Nantes bring a quite different perspective to the project that will significantly enhance the breadth of knowledge of other participants. This diversity of experience brings balance to the project in the sense that no one group has the entire skill set necessary for the work proposed. Furthermore, all of the different partners have expressed interest and enthusiasm in working with this varied group of researchers.

1.8.3 Qualification du coordinateur du projet

D. Kaplan's academic career consists of two principal lines of research that will bring breadth and experience to the project: (1) the effects of MPA on marine populations with an emphasis on how dispersal and movement interacts with spatial management efforts, and (2) oceanographic research on shelf circulation with an emphasis on the importance of transport processes for plankton species. Of particular interest and relevance to the project is my work on the theoretical and applied consequences of MPA implementation, including a number of publications in the field (e.g., Kaplan et al. 2006, Kaplan et al. *submitted*). Topics addressed in my MPA work include the effects of variability in reserve size and spacing on persistence and yield in MPA (Kaplan & Botsford 2005), the consequences of alongshore larval advection for MPA dynamics (Kaplan 2006), as well as empirical work on movement rates of blue rockfish to assess the MPA size needed to protect rockfish species (Jorgensen et al. 2006).

Equally important for this project, I have extensive applied experience in MPA through my role in the science advisory team to the MPA implementation process for California, USA (http://www.dfg.ca.gov/mlpa/). The goal of this process is to build a representative network of coastal MPA for the state. Beginning as early as 2002, I have worked on integrating model-based assessments of the consequences of MPA implementation for species persistence and fisheries yield into the MPA design process for the state (e.g., Kaplan et al. *submitted*). This work, and the work of many other scientists, contributed to the successful implementation of the first phase of this network last year. The implementation process included extensive collaboration directly with managers and fishery industry representatives. This experience will undoubtedly contribute significantly to assuring the utility and long-term impact of the proposed research in this project.

Since 2007, I have been a researcher at the IRD specializing in MPA. There, I am joined by the interdisciplinary group of researchers described above. This group complements my MPA experience with skills in empirical work, ecosystem modeling and expertise in the various study areas of the project. I have every confidence that this mix of skills will prove interesting and productive.

For more details on my research career, please see the publication list below and the short CV included in Annex B, as well as my web page: http://www.ur097.ird.fr/team/dkaplan/index.html

Five Recent Relevant Publications

Kaplan DM, Botsford LW, Gaines S, O'Farrell MR, Jorgensen S (*submitted*) Model-based assessment of persistence in proposed marine protected area designs for the central California coast. ***Ecological Applications***.

Kaplan DM, Largier JL (2006) Surface transport of particles along the coast of northern California derived from HF-radar data. ***Deep-Sea Research II*** **53**: 2906-2930.

Kaplan DM, Botsford LW, Jorgensen S (2006) Dispersal-per-recruit: an efficient method for assessing sustainability in networks of marine reserves. ***Ecological Applications*** **16**: 2248-2263.

Kaplan DM (2006) Alongshore advection and marine reserves: consequences for modeling and management. ***Marine Ecology Progress Series*** **309**: 11-24.

Jorgensen SJ, Kaplan DM, Klimley AP, Morgan SG, O'Farrell MR, Botsford, LW (2006) Limited movement in blue rockfish (Sebastes mystinus): internal structure of the home range. *Marine Ecology Progress Series* **327**: 157-170.

Experience in project management

In addition to the extensive, hands-on experience with project management I gained as part of the MPA implementation process in CA, USA (described above), I have been a major participant in a number of large research efforts, as well as independently obtained research funds. In the WEST project, an NSF-funded effort to understand the physical forcing mechanisms driving coastal upwelling in central California, I served not only in an organizational role, but also was actively involved in the publication of a special volume from that project, including two personal publications. In the COCMP project, a major California effort to develop a coastal ocean circulation observing network to understand transport of biological materials (e.g., fish larvae), I was the products manager from 2006 onward. My role was to coordinate efforts to turn raw data into useful products for managers and scientists. This involved managing researchers at five academic institutions in California, as well as producing regular progress reports for the project. Finally, I was a principal investigator on a grant to study the consequences of MPA for population genetics, and I was the head investigator on a project to combine satellite imagery and coastal circulation data to study plankton transport, though I had to leave both of these projects when I moved to France.

My own managerial experience is complemented by the extensive managerial and research experience of a number of researchers on the project. In particular, C. Mellon, F. Marsac and C. Attwood have agreed to play special roles in the project, organizing research efforts in GL, IO and SA, respectively, and assuring the timely completion of relevant WP and Tasks. There extensive experience will significantly contribute to the overall success of the project.

1.8.4 Qualification des partenaires

Partenaire	Nom*	Prénom*	Emploi actuel*	Discipline**	Personne.mois	Rôle/Responsabilité dans le projet 4 lignes max
IRD	*KAPLAN*	*David*	*Chargé de Recherche*		*36*	*Overall coordinator of project; MPA specialist; single-species bio-economic modeling; organization of symposium / special volume*
IRD	CHABOUD	Christian	Chargé de Recherche	Économiste	8	Single species, bio-economic modeling (GL,SA); use of game theory in study of MPA governance
IRD	GUILLOTREAU	Patrice	Chargé de Recherche	Économiste	12	Bio-economic modeling in IO
IRD	FONTENEAU	Alain	Directeur de Recherche		8	Expert on IO fisheries; organization and analysis of spatial distribution of fish and fishing pressure, and of behavioral data; governance issues
IRD	Le Loc'h	François	Ingénieur de Recherche		12	Isotopic signatures of SA species; ecosystem modeling in GL
IRD	MARSAC	Francis	Directeur de Recherche		8	Expert on IO fisheries; organization and analysis of spatial habitat distribution and behavioral data; Indian Ocean ecosystem modeling
IRD	MAURY	Olivier	Chargé de Recherche		24	IO ecosystem and bio-economic modeling; APECOSM
IRD	SHIN	Yunne	Chargé de Recherche		12	Isotopic signatures of SA species; ecosystem modeling in SA
IFREMER	*MELLON*	*Capucine*	*Cadre de Recherche*		*17*	*Coordinator of partner; tagging of hake in GL;* analysis of spatial habitat

						distribution and behavioral data in GL, organization of ecosystem modeling in GL;
IFREMER	BOURDEIX	Jean-Herve	Technicien		2	Hake and bluefin tuna tagging in GL; measurements of hake reproduction in GL
IFREMER	CHERET	Ysabelle	Technicienne		2	Data organization and compilation in GL, Hake and bluefin tuna tagging in GL
IFREMER	DE PONTUAL	Helene	Cadre de Recherche		4	Hake tagging in GL, analysis of spatial habitat distribution and behavioral data in GL
IFREMER	FROMENTIN	Jean-Marc	Cadre de Recherche		11	Tagging of bluefin tuna in GL; *; organization and analysis of spatial habitat distribution and behavioral data in*, ecosystem modeling in GL
IFREMER	JADAUD	Angelique	Cadre de Recherche		11	Size-specific reproduction of hake in GL; analysis of spatial habitat distribution and behavioral data in GL with emphasis on hake, ecosystem modeling in GL
IFREMER	METRAL	Luisa	Technicienne		3	Hake and bluefin tuna tagging in GL; measurements of hake reproduction in GL
IFREMER	MORTREUX	Serge	Cadre de Recherche		2	Hake and bluefin tuna tagging in GL
IFREMER	ROOS	David	Cadre de Recherche		10	Analysis of spatial habitat distribution and behavioral data in GL with emphasis on small pelagics, ecosystem modeling in GL
CDMO	*PROUTIERE-MAULION*	*Gwenaelle*	*Maître de Conférences, Directrice du Laboratoire, HDR*	*Juriste*	*12*	*Coordinator of partner; governance of high seas MPA*
CDMO	BEURIER	Jean-Pierre	Professeur Premiere Classe	Juriste	12	Governance of high seas MPA
CDMO (IAE, U. Nantes)	VALLEE	Thomas	Maître de Conférence	Economiste	10	Single-species bioeconomic modeling; use of game theory in study of MPA governance
UCT	*ATTWOOD*	*Colin*	*Professor*		*12*	*Coordinator of partner; MPA expert; habitat mapping in SA; data organization; IBM modeling of SA hake; single-species modeling of SA hake*
UCT (MCM)	HUTCHINGS	Larry	Marine Scientist		4	Side-scan sonar habitat mapping in SA
UCT (MCM)	SHANNON	Lynne	Marine Scientist		4	Ecosystem modeling in SA
UCT (Mar. Geosciences Units)	SINCLAIR	Dave	Researcher		8	Side-scan sonar habitat mapping in SA; analysis of bottom tomography data
UCT (MCM)	YEMANE	Dawit	Marine Scientist		15	Coordinator of partner; ecosystem modeling in SA

1.9 Stratégie de valorisation et de protection des résultats *(1 page maximum)*

As this project involves a number of different institutions with different histories and opinions regarding the valorization and protection of results, we feel that it is important that we agree to an “accord du consortium” in the initial phase of the project. In general, our attitude is to try to leave as many of our results and data in the public sphere as possible, primarily through prompt publication of results. We feel strongly that the applied aspects of the project and the relevance for management necessitate an open discussion and exchange of ideas. Nevertheless, there will undoubtedly be data used in the project, particularly raw data that will be synthesized in WP2, that cannot be publicly distributed because it belongs to other persons or projects. Therefore, we intend to thoroughly discuss data ownership at the kickoff meeting of the project and arrive at an agreement that on the one hand maximizes the openness of the project, while on the other hand respects the time and effort of colleagues inside and outside of the project.

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Walters CJ et al. (2007) An equilibrium model for predicting the efficacy of marine protected areas in coastal environments. ***Can. J. Fish. Aquat. Sci.*** **64**:1009-1018.

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ANNEXES

ANNEXE A. Description des partenaires (cf. § 1.8.1) ***(1 page maximum par partenaire)***

Partner 1: IRD

IRD (http://www.ird.fr) is a public institute created in 1944 (previously named ORSTOM) operated under the joint authority of the French Offices in charge of Research and Overseas Development. It is a non-profit, government-funded public organization whose general missions are to conduct research, consultancy and training with a view to promote the economic, social and cultural development in the Countries in Development. Research performed at IRD covers a wide range of fields and disciplines, with a special focus on the relationship between man and his environment in the tropical and Mediterranean countries. IRD consists of 79 research laboratories, located and operating jointly with academic partners in France, in the French overseas territories and in 35 countries in Africa, Asia, the Indian Ocean, Latin America and the Pacific area. Among the different activities of the institute, 130 researchers and technicians are specifically working on the dynamics and uses of marine, coastal and inland aquatic ecosystems.

IRD has a long experience in tropical tuna research and expertise, participating in pioneering studies on tuna biology and ecology in the Atlantic and Indian oceans. IRD has also developed an internationally recognized expertise on upwelling ecosystems, notably in the Benguela in South Africa. IRD has been recently involved in several large scale EU, international and national (ANR) projects related to both oceanic and upwelling ecosystems. Several IRD members are also serving as scientific experts at the European Commission DG FISH for Indian, Pacific and Atlantic oceans and in Regional Tuna Commissions.

The Centre de Recherche Halieutique et Mediterannée (CRH; http://www.crh-sete.org/) hosts a number of research groups from IRD, IFREMER and the University of Montpellier working in various areas of Marine Science. All the modern facilities needed for this study are available at the CRH, including a cluster of computers used to develop numerical ecosystem models and run mid- to large-size simulations, as well as laboratories for the treatment and analyses of biological samples. The majority of the models that will be used in the IRD portion of this project (OSMOSE, APECOSM) have been developed at the CRH. Furthermore, the CRH has recently embarked on a data and metadata storage process known as the Ecoscope that will eventually hose existing CRH databases (such as the SARDARA tuna database) and the results of this project.

Partner 2: IFREMER

The French institute for research and exploitation of the sea (Ifremer) is a public establishment created in 1984. It is the only French organisation with an exclusively maritime vocation and it is under the joint authority of the four Ministries: Research, Agriculture and Fisheries, Transport and Housing, Environment. Ifremer is located in 26 stations or centres along the coastline (including overseas territories) and includes about 1350 permanent employees, 50 Ph.D students and 30 post-doctoral fellowships. Ifremer budget is about 182 M€ per year. Ifremer scope of actions can be divided into four main areas: (i) understanding, assessing, developing and managing the ocean resources; (ii) improving knowledge, protection and restoration methods for marine environment; (iii) production and management of equipment of national interest and (iv) helping the socio-economic development of the maritime world. Ifremer has a long expertise in applied research on marine resources, including population dynamics modelling, observation systems, individual markers and fisheries oceanography.

The fisheries science laboratory in Sète has carried out research since the 1950s and has extensive expertise in the exploited fish populations of the north-western Mediterranean, especially in the Gulf of Lions. The laboratory has conducted some of the oldest scientific surveys on fish in the Mediterranean Sea dating back to the 1950's. Two surveys, PELMED and MEDITS, started at the beginning of 1990's. More recently, a series of surveys (MERMED, TECPEC, MERVIV) was initiated with the objectives to study bioccumulation in the hake trophic food web (MERLUMED), including studies of hake life-history parameters. This programme was supported by the ANR-ECCO-ECODYN and PNEC. Furthermore, IFREMER scientists are active participants of the General Fisheries Commission for the Mediterranean (GFCM), whose purpose is to promote the development, conservation, rational management and best utilization of living marine resources, and in the International Commission for the Conservation of Atlantic Tuna.

Partner 3: CDMO

The laboratory of the Centre de Droit Maritime et Océanique (CDMO) at the University of Nantes specializes in research around the legal disciplines linked to the marine environment. This research includes integrated management studies on living resources, the safety and wellbeing of seafarers, maritime transport law, the history of maritime law and laws on maritime sports. The aforementioned research is conducted as part of major international programs (e.g., SPICE; the CRISP research program on the protection and sustainable management of Pacific coral reefs; the network of European maritime law centers; debates on the evolution of maritime law and of research in this field), as well as national programs (NEMO) or regional programs (especially the Observatoire des Droits des Marins – Observatory of Seafarer's Rights). Furthermore, the CDMO is embedded in the Pole Mer et Littoral, which houses 8 research institutes that work on a wide variety marine related themes (including the Institut d'Economie et de Management (IAE) where project participant Thomas Vallée resides).

A senior lecturer since 1996, Gwenaele Proutière-Maulion has been director of the Centre de Droit Maritime et Océanique (Maritime and Oceanic Law Center) since 2004.

A specialist in national and EU fisheries law, she has also developed a number of research projects relating to the different maritime activities – especially as regards the use of marine resources – and to social law, often approached via the issue of responsibility. In particular, she is in charge of a line of research on biodiversity and the patentability of life within a quadrennial program set up at the University of Nantes between IFREMER and different academic research centers grouped within the sea and coastal center. She is joined on this project by Jean-Pierre Beurier, an internationally recognized expert in maritime law with a long and productive research career.

Partner 4: UCT (and MCM)

The University of Cape Town (UCT) is South Africa's oldest and second largest University with 21500 students, of which 6100 are postgraduate students. Students are drawn from 97 countries (www.uct.ac.za). UCT is rated as the top University in Africa on the basis of research outputs and ranks 398 in the world (www.topuniversities.com). Cape Town is strategically situated at the confluence of two major ocean currents, and on the doorstep on one of the most productive upwelling systems in the world. Naturally, marine science has been a major focus of at least four science Departments in the University. The Marine Research Institute was recently formed to amalgamate marine expertise in the departments of zoology, geology, applied mathematics, botany and oceanography. Each of these departments has made strong contributions to marine science in South Africa and internationally. Scientists in the Zoology Department work on the ecology and physiology of rocky-shore, sandy-shore and estuarine organisms, fisheries management and policy and mariculture, marine protected areas, pollution, invertebrate systematics and the biology of the Benguela upwelling system (www.research2006.uct.ac.za).

Marine and Coastal Management (MCM; regrouped with UCT as a single partner in this project), a division of the South African Department of Environmental Affairs and Tourism, is the principal marine science and management institution in South Africa. Roughly the South African equivalent of IFREMER, it is central to most marine and fisheries management decisions made in South Africa, including a long history of work with MPA. Furthermore, MCM is the principal backer of the African Journal of Marine Science, Africa's oldest, most-respected and highest-ranking marine science journal.

ANNEXE B. Biographies (cf. § 1.8.4) ***(1 page maximum par personne)***

Note: CV are listed in alphabetical order by last name.

CURRICULUM VITAE OF Colin G. ATTWOOD

University of Cape Town **Age**: 35, **Sex**: Male

(1) Current Address and Professional Affiliation

Marine Research Institute
Zoology Department
University of Cape Town
Private Bag X3
Rondebosch 7701, South Africa

Phone: +27 21 650 3612
Email: Colin.Attwood@uct.ac.za

(2) Description of Research

I study the effect of fishing on fish populations and I evaluate alternative strategies to conserve fish and to sustain fisheries. My work entails biological analyses, movement and migration studies, fishery assessment and modeling.

(3) Professional Preparation

1987: Bachelor of Science degree (University of Cape Town). Major subject: Zoology
1988: Honours degree in Marine Biology (University of Cape Town).
Other subjects: Applied mathematics, environmental and geographical science, botany
1991: Master of Science (Zoology), awarded with distinction. Title of thesis: Marine communities of the Prince Edward Islands (University of Cape Town).
2002: PhD (Zoology). Title of thesis: Spatial and temporal dynamics of an exploited reef-fish population (University of Cape Town).

(4) Professional Appointments

December 1988 to June 1994	Contracted to the Southern Oceans Group, South African National Antarctic Research Programme and the Benguela Ecology Programme
July 1994 to June 2007	Senior Specialist Scientist at the Department of Environmental Affairs and Tourism (Marine and Coastal Management branch).
March 2007	Associate Professor, Zoology Department, University of Cape Town

(5) Publication History

28 Publications in ISI Journals; 5 Publications in Edited Volumes; 1 Publication in Non-ISI journals

(6) Five Recent Publications

Attwood CG, Cowley PD, Kerwath SE, Næsje TF, Økland F, Thorstad EB (2007) First tracking of white stumpnose *Rhabdosargus globiceps* (*Sparidae*) in a South African marine protected area. *African Journal of Marine Science.* **29(1)**: 147-151

Kerwath SE, Götz A, Attwood CG, Sauer WHH, Wilke C (2007) Area utilisation and activity patterns of roman *Chrysoblephus laticeps* in a small South African marine protected area. *African Journal of Marine Science* **29(2)**: 259-270.

Fairhurst L, Attwood CG, Durholtz MD, Moloney CL (2007) Life-history of the steentjie *Spondyliosoma emarginatum* (Cuvier 1830) in Langebaan Lagoon, South Africa. *African Journal of Marine Science* **29(1)**:79-92.

Götz A, Kerwath SE, Attwood CG, Sauer WHH (2007) Comparison of the effects of different linefishing methods on catch composition and capture mortality of South African temperate reef fish. *African Journal of Marine Science* **29(2)**: 177-186.

Götz A, Kerwath SE, Attwood CG, Sauer WHH (in press): Effects of fishing on population structure and life history of roman *Chrysoblephus laticeps* (Sparidae). *Marine Ecology Progress Series.*

CURRICULUM VITAE OF Jean-Pierre BEURIER

Professeur des Université de 1° classe **Age**: 66, **Sex**: Male

(1) Current Address and Professional Affiliation
Faculté de Droit et des Sciences Politiques
Université de Nantes
Chemin de la Censive du Tertre, BP 81307
44313 Nantes cedex 03
France
Phone: +33 (0)2 40 14 16 23
Fax: +33 (0)2 40 14 15 00
Email: jp.beurier@univ-nantes.fr

(2) Description of Research
My current research focuses on the protection and valuation of marine and terrestrial biodiversity, especially through the creation of marine protected areas (MPA) in areas under national and international jurisdiction. My research also concerns navigational security and the struggle against ocean pollution that threatens marine and coastal biodiversity.

(3) Professional Preparation
1972 **Docteur de 3° cycle en droit maritime**, Université de Nantes
1977 **Docteur d'Etat en droit**, Université de Brest
1985 **Habilitation à diriger des recherches (HDR)**

(4) Professional Career
1969-1974 **Lawyer** in a maritime company
1975-1990 **Assistant, Maître assistant, Maître de conférences**, Université de Brest
1991-1994 **Professor**, Université des Antilles et de la Guyane
1995-2008 **Professor**, Université de Nantes

(5) Research Activity and Publication History
~100 Articles on marine law, and national and international environmental law
~50 Presentations at conferences, symposiums and colloquiums
~40 Presentations as an Invited Speaker at conferences in France and internationally
8 Collective Volumes

(6) Five Recent Publications
Droits maritimes, ed° Dalloz 2006 (5 chapters)
Droit international de l'environnement, ed° Pédone 2004 (half of the book)
Fonds international d'indemnisation pour les dommages dus à ,la pollution par les hydrocarbures (FIPOL) Jurisclasseur Environnement 2007 fasc. 4860
Le droit international face aux espèces invasives marines in l'Union européenne et la mer, ed° Pédone 2007
Nouvelles technologies et droit de l'environnement marin, ed° Kluwer law international 2000 (1 chapter)

CURRICULUM VITAE OF Patrice GUILLOTREAU

Chargé de Recherche (CR2), IRD **Age**: 42, **Sex**: Male

(1) Current Address and Professional Affiliation

Institut de Recherche pour le Développement
Centre de Recherche Halieutique
av. Jean Monnet
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Fax: +33 (0)4 99 57 32 95
Email: Patrice.Guillotreau@ird.fr
Web page: http://www.mpl.ird.fr/thetis/equipe/cv_guillotr.pdf

(2) Description of Research

My current research is on the global market for tropical tuna with emphasis on the European canning oligopsony. My particular field of interest is to look at the determining features of international trade and investment framing the fishing strategies of the European purse-seine fleets and their impact on the developing tuna economies of the western Indian Ocean.

(3) Professional Preparation

Master in Industrial Economics and foreign trade, 1989, University of Rennes 1 (France)
Ph.D., 1992, University of Rennes 1 (France)
Postdoctoral Researcher, 1993-1994, University of Portsmouth (Cemare) (United Kingdom)
Entitlement to Supervise PhD students (HDR), 2003, University of Nantes (France)

(4) Professional Appointments

1994-2007	Assistant professor, Department of Economics, University of Nantes
2007-Present	Chargé de Recherche (CR1), Institut de Recherche pour le Développement

(5) Publication History

Number of Publications in ISI Journals: 12
Number of Publications in Edited Volumes: 6
Number of Non-ISI Publications: 15

(6) Five Recent Publications

Guillotreau P., Le Grel L., Gonzales F. (2006), Cointégration verticale des prix du poisson. Stabilité des marges prix-coûts et transmission des chocs de demande, *Economies et Sociétés* **28**: 669-687.

Guillotreau P., Jiménez-Toribio R. (2006), The impact of electronic clock auction systems on shellfish prices: evidence from a structural change model, *Journal of Agricultural Economics* **57(3)**: 523-546.

Guillotreau P., Vallée T. (2006), Hétérogénéité des préférences temporelles et des quotas de pêche entre pays : conséquences sur la reconstitution des stocks halieutiques, *Annuaire de Droit Maritime et Océanique* **24**: 341-370.

Guillotreau P., Le Grel L., Simioni M. (2005) Price-cost margins and structural change; sub-contracting within the salmon marketing chain, *Review of Development Economics* **9(4)**: 581-97

Guillotreau P. (2004) How does the European seafood industry stand after the revolution of salmon farming: An economic analysis of fish prices, *Marine Policy* **28/3**: 227-233

CURRICULUM VITAE OF David M. KAPLAN

Chargé de Recherche (CR1), IRD **Age**: 35, **Sex**: Male

(1) Current Address and Professional Affiliation

Institut de Recherche pour le Développement
Centre de Recherche Halieutique
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France

Phone: +33 (0)4 99 57 32 27
Fax: +33 (0)4 99 57 32 95
Email: David.Kaplan@ird.fr
Web page: http://www.ur097.ird.fr/team/dkaplan/

(2) Description of Research

My research currently focuses on modeling the effects of marine reserves on fish populations. In particular, we are looking at how marine reserve design relates to sustainability, conservation and community structure of marine populations with distinct dispersal and reproductive potentials. I am also studying the effects of oceanographic processes, such as upwelling/relaxation, on temporal and spatial patterns of larval settlement.

(3) Professional Preparation

Honors B.Sc. (Magna Cum Laude), 1993, Brown University, Providence, RI (Math/Physics)
M.A., 1996, University of California, Santa Barbara (Physics)
Ph.D., 1997, University of California, Santa Barbara (Physics)
Postdoctoral Researcher, 1998-2001, P. Universidad Católica de Chile (Marine Sciences)
Postdoctoral Researcher, 2001-2006, University of California, Davis (Marine Sciences)

(4) Professional Appointments

1998-2001	Postdoctoral Researcher, Dept. of Wildlife, Fish & Cons. Bio., UCD
2001-2006	Postdoctoral Researcher, ECIM, P. Universidad Católica de Chile
2006-2007	Assistant Researcher, Institute of Marine Sciences, UCSC
2007-Present	Chargé de Recherche (CR1), Institut de Recherche pour le Développement

(5) Publication History

Number of Publications in ISI Journals: 14
Number of Publications in Edited Volumes: 1
Number of Non-ISI Publications: 3

(6) Five Recent Publications

Kaplan DM, Botsford LW, Gaines S, O'Farrell MR, Jorgensen S (*submitted*) Model-based assessment of persistence in proposed marine protected area designs for the central California coast. ***Ecological Applications***.

Kaplan DM, Largier JL (2006) Surface transport of particles along the coast of northern California derived from HF-radar data. ***Deep-Sea Research II*** **53**: 2906-2930.

Kaplan DM, Botsford LW, Jorgensen S (2006) Dispersal-per-recruit: an efficient method for assessing sustainability in networks of marine reserves. ***Ecological Applications*** **16**: 2248-2263.

Kaplan DM (2006) Alongshore advection and marine reserves: consequences for modeling and management. ***Marine Ecology Progress Series*** **309**: 11-24.

Jorgensen SJ, Kaplan DM, Klimley AP, Morgan SG, O'Farrell MR, Botsford, LW (2006) Limited movement in blue rockfish (Sebastes mystinus): internal structure of the home range. *Marine Ecology Progress Series* **327**: 157-170.

CURRICULUM VITAE OF François LE LOC'H

Ingénieur de Recherche (IR2), IRD **Age**: 32, **Sex**: Male

(1) Current Address and Professional Affiliation

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Email: francois.le.loch@ird.fr

(2) Description of Research

My research currently focuses on the functioning of the exploited marine ecosystem. In particular, I am looking at the trophic functioning by the mean of stable isotopes and Ecopath modeling.

(3) Professional Preparation

2004: PhD in Biological Oceanology (with best distinction) - Univ. Bretagne Occidentale, France.
1999: Master of Science in Biological Oceanology (with distinction) - Univ. Paris VI, France.
1997: Bachelor of Science in Ecology - Univ. Bretagne Occidentale, France.

(4) Professional Appointments

2004-2005	Postdoctoral Researcher, IFREMER, Nantes, France
2005-Present	Research engineer (IR2), IRD, CRH, Sète, France

(5) Publication History

Number of Publications in ISI Journals: 14

(6) Five Recent Publications

Le Loc'h F., Hily C. and J. Grall. Benthic communities and food web structure on the continental shelf of the Bay of Biscay (North Eastern Atlantic) revealed by stable isotopes analysis. In press in Journal of Marine Systems, doi:10.1016/j.jmarsys.2007.05.011

Hily C., Le Loc'h F., Grall J. and Glémarec M. Soft bottom macrobenthic communities of the North Biscay revisited: a long term evolution under fisheries-climate forcing. In press in Estuarine Coastal and Shelf Science doi:10.1016/j.ecss.2008.01.004

Bodin N., Le Loc'h F., Hily C., Caisey X., Latrouite D., Loizeau V., Abarnou A. and Le Guellec A.-M. 2008. Congener-specific accumulation and trophic transfer of polychlorinated biphenyls in spider crab food webs revealed by stable isotope analysis. Environmental Pollution, 151: 252-261

Grall J., Le Loc'h F., Guyonnet B. and Riera P. 2006. Community structure and food web based on stable isotope ($\delta^{15}N$ and $\delta^{13}C$) analysis of a North Eastern Atlantic maerl bed. Journal of Experimental Marine Biology and Ecology, 338: 1-15

Le Loc'h F. and Hily C. 2005. Stable carbon and nitrogen isotope analysis of the *Nephrops norvegicus/Merluccius merluccius* fishing grounds in the Bay of Biscay (Northeast Atlantic). Canadian Journal of Fisheries and Aquatic Sciences, 62: 123-132

CURRICULUM VITAE OF Olivier MAURY

Age : 37, **Sex** : Male

Address : Institut de Recherche pour le Développement (IRD), CRH (Centre de Recherche Halieutique Méditerranéenne et Tropicale) av. Jean Monnet, B.P. 171, 34203 Sète cedex, FRANCE
Phone: +33 (0) 499 57 32 28 Fax: +33 (0) 499 57 32 95 e-mail : Olivier.Maury@ird.fr

Education and Qualification :

PhD. (Hons) Spatial fish population dynamics, june 1998. Ecole Nationale Supérieure Agronomique de Rennes (ENSAR), 1995-1998.

DAA (equivalent to a M. Sc.) in fishery science, october 1994. (ENSAR). Engineer degree from Grandes Ecoles.

DAG Ecole Nationale Supérieure Agronomique de Toulouse (ENSAT), 1991-1993.

Bio-math-sup. and Bio-math-spe. (preparation to the competitive examination to enter the Grandes Ecoles), Ecole Nationale de Physique Chimie Biologie, Paris, 1988-1991.

Baccalauréat C (Mathematics), Lycée Buffon, Paris, 1988.

Employment :

Senior Research Associate (CR1), Institut de Recherche pour le Développement (IRD), 2003-today. Based in : Seychelles SFA (Seychelles Fishing Authority) 1/2003-8/2003, Sète IRD-CRH 10/2003-today.

Research Associate (CR2), Institut de Recherche pour le Développement (IRD), 1999-2003. Based in : Montpellier HEA 04/1999-07/1999, Paris LODYC (Univ. Paris VI) 07/1999-02/2000, Sète CRH 02/2000-07/2001, Seychelles SFA (Seychelles Fishing Authority) 11/2001-12/2002.

Postdoc, ENSAR, Rennes, sept 1998-feb 1999.

Publication History : 17 publications in refereed journals, 29 non-refereed publications

Selection of recent publications :

Faugeras B., **O. Maury**, 2007. Modelling fish population movements: from an individual-based representation to an advection-diffusion equation. J. Theoretical Biology 247 (2007) 837–848.

Maury, O., Y-J. Shin, B. Faugeras, T. Ben Ari, and F. Marsac, 2007. Modelling environmental effects on the size-structured energy flow through marine ecosystems. Part 2: simulations. Prog. Oceanogr. **74**(4) : 500-514.

Maury, O., B. Faugeras, Y-J. Shin, J.C. Poggiale, T. Ben Ari, and F. Marsac, 2007. Modelling environmental effects on the size-structured energy flow through marine ecosystems. Part 1: the model. Prog. Oceanogr. **74**(4): 479-499.

Faugeras B. and **O. Maury**, 2005. An advection-diffusion-reaction size-structured fish population dynamics model combined with a statistical parameter estimation procedure: Application to the Indian Ocean skipjack tuna fishery. Math. Biosciences and Engineering, 2(4):719–741.

Faugeras B. and **O. Maury**, 2005. A multi-region nonlinear age-size structured fish population model. Nonlinear Analysis: Real World Appl., 6(3):447–460.

Maury, O. and P. Lehodey (Eds.). 2005. Climate Impacts on Oceanic TOp Predators (CLIOTOP). Science Plan and Implementation Strategy. GLOBEC Report No.18, ii, 42pp.

Maury O., B. Faugeras, V. Restrepo, 2004. FASST: A Fully Age-Size and Space-Time structured statistical model for the assessment of tuna populations. Col. Vol. Sci. Pap. ICCAT, 57: 206-217.

Maury O., 2004. How to model the size-dependent vertical behaviour of bigeye tuna in its environment? Col. Vol. Sci. Pap. ICCAT, 57(2) (2005) : 115-126.

Research activity, advisory roles and representation

Member of the GLOBEC Scientific Steering Committee (2006-2009); Member of the GLOBEC-IMBER Transition Task Team (2008-2009); co-chairman of the GLOBEC regional program CLIOTOP (2003-), leading role in launching project. Member of the SCOR-France Scientific Committee (2006-). Leader of several funded projects (IOTC ; PNEC ; PFRP) ; leader of the modelling component of the IRD UR THETIS ; supervision of Ms students, engineers and postdocs ; numerous participations to ICCAT (1997-2001) and IOTC (1999-2005) Working Parties, development of new methods for stock assessment (the associated softwares PROCEAN, CATAGE-TREND and FASST being used in ICCAT and IOTC) ; member of the IOTC Scientific Committee ;

CURRICULUM VITAE OF Capucine MELLON-DUVAL

Cadre de Recherche (II), IFREMER **Age**: 52, **Sex**: Female

(1) Current Address and Professional Affiliation

Institut Français de Recherche pour l'Exploitation de la Mer
Centre de Recherche Halieutique
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Email: mellon@ifremer.fr

(2) Description of Research

My research currently focuses on (1) trophic interactions in demersal fish (hake) and (2) biological parameters as growth and reproduction. I used to work previously on artificial reef in Mediterranean and then on stock assessment of demersal fish (cod, saithe, whiting) in the North Sea and Eastern Chanel.

(3) Professional Preparation

Thesis , 1983, Aix-Marseille II University, (Marine Sciences)

(4) Professional Appointments

1984-1988	IFREMER Sète (Artificial reef in Mediterranean)
1988-2001	IFREMER Boulogne-sur-mer (Sampling strategy and stock assessment)
2001- Present	IFREMER Sète (coordination of Merlumed programme sustain by PNEC, ANR-ECCO-ECODYN, IFREMER-MEDICIC and Regional programme)

(5) Five Recent Publications

Ferraton F., Harmelin-Vivien M., Mellon-Duval C., Souplet A., 2007. Spatio-temporal variation in diet may affect condition and abundance of juvenile European hake (*Merluccius merluccius*) in the Gulf of Lions (NW Mediterranean). Marine Ecology Progress Series, 337:197-208)

Ferraton F., Mellon-Duval C., Luisa Métral, · François Roupsard · Mireille Harmelin-Vivien, 2008. Evidence of nitrogen isotope fractionation variability in fish from field data: consequence on trophic level estimation (soumis février 2008 à Oecologia)

Courbin Nicolas, Fablet Ronan, Mellon Capucine, De Pontual Hélène, 2007. Are hake otolith macrostructures randomly deposited ? Insights from an unsupervised statistical and quantitative approach applied to Mediterranean hake otoliths. ICES J. Mar. Sci., September 2007; 64: 1191 - 1201

Harmelin-Vivien Mireille, Véronique Loizeau, Capucine Mellon, Beatriz Beker, Denise Arlhac, Xavier Bodiguel, Franck Ferraton, Xavier Philippon, Chantal Salen-Picard, 2007 Comparison of C and N stable isotope ratios between surface particulate organic matter and phytoplankton in the Gulf of Lions (NW Mediterranean). Continental Shelf Research (2008)

Bodiguel X., J. Tronczynski, V. Loizeau, C. Munschy, N. Guiot, A.M. Le Guellec, N. Olivier, F. Roupsard, C. Mellon. Classical and novel organohalogen compounds (PCBs and PBDEs) in hake (M. merluccius, L.) from Mediterranean and Atlantic coasts (France)" for publication in the Environmental Toxicology 2008 conference book.

Mellon-Duval C., H. de Pontual, L. Métral, 2008. Growth of European hake (*Merluccius merluccius)* in the Gulf of Lions based on conventional tags (to be submitted May 2008, ICES J. Mar. Sci.)

CURRICULUM VITAE OF Gwenaele PROUTIÈRE-MAULION

Maître de conférence, HDR **Age**: 38, **Sex**: Female

(1) Current Address and Professional Affiliation

Faculté de Droit et des Sciences Politiques
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Email: gproutièremaulion@hotmail.com

(2) Description of Research

My research focuses on the legal and juridic issues related to the world of the sea, with the aim of understanding the legal framework for the exploitation and the protection of the sea, with relevance for its uses as a way of navigation and communication, but also as a provider of multiple resources. This research consists of work on the integrated management of the marine resources, as well as on the safety and wellbeing of seamen.

(3) Professional Preparation

1994 **Doctorate in Law with Honorable Mention** entitled “La politique communautaire de réduction de l’effort de pêche des Etats membres, de la liberté de pêche au droit d’exploitation des ressources”, Faculté de Droit, Université de Nantes

1999 **Habilitation à diriger des recherches (HDR)**

(4) Academic Appointments

1999-2004 **Assistant Director**, Centre de droit maritime et océanique, Faculté de Droit, Université de Nantes

2004-Present **Director**, Centre de droit maritime et océanique, Faculté de Droit, Université de Nantes

(5) Research Activity and Publication History

Number of Books or Participation in Collective Volumes: **8**
Number of Publications in Reviewed Journals: **42**
Presenter at or Organizer of Conferences and Colloquiums: **16**
Research Contracts: **4**

(6) Five Recent Publications

G. Proutière-Maulion (2008) A paraître : Droits maritimes, sous la direction de Jean-Pierre Beurier, Dalloz Action 2008/2009. (*chapitres relatifs au droit communautaire et national des pêches et des cultures marines*).

G. Proutière-Maulion (2007) La dimension internationale de l’Union européenne, sous la direction d’Alain FENET, Litec, Objectif droit 2006 (*réalisation des chapitres relatifs à la politique commune des transports, politique agricole commune, politique commune des pêches et politique commune de l’environnement*).

G. Proutière-Maulion (2007) Quelle gouvernance pour la biodiversité marine au-delà des zones de juridiction, IDDRI, Idées pour le débat « Gouvernance mondiale », 5/2007, en collaboration avec J.P Beurier.

G. Proutière-Maulion (2006) Proposte e prospettive per una pesca sostinibile nel Mediterraneo, Centro siciliani per gli studi di diritto maritimo, pp 47-66.

G. Proutière-Maulion (2006) From Resources conservation to sustainability of fishing activity : assessment of two decades of the European Union’s Common Fisheries Policy ? *Ocean and coastal law journal, University of Maine School of law.*

CURRICULUM VITAE OF Yunne-Jai SHIN

Chargée de Recherche (CR1), IRD **Age**: 35, **Sex**: Female

(1) Current Address and Professional Affiliation

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Centre de Recherche Halieutique
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Web page: http://www.ur097.ird.fr/team/ CV-shin-2006-anglais.pdf

(2) Description of Research

My research currently focuses on ecosystem modelling, size-based theory, trophic ecology, and indicators analyses. I developed the multispecies fish model OSMOSE, allowing to produce a wide range of ecosystem indicators, and to simulate various multispecies and spatial fishing scenarios (e.g. instauration of Marine Protected Areas). Recent developments are being made for building an end-to-end model OSMOSE-NPZD-ROMS of the Benguela ecosystem. I am also involved in the international research on ecosystem indicators, and have been chairing several WG and Task Teams, such as the Eur-Oceans WG "EAF indicators: a comparative approach across ecosystems", the SCOR/IOC 119 task team on "Size-based indicators".

(3) Professional Preparation

Master degree and Engineer Diploma, 1995, ENSAR Rennes (Fisheries science)
Master Degree, 1996, University Paris 6-7 (Bio-Mathematics)
Ph.D., 2000, University Paris 6-7 (Bio-Mathematics)

(4) Professional Appointments

2001-2004 Chargé de Recherche (CR2), Institut de Recherche pour le Développement
2005-Present Chargé de Recherche (CR1), Institut de Recherche pour le Développement

(5) Publication History

Number of Publications in ISI Journals: 16
Number of Publications in Edited Volumes: 7
Number of Non-ISI Publications: 12

(6) Five Recent Publications

Shin Y.-J., Travers M., Maury O., 2008. Coupling models of low and high trophic levels: towards a pathways-oriented approach for end-to-end models. *Progress in Oceanography*. Accepted.

Cury P., Shin Y.-J., Planque B., Durant J.M., Fromentin J.M., Kramer-Schadt S., Stenseth N. Chr., Travers M., Grimm V., 2008. Ecosystem Oceanography for global change in fisheries. *Trends in Ecology and Evolution*. In press.

Travers M., Shin Y.-J., Jennings S., Cury P. 2007. Towards end-to-end models for investigating trophic controls and large changes induced by climate and fishing in marine ecosystems. *Progress in Oceanography*, 75: 751-770.

Shin Y.-J., M.-J. Rochet, S. Jennings, J. Field, H. Gislason, 2005. Using size-based indicators to evaluate the ecosystem effects of fishing. *ICES Journal of marine Science* 62(3): 394-396.

Shin Y.-J., P. Cury, 2004. Using an individual-based model of fish assemblages to study the response of size spectra to changes in fishing. *Canadian Journal of Fisheries and Aquatic Sciences*, 61: 414-431.

CURRICULUM VITAE OF Dawit YEMANE GHEBREHIWET

Marine Scientist I (MCM) **Age**: 32, **Sex**: Male

(1) Current Address and Professional Affiliation

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Cape Town, South Africa

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(2) Description of Research

Currently my research interest include different issues relevant for an ecosystem approach to fisheries ranging from computation of various indicators for tracking ecosystem change to exploration measures important for achieving objectives of ecosystem approach to fisheries (e.g. Marine Protected Areas MPAs). Specifically I will be looking at the response of ecosystems to the introduction of MPAs through comparative approach using two ecosystem models.

(3) Professional Preparation

2001 **B. Sc.**, University of Asmara, Eritrea (Marine Biology and Fisheries)
2007 **PhD.**, University of Cape Town, South Africa (Zoology)

(4) Professional Career

2008- **Marine Scientist I**, Marine and Coastal Management

(5) Research Activity and Publication History

Number of publications in ISI journals: 4 plus (1 accepted, +3 submitted)

(6) Recent Publications

Yemane, D., Griffiths, M. H. and J. G. Field 2005. Comparison of fish community size spectra based on length frequencies and mean lengths: A Note. Afr. J. Mar. Sci. 27 : 337 – 341.

Yemane, D., Field, J. G. and R. W. Leslie 2005. Exploring the effects of fishing on fish assemblages using Abundance Biomass Comparison (ABC) curves. ICES J. Mar. Sci. 62: 374 – 379.

Yemane, D., Field, J. G. and M. H. Griffiths 2004. Effects of fishing on the size and dominance structure of linefish of the Cape region, South Africa. In Ecosystem Approaches to Fisheries in the Southern Benguela. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. Mar. Sci. 26 : 161 – 177.

ANNEXE C. Implication des personnes dans d'autres contrats (cf. § 1.8.4)

Note: The person months indicated below only include time during the four years of this project.

partenaire	Nom* de la personne participant au projet	Personne. mois	Intitulé de l'appel à projets Source de financement Montant attribué	Titre du projet	Nom* du coordinateur	Date début - Date fin
N°1	Chaboud	8	ANR Blanc 150,000€	GAIUS	François Feral	2008-2011
N°1	Guillotreau	12	Western Indian Ocean Marine Sciences Foundation 90,000€	ECOTUN		2009-2010
N°1	Kaplan	9	ANR Jeun Chercheur (proposal)	Biophysical modeling to study marine population connectivity	Christophe Lett	2009-2011
N°1	Le Loc'h	8	ANR Jeun Chercheur 25 k€ (personal budget)	LAGUNEX	A. Darnaude	2008-2011
N°1	Le Loc'h	8	ANR Blanc 5 k€ (personal budget)	AMPHORE	Raymond Lae	2008-2011
N°1	Marsac	10	Banque Mondial 19 million €	South West Indian Ocean Fisheries Project	International	2008-2011
N°1	Marsac	5	EU-FP7	MADE	Laurent Dagorn	2008-2011
N°1	Shin	16	EU-FP7	MEECE	Icarus Allen	2008-2012

partenaire	Nom* de la personne participant au projet	Personne. mois	Intitulé de l'appel à projets Source de financement Montant attribué	Titre du projet	Nom* du coordinateur	Date début - Date fin
N°2	Jadaud	~12	SIH, IFREMER	SIH-EDERU		Renewed each year
N°2	Jadaud	~12	SIH, DCR (Data Collection Regulation)	SIH-DCR-Coordination Façade Méditerranée		Renewed each year
N°2	Jadaud	~12	SIH, DCR	SIH-DCR-MEDITS		Renewed each year
N°2	Mellon	8	ANR Contaminants, Ecosystème, Santé (CES)	COSTA	Jacek Tronczynski	2009-2012
N°2	Metral	8	ANR Contaminants, Ecosystème, Santé (CES)	COSTA	Jacek Tronczynski	2009-2012
N°2	Roos	3	EU-FP6 2,333,000€ (IFREMER 713,000€)	SARDONE	Enrico Arneri	2007-2009
N°2	Roos	~4	DCR	SIH-DCR-Coordination Façade Méditerranée		Renewed each year
N°2	Roos	2	Agence des AMP	PAMPA	Dominique Pelletier	2007-2009

partenaire	Nom* de la personne participant au projet	Personne. mois	Intitulé de l'appel à projets Source de financement Montant attribué	Titre du projet	Nom* du coordinateur	Date début - Date fin
N°3	Beurier	10	IRD / Agence Française de Développement 60,000€ (CDMO budget)	CRISP	Cécile Debitus	Ongoing

N°3	Proutière-Maulion	4	Région Pays de la Loire / IFREMER Nantes 16,000€ (CDMO budget)	GERRICHO	Pascal Jaouen	2007-2009
N°3	Proutière-Maulion	6	ANR (project in preparation)	TAMARIS		2009-2012

partenaire	Nom* de la personne participant au projet	Personne. mois	Intitulé de l'appel à projets Source de financement Montant attribué	Titre du projet	Nom* du coordinateur	Date début - Date fin
N°3	Beurier	10	IRD / Agence Française de Développement 60,000€ (CDMO budget)	CRISP	Cécile Debitus	Ongoing
N°3	Proutière-Maulion	4	Région Pays de la Loire / IFREMER Nantes 16,000€ (CDMO budget)	GERRICHO	Pascal Jaouen	2007-2009
N°3	Proutière-Maulion	6	ANR (project in preparation)	TAMARIS		2009-2012

ANNEXE D. Additional information regarding other relevant research projects

Below you will find a more detailed discussion of the relationship that other research projects and management efforts have with the research proposed in this project (see Section 1.4.1 for more information):

MADE

MADE is an EU funded project to examine ways to mitigate the negative effects of industrial fisheries in the Indian Ocean on by-catch species. In addition to collecting a wide variety of data on the behavior and life histories of target (e.g., tuna) and by-catch (e.g., sharks and turtles) species, the project will consider a number of mitigation methods, including the use of MPA.

Our project will both benefit from the data MADE will produce and contribute to the success of that project by exploring in much greater detail and from a variety of different modeling perspectives how MPA will affect Indian Ocean ecosystems and fisheries. We expect a particularly close working relationship between the two projects given that several individuals will be in both (e.g., Francis Marsac, Patrice Guillotreau, David Kaplan). Furthermore, we have asked the organizer of this project, Laurent Dagorn, to participate in the steering committee of AMPED.

AMPHORE

The project AMPHORE is an ANR funded study to define biological, ecological, economical and social indicators for the efficacy of marine reserves and to use these indicators to test MPA efficacy in five reserves in France, Mauritania and Senegal.

While this project will work exclusively with coastal and estuarine MPA, there are two important links between AMPHORE and this proposal. Though none of the MPA studied in AMPHORE are located in the Gulf of Lion, several are nearby, contain relatively similar species distributions and may serve as nursery grounds for some of the species to be studied in this project (e.g., hake). As such, we are very interested in their results on the effect of MPA on juveniles of these mobile species. Furthermore, AMPHORE proposes to simulate how these coastal MPA effect the species in them, including determining if MPA can effectively protect the nursery grounds of mobile species. As such, we expect to develop a strong working relationship with this project as it relates to mobile species and believe that our focused analysis of how protecting different life phases of these species affects their dynamics will be complimentary to their work. Furthermore, we have asked the director of AMPHORE, Raymond Lae, to participate in the steering committee of this project.

PAMPA

Through a series of workshops that will gather together MPA scientists and resource managers, this project aims at building consensus on the appropriate indicators of efficacy, methodologies for evaluation and governance approaches that are essential to all MPA implementation efforts.

We will follow the results of these workshops closely and, where appropriate, frame our results in terms of the indicators and methodologies developed in PAMPA. We have also invited the project leader, Dominique Pelletier, to participate in the steering committee of this project.

GAIUS

The goals of the ANR-funded project GAUIS are to develop good governance techniques for MPA and, in particular, to link MPA governance with appropriate indicators for ecosystem and MPA functioning. The approach will be based on an analysis of coastal MPA implementation efforts in the Mediterranean and in French DOM-TOM.

This project is a natural and necessary point of reference for the proposed work in AMPED on high seas governance and MPA. Christian Chaboud (IRD) will serve as a bridge between the two projects through his participation in both.

IOC project on MPA in the Indian Ocean

This is an effort to develop an integrated MPA plan for the countries active in the Indian Ocean Commission (IOC). The project includes the collection of spatial habitat data and the determination of priority sites for protecting, principally through reserve-selection algorithms such as MARXAN.

This work will serve as a basis for some of our spatial, model-based analyses and is naturally complementary to our efforts. We have invited a representative of the IOC, Dennis Etienne, to participate in the steering committee of AMPED.

OMPA

South Africa has embarked on a general protected areas expansion program. Shelf and deep-sea habitats have been identified as poorly represented in the existing network (Lombard et al. 2007). This neglect has spawned the Offshore Marine Protected Areas Programme (OMPA), led by the South African National Biodiversity Institute (SANBI). The OMPA project aims to identify a potential offshore MPA network that will contribute to a national representative network of protected areas for South Africa. This project focuses on gathering information on the spatial distribution of habitats and using systematic planning tools, such as MARXAN, to identify priority areas for protection.

This work will be very useful for and complimentary to the model-based population dynamics perspectives that will be the principal focus of the work proposed here. Furthermore, Colin Attwood is a participant in both project and will serve as the link between AMPED and OMPA.

CODYSSEY

Cod spatial dynamics and vertical movements in European waters and implications for fishery management (CODYSSET) was a 4-year EU-funded R&D project that involved nine European research institutions between 2002 and 2007. The principal aim of CODYSSEY was to improve the biological and ecological understanding of cod stocks in four ecosystems (the Barents Sea, the North Sea, the Baltic Sea and the Icelandic/ Faroe plateau) by combining individual-based behavioral data collected from electronic data storage tags (DSTs) with environmental data to understand the processes that underpin horizontal and vertical movements in different ecosystems. The project included a consideration of how spatial movement of individuals might affect the potential use of MPA as part of the management of cod.

Greenpeace world MPA map

This was a study funded by Greenpeace in 2006 to determine a MPA network for the world's open ocean based on a MARXAN analysis of habitat distribution and fishing activity. The map included 40% of the world's ocean in reserves. However, this estimation does not include the population dynamics of effected species.

This study serves as a starting point for the discussion of MPA in the open ocean, but we believe the population and ecosystem perspectives developed in AMPED will eventually prove far more effective than habitat-based approaches alone.

Port-Cros Declaration of 2007

This declaration promoting the development of a network of MPA for the Mediterranean establishes the urgency and timeliness of our project looking at the effectiveness of MPA for mobile species in the Gulf of Lion.

Agence des Aires Marines Protégées

This agency was recently established to facilitate the implementation and management of MPA in French territorial waters. As such, our efforts are extremely relevant to the agencies work and we hope to contribute to their goals.

ADDENDUM

Réponses aux Révisions

Ci-dessous vous trouverez nos réponses aux commentaires compris dans les révisions. Le texte original des révisions est présenté en rouge et nos réponses sont en noir.

Marquage de Poissons
« Toutefois, des points de méthodes restent à préciser. Pour le merlu il faudra clarifier comment deux positions (relâche et recapture) peuvent informer sur les migrations. Pour les thons, il faudra clarifier quel nombre de marquages est pertinent pour obtenir des données représentatives. »
Vous trouverez ci-attaché un document décrivant l'intérêt et l'utilité des travaux de marquage inclus dans le projet. En gros, les données de relâche-recapture de merlu restent très utiles dans le contexte d'AMP puisque une question déterminante pour les effets d'AMP dans le Golfe du Lion est si les individus gros reproductifs se déplacent entre les différents canyons du bord du plateau continental. Nous pouvons répondre à cette question avec un nombre limité de recaptures. En plus, l'étude présente des innovations méthodologiques intéressantes. Pour le thon rouge, il faut souligner que les données collectées seront complémentaires aux données existantes et nous donnerons une vision du comportement des thons rouges dans ce lieu d'alimentation essentiel pour l'espèce pendant une époque qui n'a pas été étudiée avant.

Intégration des Volets du Projet
« Enfin si toutes les tâches sont bien intégrées à travers la modélisation, celle sur la gouvernance devra être renforcée, en particulier en regard de proposition visant la modification de l'effort de pêche suite à l'institution d'une Aire Marine Protégée. En conséquence, l'activité de synthèse doit être élargie au delà de la partie modélisation pour inclure tous les volets du projet y compris la gouvernance. »
Nous sommes complètement d'accord qu'il faut une bonne intégration et synthèse de tous les volets du projet. En suivant les recommandations des réviseurs, nous avons déplacé la tâche 3.7 (« Comparisons among different modeling approaches ») au Work Package 5 (« Synthesis of Results and Ensuring Project Impact ») pour mettre l'accent sur l'importance d'une intégration de tous les éléments du projet. Nous avons inclus dans la nouvelle tâche 5.1 (« Comparison and synthesis across project Tasks and Work Packages ») de comparaisons additionnelles qui montrent la pertinence-mutuelle des différents travaux, incluant ces proposés dans le Work Package 4 sur le gouvernance.

Autres Modifications

En addition aux modifications en réponse directe aux commentaires des réviseurs, nous avons fait quelques autres modifications complémentaires au projet:

1) **Intégration de Sébastien Roussel dans le projet (8 mois de participation sur 4 ans)**.
M. Roussel est un économiste expert en gestion de ressources marines (voir CV attaché) qui va se charger, en collaboration avec D. Kaplan et C. Mellon, de l'intégration d'effets économiques dans les modèles biologiques de merlu dans le Golfe du Lion et en Afrique du Sud développés dans le Tâche 3.2. Au moment de soumettre le projet, M. Roussel était entre une position postdoctorale à l'Ifremer et sa position actuelle, maître de conférence à l'Université de Montpellier, et donc difficile d'inclure dans le projet. Nous avons inclus M. Roussel sur le budget de l'IRD pour simplicité (même s'il va travailler avec l'Ifremer et l'IRD). Nous avons ajouté au budget 2600€ pour des missions et 2000€ pour un ordinateur our M. Roussel. Etant donné l'importance de la contribution de M. Roussel au projet, nous croyons que ces additions mineures au budget sont justifiées.

2) **Échange entre doctorant en biologie et postdoc en économie**.
Nous avons échangé le doctorant en biologie initialement prévu pour O. Maury avec le postdoc en économie initialement prévu pour P. Guillotreau. Cette modification est due principalement à l'identification d'une très bonne candidate doctorale avec expertise en modélisation bioéconomique.

3) **Intégration de thèse sur le changement global dans l'Océan Indien avec des fonds externes au projet**.
Le travail de cet étudiant, dirigé par O. Maury, est très complémentaire au travaux du projet et représente un valeur ajouté considérable sans coûts pour l'ANR.

4) **Autres corrections mineures**. Plus de détails sur les autres modifications au projet, qui sont en général sans importance et de caractère correctionnel, sont disponibles sur demande.

CURRICULUM VITAE OF SEBASTIEN ROUSSEL

Assistant Professor (Maître de Conférences),
Université Montpellier 3 Paul Valéry (UM3)
Age: 28, **Sex**: Male

(1) Current Address and Professional Affiliation

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Appliquée (LAMETA), Université Montpellier 1 (UM1)
Faculté de Sciences Economiques
Avenue de la Mer – Site de Richter CS 79606
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Email: roussel@lameta.univ-montp1.fr
Web page:
http://www.lameta.univ-montp1.fr/spip/index.php?id_rubrique=45&lang=fr

(2) Description of Research

My research mainly focuses on Integrated Coastal Zone Management (ICZM) processes regarding coastal issues (urban pressure and planning, coastal risks management (coastal erosion, marine floods), marine areas) and governance progress. In particular, I do use economic modeling with regards to Common-Property Resource (CPR) use and property regimes as well as interdisciplinary approaches to construct sustainable development indicators (coconstruction processes with stakeholders, etc.). I am currently working on systems approach and systems dynamics modeling in collaboration with research fellows in ecology and physics to assess coastal issues and management practices in a sustainable manner with stakeholders.

(3) Professional Preparation

B.Sc., 1997-2001, Université Paris 2 Panthéon-Assas & Université Paris 1 Panthéon-Sorbonne (Economics)
M.Sc., 2002, Université Paris 1 Panthéon-Sorbonne (Environmental & Resource Economics)
Ph.D., 2007, Université Montpellier 1 (Economics)
Postdoctoral Research Fellow, 2007-2008, IFREMER

(4) Professional Appointments

2003-2005
2005-2007
2007-2008
2008-Present
Ph.D. Scholarship, Région Languedoc-Roussillon, Centre National de la Recherche Scientifique (CNRS)
Temporary Lecturer, Université Montpellier 1 (UM1) & Université Montpellier 3 Paul-Valéry (UM3)
Postdoctoral Research Fellow, IFREMER
Assistant Professor (Maître de Conférences), Université Montpellier 3 Paul-Valéry (UM3)

(5) Publication History

Number of Publications in ISI Journals: 2
Number of Publications in Edited Volumes: 1
Number of Non-ISI Publications: 3

(6) Five Recent Publications

Roussel S., Rey-Valette H., Hénichart L.-M. Pi Alperin M.-N. (2008), Perception des risques côtiers et Gestion Intégrée des Zones Côtières (GIZC), *La Houille Blanche, revue internationale de l'eau* (Forthcoming) .

Roussel S., Crinquant N., Bourdat E. (2007), In search of coastal zone sustainability by means of social carrying capacity indicators construction: lessons learned from the Thau lagoon case study (Région Languedoc-Roussillon, France). *International Journal of Sustainable Development* **10 (1/2)** : 175-194 .

Rey-Valette H., Damart S., Roussel S. (2007), A multicriteria participation based methodology for selecting sustainable development indicators: an incentive tool for concerted decision-making beyond the diagnosis framework. *International Journal of Sustainable Development* **10 (1/2)** : 122-138 .

Claudet J., Roussel S., Pelletier D., Rey-Valette H. (2006), Spatial management of inshore areas: Theory and practice, *Vie et Milieu / Life and Environment*, **56(4)**: 301-305.

Rey-Valette H., Carbonnel P., Roussel S., Richard A. (2006), L'apport de la Gestion Intégrée de la Zone Côtière (GIZC) à la gestion de l'érosion côtière : intérêt et exemple en Méditerranée française, *VertigO, la revue électronique en sciences de l'environnement* , **7(3)**.