Programme « Biodiversité » 2006

Appel à Projets

LETTRE d'INTENTION[1]

Formulaire de soumission

ANR- IFB

ECOKELP

[1] La lettre d'intention constitue une version simplifiée du projet futur, lequel pourra être présenté ultérieurement si cette déclaration d'intention est retenue à l'issue de la présélection.

I – FICHE D'IDENTITE DU PROJET

Champ thématique *(selon la classification de l'Appel à Projets reprenant les thèmes de la Stratégie Nationale de Recherche sur la Biodiversité)* **:**

☐ Caractériser et évaluer la biodiversité;
☑ Comprendre la dynamique de la biodiversité et prédire ses changements ;
☑ Evaluer l'impact écologique, économique et social des changements de biodiversité
☑ Développer des pratiques d'utilisation durable et de conservation des espèces et de leur habitat

Type de projet *(selon la classification de l'Appel à Projets) :*

☑ Recherche cognitive ☐ Recherche finalisée ☐ Plateformes expérimentales

Nature de l'activité *(selon la nomenclature européenne)* :

☑ Recherche fondamentale ; ☐ Recherche industrielle ; ☐ Développement préconcurrentiel

Titre du projet *(maximum 120 caractères)*

Dynamique de la biodiversité des forêts d'algues brunes des hémisphères nord et sud : aspects écologiques, sociaux et économiques

Project title

Dynamics of kelp forest biodiversity in northern and southern hemispheres: ecological, social and economics aspects

Acronyme ou titre court / Project acronym or short title (12 caractères)

ECOKELP

Coordinateur du projet (Partenaire 1) / Principal investigator (partner 1)

Mr, Mrs	Nom/ *Last name*	Prénom / *First name*	Laboratoire (nom complet et établissement de rattachement) *Laboratory and institution*	Type (établissement public, fondation, association, entreprise…) / *legal type*
Mrs	VALERO	Myriam	UMR 7144 « Adaptation & Diversité en Milieu Marin » (AD2M) CNRS-UPMC, Roscoff	EPST

Autres partenaires[2] (publics et privés) / Other partners

Mr, Mrs	Nom/ *Last name*	Prénom / *First name*	Laboratoire (nom complet et établissement de rattachement) *Laboratory and institution*	Nom du Directeur d'Unité / *Name of Director*	Type (établissement public, …) / *legal type*
Mr	POTIN	Philippe	UMR7139 « Végétaux Marins et Biomolécules », CNRS-UPMC, Roscoff	Catherine BOYEN	EPST
Mr	GEVAERT	François	« Equipe Phycologie et Production Primaire », FRE 2816, Station Marine de Wimereux CNRS –Université Lille 1 Wimereux	Jean Benoist DUBURCQ	EPST
Mr	ARZEL	Pierre	Laboratoire de Biologie Halieutique IFREMER Brest	Catherine TALIDEC	EPIC
Mrs	FRANGOUDES	Katia	CEDEM« Centre de Droit et d'Economie de la Mer » EA2221 IUEM-UBO « Institut Universitaire Européen de la Mer - Université de Bretagne Occidentale »,Brest	Annie CUDENNEC	EPST
Mr	SIORAT	François	Réserve naturelle des sept îles, LPO « Ligue de Protection des Oiseaux », Pleumer-Bodou	François SIORAT	Association

[2] Insérer autant de lignes que nécessaire

Mr	MAREC	Erick	CSNAM « Chambre Syndicale Nationale des Algues Marines » Brest	Erick MAREC (Président)	Syndicat professionnel
Mr	FAUGERON	Sylvain	CASEB « Centre for Advanced Study in Ecology and Biodiversity» PUC « Pontifica Universidad de Chile» Santiago, Chili	Juan CORREA	Université privée
Mrs	SERRAO	Ester	MAREE-« Marine Ecology and Evolution», CMAR - Centre of Marine Sciences, University of Algarve Faro, Portugal	Adelino CANARIO	Université publique

Disciplines associées

Biologie de la conservation, Droit, Economie des Ressources Naturelles et de l'Environnement, Ecologie chimique, Ecologie fonctionnelle, Ecophysiologie, Génétique et Biologie des Populations, Phylogéographie, Sciences Politiques
Conservation Biology, Law, Economy of Environment and Natural Resources, Chemical Ecology, Functional Ecology, Ecophysiology, Population Biology and Genetics, Phylogeography, Political Sciences

Résumé du projet [3]**(***maximum 1800 caractères)*
(objectifs, résultats attendus, méthodologie)

Les forêts sous-marines d'algues brunes jouent un rôle clé dans les milieux rocheux côtiers (habitat et production primaire). Ces espèces sont soumises à d'importantes nouvelles contraintes, physiques (changement climatique, El Niño) et anthropiques (introduction d'espèces et exploitation de la ressource) pouvant modifier de façon durable leur pérennité, leur distribution ainsi que la biodiversité des communautés associées. ECOKELP vise à caractériser la diversité des populations de ces espèces, à analyser leurs réponses à différentes pressions de sélection (naturelles et anthropiques) et à proposer des scénarios de fonctionnement et d'évolution dans leur habitat. Ce projet propose également d'analyser les moteurs économiques, la perception sociale et les politiques de gestion et de conservation de cette ressource. Deux régions homologues seront étudiées et comparées : les côtes nord chiliennes et européennes, en se focalisant sur quelques espèces emblématiques de Laminariales.
Quatre axes de recherche sont proposés : (1) une caractérisation de la biodiversité couplée à des analyses phylogéographiques; (2) une étude fonctionnelle de la diversité axée sur les interactions herbivores/macro-algues; (3) une analyse intégrative de la dynamique de la diversité via (i) une approche expérimentale écologique et physiologique en laboratoire et *in situ*, (ii) une étude de la diversité génétique en fonction de la position des populations dans l'aire de distribution et du type d'habitat et (iii) le développement d'un modèle théorique sur le devenir des populations soumises à différentes contraintes; (4) une analyse des processus économiques et sociaux qui contribuent à réduire ou renforcer la durabilité de ces systèmes au Chili et en France. Finalement, l'intégration des résultats issus des axes précédents se fera en partenariat avec des représentants des industriels et des gestionnaires de réserves naturelles impliqués dans ce projet. Ceci permettra de mettre en place une politique d'information, de gestion de la ressource et de conservation de la biodiversité associée.

Abstract [3] *(not exceed 1800 car.)*
(objectives, expected results, methodology)

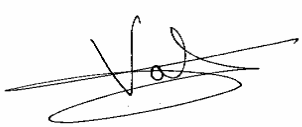
Kelp forests are important biota playing a key role in rocky shores (as habitat and producers) but are subject to important novel constraints of physical (climatic changes, El Niño) and anthropic (introduction of exotic species, resource exploitation, habitat degradation) origins that can modify durably their sustainability, their distribution and the biodiversity of associated species. ECOKELP aims to characterize population diversity of these species, to analyse their response to different natural and anthropic selective pressures and to propose a general scenario about their functioning and evolution. In addition, this project intends to assess economic drivers, social perceptions and policy agendas of management and conservation of this resource. Two homologous zones will be studied and compared: northern Chile and European Atlantic coasts focusing on few emblematic target species of Laminariales.
Four axes of investigation are proposed: (1) a biodiversity characterization and monitoring coupled with phylogeography analyses; (2) a functional study of biodiversity focused on macro-algae/grazers interactions; (3) an integrative analysis of diversity dynamics including (i) ecological and physiological experimental approaches in controlled conditions and in the field; (ii) a genetic diversity analysis according to habitat state and to population locations respective to their range distribution; (iii) a theoretical modelling on dispersal and expansion of populations under different constraints; (4) an analysis of economic and social processes that contribute to threaten or improve sustainability of these systems in Chile and in France. Finally the integration of results of the previous axes will be implemented in association with industrial partners and protected area managers in order to improve policies of communication and of sustainable practices of kelp forest management and conservation.

Mots-clés / ***Keywords*** **(5 maximum) :**

Diversité génétique / Interactions trophiques / Restauration et dynamique des populations/ Gestion des ressources et politique de réserves naturelles /Changement climatique et adaptation
Genetic diversity/ Food web/ Population restoration and dynamics / Resource management and protected area policy /Global change and adaptation

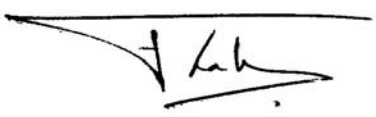
Je déclare exactes toutes les informations contenues dans ce document

Lu et approuvé, le 02 Mai 2006
signature du coordinateur de projet : Myriam Valero



Visa du directeur du laboratoire

François Lallier, Dir. UMR 7144
Le 02 Mai 2006



Nom , Prénom, date et signature

[3] A remplir **obligatoirement** dans les deux langues (français et anglais)

- **Nombre de personnes impliquées dans ce projet (en équivalent temps plein : ETP) :** ***Number of personnel involved in the project***

- Chercheurs et enseignants-chercheurs permanents :……3.6 ETP (20 personnes) *(Scientists with permanent position)*
- Post-doctorants déjà recrutés */ Postdoctoral fellows :*…… 1.6 ETP (3 personnes)
- Doctorants / *PhD Students* :…… 1.8 ETP (4 personnes)
- Ingénieurs et techniciens */ Technical personnel :*…… 2.4 ETP (11 personnes)

- **Durée du projet** / *Duration* :

☐ 1 an / *year* ☐ 2 ans / *years* ☐ 3 ans / *years* ☑ 4 ans / *years*

- **Montant total de l'aide demandée** / *Total cost requested* **(€)** (cf.page 9) :

765 000 €

- **Estimation (pour information) du coût complet du projet** / *Total cost of the project* **(€)** (cf.page 9):

1 635 000 €

- Une partie de ce projet a-t-elle été soumise à un autre appel de l'ANR / *Has this project been presented to another ANR call* ?

☐ oui ☑ non

- Avez-vous obtenu un cofinancement pour une partie de ce projet / *Did you receive a cofunding for this project* ?

  ☐ oui ☑ non

  Si oui, par qui, et date de versement / *If yes, who funded, when*? :

  Quel montant / *how much* ? **(€)** :

- Etes-vous en attente d'une réponse pour un cofinancement pour une partie de ce projet / *Are you watching for an answer, funding for this project* ?

  ☐ oui ☑ non

  Si oui, par qui et date prévue de versement / *If yes, who, when is it expected* ?:

  Quel montant / *how much* ? **(€)**:

- Le projet est-il labellisé ou a-t-il fait l'objet d'une demande de labellisation par un pôle de compétitivité ?

  ☑ oui ☐ non

  Si oui, quel(s) pôle(s) ?:

Demande en cours d'instruction au Pôle Mer-Bretagne

II – Présentation détaillée du projet / *Detailed description of the project*

A – Informations sur le coordinateur et les partenaires privés / *Principal investigator and private partners*

Acronyme ou titre court / ***Project acronym or short tite***: **ECOKELP**

A1. Partenaire 1 = Coordinateur du Projet / *Partner 1 = Principal investigator*

(Données à remplissage obligatoire)

Mr, Mrs	Nom / *Last name*	Prénom / *First name*
Mrs	VALERO	Myriam
Grade / Fonction	DR2 CNRS	
Mail	valero@sb-roscoff.fr	
Tél	0298292328	**Fax** 0298292336
Discipline		

Laboratoire public ou Entreprise / *Public laboratory or entreprise*
Pour les laboratoires, nom complet de l'unité, sigle, numéro d'unité et pour les UMR, liste des instances de tutelles la première étant l'instance principale, souligner l'établissement susceptible d'assurer la gestion du projet)
Equipe « Evolution et Génétique des populations » (EGPM), UMR « Adaptation et Diversité en Milieu Marin » AD2M, UMR CNRS/UPMC 7144
Adresse complète du laboratoire public ou de l'entreprise / *Adress*
Station Biologique de Roscoff Place Georges-Teissier, BP 74

Ville/ *City*	ROSCOFF	**Code postal / *Area code***	29682	**Région**	Bretagne

A2. Partenariats Public/Privé et Partenaires n'appartenant pas à la recherche /
Public/ Private Partnership and non research partners
(1 page maximum, Arial 11, interligne simple)

Nom du partenaire[4]/ *Name*	***Commentaires / Comments***
Partner 1: UMR 7144 ***EGPM team :*** Myriam Valero (DR2 25%) Christophe Destombe (MCF 25%) Frédérique Viard (CR1, 4%) Marie Voisin (PHD, 20%) Florence Tellier (PHD, 50%) Claire Daguin (IE, 10%) ***EB team(Ecologie Benthique)*** Dominique Davoult (Pr2 10%) Guy Levavasseur (CR1 10%) Pascal Riera (MCF 20%) Renaud Michel (T 20%)	**EGPM team:** Coordinator. Expertise in life history evolution, population genetics, and invasive biology. Will be responsible for 1) phylogeography analyses; 2) dynamics of genetic diversity according to habitat state and population location respective to range distribution **EB team:** expertise in functional ecology (food web analyses and primary productivity). Will be responsible for food web analyses using isotopic mass spectrometry and identification of key herbivores for each study kelp species, **Both teams** will be co-responsible of demography survey, population dynamics, in situ biodiversity survey and restoration following experimental removal of Brittany populations
Partner 2 : **CEDEM** Frédérique Alban (MCF 25%) Katia Frangoudes (PostDoc 33%) Olivier Curtil (MCF 30%)	Expertise in economics, law and political sciences applied to the analysis of public policies related to coastal resources and ecosystems. Will be responsible for 1) the analysis of economic drivers of anthropic pressures on kelp ecosystems 2) the analysis of perceptions and political that support institutional change.
Partner 3 :UMR7139 ***BDA team*** Philippe Potin (CR1 15%) Catherine Leblanc (CR1 20%) Ludovic Delage (IE, 20%) Audrey Cosse (PhD, 10%)	Expertise in molecular biology of brown seaweed including transcriptomic approaches of stress response Will be responsible for 1) study of defence reaction against herbivory using experimental and transcriptomic approaches; 2) development of putative non neutral markers to be used in population.
Partner 4 : IFREMER BREST Pierre Arzel (12.5%) Technician (2%)	Expertise in fisheries and algal resources assessment and management. Will be responsible for developing sustainable practices of resource management and conservation of kelp ecosystems
Partner 5 :FRE 2816, ***EPPP team*** François Gevaert (MCF 30%) Marie-Andrée Janquin (IE 2%)	Expertise in ecophysiology of brown algae Will be responsible for 1) analyses of kelp species photosynthetic performances by chlorophyll fluorescence measurements in the lab and in the field and pigment analysis, 2) controlled experiments of temperature and light tolerance optimum for the selected kelp species
Partner 6: LPO, Réserve naturelle des sept îles François Siorat (2%) Technicien (5%)	Expertise in management of a natural reserve Will be responsible for 1) testing acoustic methods for density estimation of kelp biomass, 2) spreading of the ECOKELP results to services mainly related to tourism Will participate to the development of policy recommendation for sustainability of Kelp forests and for promotion of marine protected areas
Partner 7 : CSNAM Erick Marec (2%) Jean Pierre L'Honneur (2%)	Cluster of industrials and SMEs exploiting seaweed resources in Brittany. Role in concerted management of resources Will be responsible for the spreading of the ECOKELP results to the stakeholders and fishermen living on kelp extraction Will participate to the development of policy for rational management of extraction and if necessary to the promotion of new practices in order to improve resources sustainability.
Subcontracting partner ***Partner 8 : CASEB, Chile*** Sylvain Faugeron (Pr 50%)	Expertise in experimental and theoretical community ecology of coastal ecosystems, conservation biology and policy for marine reserve establishment and marine protected areas Will be responsible for 1) in situ biodiversity survey and

[4] Insérer autant de lignes que nécessaire

Juan Correa (Pr 5%) Pablo Marquet (Pr 5%) Stephan Gelcich (Post Doc 75%) Juan Carlos Castilla (Pr 10%) Miriam Fernandez (Pr 10%) Monica Mendosa (T. 50%)	restoration following experimental harvesting in Chile 2) analyses of the impact of harvesting and climatic changes (El Niño) on genetic and demography of the Chilean kelp species, 3) development of theoretical model predicting consequences of human activities on population connectivity including theoretical predictions for demographic viability of networks of marine reserves.
Subcontracting partner ***Partner 9 : CCMAR, Portugal*** Ester Serrao (Pr 20%) Gareth Pearson (Pr 20%) Filipe Alberto (Post Doc 50%) Local PhD student (100%)	Expertise in reproductive ecology and adaptive evolution of abiotic stress tolerance of brown algae. Will be responsible for 1) demography survey and population dynamics of marginal populations in Portugal, 2) in situ biodiversity survey and restoration following experimental removal in Portugal, 3) studying changes in reproductive traits and stress tolerance in marginal populations.

B/ Description du projet / *Description of the project*

Acronyme ou titre court du projet / *Project acronym or short title:* **ECOKELP**

(maximum 5 pages, Arial 11, interligne simple)

- **Problématique et objectifs scientifiques poursuivis**

There is now ample scientific consensus that most natural ecosystems of the world are facing multiple and rapidly growing pressures as a direct or indirect result of the increasing human population and economic demands. Questions about how species are likely to respond to global environment change beg an understanding of what determines the limits of their geographic ranges (Gaston 2003). Ecologists have thus to study the processes which affect the distribution and the abundance of species on larger scales than those classically studied. This requires an integration of various fields such as population genetics, biogeography and community ecology (Avise 2000).

The goal of this proposal is to get a comprehensive picture of the processes acting on the evolution of kelp species, which are key species in coastal marine habitats. It aims not only at joining scientists from different fields of expertise around questions about maintenance of kelp forest biodiversity but also to bring together scientists with industrial partners and protected area managers. ECOKELP is mainly a basic research project that aims to better understand the biological processes affecting species distribution and diversity in the coastal environment and to assess the economic drivers, social perceptions and policy agendas that support on-going institutional changes. But ECOKELP, by involving together scientists and some stakeholders of kelp forests, is also addressing applied issues that shall end up with the development of guidelines for new policies for conservation and sustainable management of coastal marine resources.

ECOKELP will be mainly focused on themes 2 and 3 of the ANR-IFB Program. Firstly, we will characterize the genetic diversity of kelp forests and the associated biodiversity in central and marginal populations in order to understand the population dynamics, and to identify epiphytic plant and animal species specific to the target species. Secondly, experimental and functional approaches are proposed to understand the response of selected kelp species to natural and human-associated selective pressures. Thirdly, this project will provide predictive scenarios through computational ecology in order to investigate the likelihood of recolonization after perturbation. In addition, the project will investigate the social and economic impacts of the above demonstrated changes in kelp populations induced by humans and global change. Finally as an attempt of integration, the proposal will explore some aspect of axis 4 such as developing sustainable practices of management and conservation of kelp ecosystems.

- **Etat de l'art (présentation et analyse critique) et contribution scientifique originale de cette proposition**

Kelps, the giant brown algae, are a dominant feature of many temperate coastlines and are the main determinants of the community structure (Duggins *et al*. 1989). Kelps form ecosystems similar (in terms of complexity of the community structure and biodiversity) to terrestrial forests. Kelps are considered as bioengineer species, as it has been shown that removal of some key species within a kelp ecosystem, such as a top predator, can cause deep perturbations of the whole ecosystem, modifying community structure and eventually leading to kelp forest extinction (Estes et al 1989). Besides being a strong trophic link, major secondary producers and providing habitats to a wide range of organisms, they also are of commercial interest around the world either as exploited natural resources or cultivated resources (Critchley et al. 1998). However, in spite of their ecological and economic importance, the effects of human activities on kelp ecosystem diversity have not been taken into account by the resource management bodies responsible for the sustainability of this marine resource. In 1998, in the context of a UK Marine Species Area Conservation's Project, Birkett *et al.* point out the major gaps and requirements for further studies. In particular, they underlined "the absence of so much basic scientific information" on biological and ecological aspects of the kelp beds in Europe.

Over-exploitation of the natural resources has led to dramatic population declines and drastic measures taken by the government, such as harvest prohibition during long periods of time. The effects of these policies, however, seemed to have had only limited effects on the conservation of

the resources. On the other hand, there is a global effort to create networks of no-take areas that would contribute to the conservation of biodiversity. These marine reserves have been suggested as a means for overcoming shortfalls in current management techniques that would contribute to rebuild stocks (Gell & Roberts 2003). In addition to no-take areas, Chile has a unique expertise, due to the work of the partners involved in this project, to implement limited access areas allocated to communities having long-term artisanal fishing traditions and organisational skills (Fernandez & Castilla 2005). This has served to develop community-based management of each fishery and permitted the development of fisheries experiments, monitoring and adaptive local management, including participation by the resource users. Although ecological research may not be the most productive way to determine the limits of sustainability of any fishery, such limits cannot continue to be approached without better understanding of the ecosystems (Castilla 2000). Long-term experimentation in fisheries has to be done and in that context, there is a need for hypotheses testing. The social control of seaweed exploitation, primarily aiming at regulating distributive issues, has a long history on the coast of northern Brittany. More recently, sustainability of exploitation, including concerns about impacts on the ecosystem, became central on the agenda of the industry. The proposal to turn a large area at the western tip of northern Brittany into a national park (parc d'Iroise) has created tensions between the tenants of conservation and the various extractive uses (Boncoeur 2005). After more than ten years of unconclusive policy process, it seems that a new scene is building up, more consensual, and that should lead to a new framework under which sustainability concerns will be taken up. This makes the coming years a unique period to analyse how economic drivers, stakeholder perceptions and political process enables or inhibits the institutional innovation deemed to improve sustainability.

Anthropogenic activities can lead to phenomena of eutrophication and massive mortality rates of populations (Cederwall & Elmgren, 1990) or can progressively change population structures which, in turn, profoundly modify entire food chains (Radach *et al*., 1990). For example, the introduction of new species within a habitat may abruptly modify the interactions among species and the stability of the whole ecosystem (Levin and D'Antonio 1999). Human impact can also affect species distribution in different ways, leading to contrasting situations: expanding the range of a species distribution by introducing individuals in new sites or habitats or conversely, lead to a fragmentation or to a reduction of suitable habitats, which may result in a reduction of a species' range. Although several studies have analysed changes in kelp community structure associated with the reduction or extinction of local populations of some key species (Estes et al. 1989), none has yet investigated the direct influence of human intervention, such as seaweed harvesting on specific trophic links between seaweed and the associated fauna.

Recent studies suggest that kelps are particularly sensitive to increased temperatures (such as the conditions that accompany El Niño Southern-Oscillation (Martinez et al, 2003)) as well as excessive light exposure. Because they are assumed to live very close to their thermal tolerance limits (Doty, 1946), organisms inhabiting the rocky intertidal zone have emerged in recent years as potential harbingers of the effect of climate change on species distributional patterns in nature (Stillman, 2003). Most studies to date have focused only on geographic patterns of water temperature in setting the distribution of intertidal species (Southward et al., 1995; Broitman et al., 2001). Under such a model, climate change is predicted to cause poleward shift in the distribution patterns of species. Although this approach is appropriate for subtidal organisms, Helmuth et al. (2002) has shown an interaction between climate and the timing of low tide for intertidal organisms creating a mosaic of thermal environments. Light could also influence the vertical distribution of kelps in the subtidal and intertidal zones. These aspects will be explored in ECOKELP by comparing two different kelp ecosystem (subtidal vs intertidal).

Finally, the responses of the individual species will depend not only on their physiology but also on the physiology of the species with which they interact. All sessile plants, from benthic algae to terrestrial seed plants, are subject to attack by grazers. In terrestrial ecosystems it has been shown that changes in the plant chemical defence levels can govern the population dynamics of common herbivores and the function (e.g. nutrient dynamics) of entire ecosystems (Penuelas & Estiarte 1998). In contrast, while predation has been considered a major factor in driving the structure of natural communities and populations of marine algae, interactions with grazers have not been considered in terms of the importance of defence reactions for the understanding of the functioning of marine ecosystems.

Here, we propose an integrated approach of biology, ecology and social sciences in order to gain and organise knowledge valuable for kelp resource management and ecosystem conservation. The interaction between scientists, industrial partners and protected area managers within ECOKELP will offer the unique opportunity to propose practice ensuring an adequate balance among fishing or other human activity and preservation of marine ecosystems. In addition to the scientific complementary of the teams involved in the project, their geographical location in northern and southern hemispheres offers unique opportunities to evaluate the generality of our findings by contrasting two kelp ecosystems and their associated artisan fishermen community: one along the coast of Chile against a similar one in Europe,.

- **Méthodologie**

Seven different target species of Laminariales will be studied in ECOKELP. Four of these species, namely *Laminaria digitata* (*Ld*), *Laminaria hyperborea* (*Lh*), *Lessonia nigrescens* (*Len*) and *Lessonia trabeculata* (*Let*), are harvested. These two pairs of closely related species offer a unique opportunity to compare homologous kelp ecosystems for biological, social and economical purposes between North and South hemispheres. Indeed, in the overlapping part of their distribution range, these species (respectively *Ld/Lh* in Europe and *Len/Le*t in Chile) are usually found in the same area but at different depths (intertidal/low intertidal for *Ld* and *Len versus* subtidal habitats for *Lh* and *Let*). Moreover, they are harvested in Chile and in Brittany by artisan fishermen communities whose survival is strongly threatened by recent decrease in resource uptakes. Contrarily to the four previous Laminariales that are defined as cold temperate species, the other target species that have been chosen — *Saccorhiza polyschides* (*Sp*) and *Laminaria ochroleuca* (*Lo*) — are found in warmer seawater. In the context of global warming, they are then susceptible to out-compete *Ld* and *Lh* in the northern European coast and particularly in Brittany where they all occur in sympatry. The annual species *Sp* is potentially an important competitor due to its short life history traits in comparison with all other target species. In addition, the recent occurrence (since 1940) of *Lo* on the coast of Southern England may be indicative of a slow northward extension of warmer water. The last target species, *Undaria pinnatifida* (*Up*) is a non native introduced species and accidentally escaped from culture. It has been chosen to study the interaction between native and introduced species on kelp biodiversity dynamics.

Different sites in Chile, France and Portugal will be chosen for each of the species depending on the question addressed: some will be representative of different levels of human activities (protected versus non protected areas); habitat types (ports, estuaries versus rocky shores) and geographic locations respective to the range distribution of the target species (marginal versus central populations).

In order to characterize and monitor kelp-associated diversity, the composition and structure of main species associated to kelps will be surveyed. Two kinds of survey will be implemented in the first year: i) a visual survey consisting in recording the relative abundance of species appearing within marked quadrats, and ii) a destructive survey consisting of removing all individuals present within quadrats. Visual surveys will be carried out each year in the different selected sites. In addition, this temporal survey will be used to validate and calibrate acoustic methods for location of kelp beds and biomass estimation. In Europe, we will focus on comparisons of community structure at the central versus range limit distribution of kelp species. In Chile, temporal variability will be assessed in the northern part of country, where kelp ecosystems are under strong El Niño effects.

In order to understand the dynamics of kelp forest biodiversity ECOKELP will favour four complementary axes of research. Firstly, food web analyses based on stable isotope methods are proposed to compare trophic interactions in sites characterized by various levels of eutrophication and human-induced perturbations. Once the main putative kelp-associated grazers will be identified (first year of surveys analysis), macroalgae, other potential food sources and grazers will be analysed. Carbon and nitrogen isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) will be analysed with a Finnigan Delta S mass-spectrometer. Secondly, we propose to identify gene-regulated responses to grazing in kelp species. Subtractive libraries for grazing-responsive genes will be constructed to generate a database of ESTs specific of grazed and ungrazed conditions. RNA from both artificially-“grazed” and “grazed” individuals in laboratory and field samples will be used

to synthetise cDNA probes for micro-array hybridization. The validation of these micro-arrays will then be conducted using Real Time qPCR of selected genes. In parallel to ecological interactions approach, the degree of connectivity of populations is a central issue in predicting biodiversity dynamics. This is a central point in both native and exotic species. In this context, a combination of historical (phylogeography) and contemporary (assignment tests) approaches using the tools of population genetics are proposed to define the respective importance of factors susceptible to change the range distribution of species and in particular to test the hypothesis that species disperse more easily than they adapt to environmental changes. Finally the effect of introduced species on kelp biodiversity dynamics will be analysed: Previous results suggested that besides farms and ports, *Up* is also expanding on the rocky shores at the edge of the *Ld* populations. In this context, we still do not know what is the actual population dynamics and the origin of the new recruits observed in populations that are located near cultures. The fine-scale processes acting on the settlement of this species will be analysed using molecular tools by ascertaining the role of the cultures in providing propagules.

In order to evaluate ecological impacts of changes in biodiversity induced by humans and global change ECOKELP proposes to combine experimental and theoretical approaches. Firstly, experimental studies of changes in community structure and ecosystem resilience under different regimes of perturbation (harvested and exotic species) will be set-up using a similar protocol in Chile and Europe. The dynamics of recovery after experimental removal will be assessed by field surveys of the biodiversity of the areas used for the experimental regime of perturbation. These aspects will be investigated in Chile within the MEARB, in close collaboration with fishermen, in order to organize an experimental harvesting strategy that will have different intensities in different areas. In Brittany, experimental manipulation of the canopy removal will be compared to an ongoing project between partners 1 and 5 on the effect of harvesting techniques on *Lh* population demography and on diversity of the associated community. In addition, since the recovery of a population is known to rely strongly on several key life history traits, namely dispersal, reproductive success and mating system, we propose to investigate these aspects by a combined approach of population genetics and reproductive ecology. The objective is to identify the conditions that are limiting or favouring the recolonization process. Second, two kind of experimental studies of thermal responses of kelp species facing regional and global climatic changes will be proposed. (1) Using material originating from different populations throughout the distributional range, thermal responses will be tested in culture chambers maintained at a range of different temperatures by quantifying fitness of individuals at each pre-determined experimental temperature. (2) Physiological responses of target species to variation of light intensity and temperature will be measured in the field and in the laboratory under controlled conditions and compared throughout their European distributional ranges using a submersible pulse amplitude modulated fluorometer (Diving PAM, Walz, Effeltrich), which allows underwater measurements.

Finally, ECOKELP provides an opportunity to develop theoretical models and gather empirical information on the optimal design of networks of marine protected areas considering seaweeds with complex life cycles (e.g., kelp heteromorphic haplo-diploid cycles), which typically show several dispersive stages (male gametes and spores) of different dispersal potential. As a consequence, the consideration of more complex but more realistic models including a variety of life cycles and life history traits, and different spatial configurations of kelp communities with different harvesting pressures will allow the identification of the factors involved in the viability of different network configurations.

In order to evaluate the economic and social components of kelp forest sustainability, two complementary approaches will be developed in parallel. Despite this evident success, in Chile with the creation of MEARBs designed for self-management of artisanal fisheries or in Northern Brittany in France with MAB (Man and Biosphere) reserve, there are few attempts to evaluate the real benefits of such co-managed areas nor in the context of artisan fishermen communities in Chile (Gelcich et al. 2005) neither for marine reserves and parks in France (Boncoeur et al. 2005). The proposed work to be led by the social science component of the program in cooperation with natural sciences and with local stakeholders deals first with understanding the economic drivers of anthropic pressures on kelp forests The economic valuation framework developed by CEDEM (EMPAFISH program) will be adapted to describe the typical structure of the economic value of a kelp forest. As a second objective, focus will be put

on social determinants of institutional innovation towards sustainability. The scenes of setting management or conservation policies in relation to kelp forest will be surveyed in both Chile and France to analyze the social and political processes that have enabled or inhibited, partly or totally, innovative approaches.

Towards the end of the project, all partners will confront the outcomes of the various research components of the program to produce policy recommendations and integrated research prospectives. This will be done in the format of dedicated workshops involving participants beyond the strict partnership of this proposal. Integrated modeling, including ecological, social and economic dimensions, to support a scenario based approach is much demanded by agencies in charge of policy design. As for now, no operational tool is available for such modeling of coastal systems. By the end of the program, it is expected that major advancements will be made under the EU funded Integrated Project SPICOSA that will start in November 2006 under the scientific coordination of CEDEM. ECOKELP team will explore the possibility to develop integrated modeling as a continuation of this project.

- **Autres éléments de crédibilité**

All the equipments necessary for the feasibility of ECOKELP are available in the different institutions involved in the project. In addition, the exchanges between Chile and Europe will be facilitated by the existing "Associated International Laboratory" (LIA DIAMS) between members of the Station Biologique de Roscoff (France) and researchers at the Department of Ecology (PUCCh, Chile).

- **Références bibliographiques / *Bibliography***

Avise, J. C. (2000). *Phylogeography: the history and formation of species.* Cambridge, MA: Harvard University Press.

Birkett, D. A., Maggs, C. A., Dring, M. J., Boaden, P. J. S. and Seed, R. (1998). *Infralittoral reef biotopes with kelp species (volume VII).* pp. 174: Scottish Association of Marine Sciences (UK Marine SACs Project)

Boncoeur J. (Ed.) (2005) *Activités halieutiques et activités récréatives dans le cadre d'un espace à protéger : le cas du Parc National de la Mer d'Iroise*. UBO-CEDEM / Ifremer / UVSQ-C3ED. Rapport final, 516 p

Broitman, B. R., S. A. Navarrete, F. Smith & S. D. Gaines (2001) *Marine Ecology Progress Series* 224:21-34.

Castilla JC (2000). *J. Exp. Mar. Biol. Ecol.* 250:3-21

Cederwall H., Elmgren R., (1990). *Ambio,* 19: 109-112

Critchley, Ohno, Largo and Gillespie (1998) *Seaweed Resources of the World Published by JICA (Japanese International Cooperation Agency)* Critchley, Ohno, Largo and Gillespie (Eds).

Doty, M. S. (1946).. *Ecology* 27, 317-328.

Duggins, D.O., C.A. Simenstad, and J.A. Estes. (1989). *Science* 245: 170-173.

Estes, J.A., D.O. Duggins, and G. Rathbun. (1989).. *Conservation Biology* 3: 252-264.

Fernandez, M. and Castilla, J. C. (2005). *Conservation Biology* **19**, 1752-1762.

Gaston, K. J. (2003). *The structure and dynamics of geographic ranges.* Oxford, NewYork: Oxford University Press.

Gelcich, S., Edwards-Jones, G. and Kaiser, M. J. (2005). *Conservation Biology* **19**, 865-875.

Gell, F. R., and Roberts, C. M. (2003).. *Trends Ecol. Evol.* 18:448-455.

Helmuth, B., Harley, C. D. G., Halpin, P. M., O'Donnel, M., Hofmann, G. E. and Blanchette, C. A. (2002). *Science* 298, 1015-1017.

Martinez EA, Cardenas L, Pinto R (2003). *J. Phycol.* 39:504-508

Penuelas J. and Estiarte M. (1998). *Trends Ecol. Evol*, 13: 20-24

Radach G., Berg J., Hagmeier E., (1990). *Cont. Shelf Res*., 19: 305-328

Southward, A. J., Hawkins, S. J. and Burrows, M. T. (1995). *J. Therm. Biol.* 20, 127-155.

Stillman, J. H. (2003). *Science* 301, 65.

Vitousek, P. M., Mooney, H. A., Lubchenco, J. & Melillo, J. M. 1997. *Science* 277: 494-9.

C/ SAVOIR-FAIRE DES EQUIPES PARTICIPANTES ET DU RESPONSABLE

- **Publications récentes en rapport avec le sujet proposé**

Arnaud-Haond S, Teixeira S, Massa S, Billot C, Saenger P, Coupland G, Duarte CM, **Serrão EA** (2006). Genetic structure at range-edge: low diversity and high inbreeding in SE Asia mangrove (Avicennia marina) populations. Mol. Ecol. In press.

Arzel P. Huet J. & Pitel M. (2003). Etude de la Mécanisation de la récolte des fucales, Contrat Ifremer/Chambre Syndicale Nationale des Algues marines. Ifremer Brest, 52 p.

Alban, F., Le Floc'h, P. and Boncoeur, J. (2004). The impact of economic and regulatory factors on the relative profitability of fishing boats: A case study of the seaweed harvesting fleet of Northwest Brittany (France). *Aquatic Living Resources* **17**, 185-193.

Billot, C., Engel, C. R., Rousvoal, S., Kloareg, B. and **Valero, M.** (2003). Current patterns, habitat discontinuities and population genetic structure: the case of the kelp *Laminaria digitata* in the English Channel. MEPS, 253, 111-121.

Castilla J.C. & O. Defeo. (2005). Paradigm Shifts Needed for World Fisheries. Science 309: 1324.

Engel CR, **Destombe C, Valero M** (2004) Mating system and gene flow in the red seaweed Gracilaria gracilis: effect of haploid-diploid life history and intertidal rocky shore landscape on fine-scale genetic structure. Heredity 92, 289-298.

Faugeron, S. Andrade, R. Pinto & L. Contreras. (2006). Experimental transplants of the large kelp *Lessonia nigrescens* (Phaeophyceae) in high-energy wave exposed rocky intertidal habitats of northern Chile: experimental, restoration and management applications. JEMBE: in press.

Faugeron, S., Correa, J. A., Cardenas, L., Martinez, E. A., **Destombe, C.** and **Valero, M.** (2004) Reduced genetic diversity and increased population differentiation in peripheral and over-harvested populations of the marine seaweed Gigartina skottsbergii (Rhodophyta, Gigartinales) in southern Chile. J. Phycol. 40, 454-462.

Gevaert F, Creach A, **Davoult D**, Holl A-C, Seuront L & Lemoine Y (2002) Photoinhibition and seasonal photosynthetic performance of the seaweeds *Laminaria saccharina* during a simulated tidal cycle: chlorophyll fluorescence measurements and pigment analysis, Plant, Cell & Environment, 25: 859-872

Küpper FC, Gaquerel E, Boneberg EM, Morath S, Salaün J-P & **Potin P** (2006). Early events in the perception of lipopolysaccharides in the brown alga Laminaria digitata include an oxidative burst and activation of fatty acid oxidation cascades. J. Exp. Bot., sous presse.

Ladah L, Bermudez R, **Pearson G, Serrão E**. (2003). Fertilization success and recruitment of dioecious and hermaphroditic fucoid seaweeds with contrasting distributions near their southern limit. MEPS. 262: 173-183.

Laurand S., **Riera P**., (2006) Trophic ecology of the supralittoral rocky shore (Roscoff, France): a dual stable isotopes (d13C, d15N) and experimental approach. J. Sea Res., in press.

Navarrete, S.A., Wieters, E.A., Broitman, B., **Castilla, J.C**. (2005). Scales of benthic–pelagic coupling and the intensity of species interactions: From recruitment limitation to top-down control. PNAS-U.S.A.: 102: 18046-18051.

Rodrigues A. S. L., Andelman S. J., Bakarr M. I.,.Boitani L, Brooks T. M., Cowling R. M., Fishpool L.D. C., da Fonseca G. A. B., Gaston K. J., Hoffman M., Long J., **Marquet P. A.**, Pilgrim J. D., Pressey R. L., Schipper J., Sechrest W., Stuart S. N., Underhill L. G., Waller R. W., Watts M. E. J., and Yan X.. (2004) Effectiveness of the global protected area network in representing species diversity. Nature 428: 640-643.

Voisin, M., C. Engel, et **F. Viard** (2005). Differential shuffling of native genetic diversity across introduced regions in a brown alga: aquaculture vs. maritime traffic effects. PNAS-U.S.A. 102: 5432-5437.

- **Expériences passées ou en cours en rapport avec la déclaration d'intention soumise**

All the partners involved in ECOKELP have already demonstrated their expertise in the context of kelp ecology and seaweed resource management. Several of them (UMR 7144, UMR7139, CASEB) have been involved in European projects (EPIFIGHT, FP5-INCO-DEV2 2001-2005; NoE Marine Genomics Europe, MarBef) and in an IFB national project (with IFREMER and FRE2816 partners). At a regional scale, UMR 7144 is involved with IFREMER and CSNAM in the valuation of the impact of aquaculture and different practices of seaweed harvesting on brown algal resources and the associated intertidal and subtidal biodiversity (PRIR Talimoan, Contract CSNAM, project CAIN-up). CASEB and CEDEM will bring a multidisciplinary approach in social sciences combining their expertise in economy and legal aspects of the sustainable management of coastal ecosystems (Integrated project SPICOSA and EMPAFISH for CEDEM).

- **Autres éléments attestant des capacités qui seront mobilisées**

Four PHD projects have been submitted that are complementary to ECOKELP. Because many of the study species are subtidal, the project is involving both diving teams of the CASEB (Chile) and "service Mer and Observation" of the Station Biologique de Roscoff (FR 2424).

III –FICHE FINANCIERE RECAPITULATIVE[5]

(sur la durée totale du projet en K€)

Partenaires	Type[6]	Dépenses de Personnel / *wages*				Fonctionnement (prestations de service internes ; prestation de service externes ; frais : assistance, encadrement,…) K€ HT / *Current expenditure*	Investissements en équipement (équipement de R&D ; petits matériels ;consommables ; frais de mission…) K€ HT / *Investment*	Coût complet du projet / *Total cost*	Aide demandée à l'ANR / *request to ANR*
		Permanent		Non permanent					
		Cadre	Non cadre	Cadre	Non cadre				
Coordinateur UMR7144	EPST	281	24	79	186	**Sous contractants étrangers :** Partenaire 8 : 45 Partenaire 9 : 40 **Service internes :** Mer et Observation (FR 2424) : 60	Investissements :15 Consommables : 40 Missions :24	794	410
Partenaire 2 CEDEM	EPST	130		144			Investissement : 9 Missions : 15	298	114
Partenaire 3 UMR7139	EPST	132		88			Consommables :20 Mission : 5	245	105
Partenaire 4 IFREMER	EPIC	50			3		Consommables : 3 Missions : 7	63	10
Partenaire 5 FRE2816	EPST	88			70		Consommables :20 Missions : 20	198	110
Partenaire 6 LPO	Association	5	7				Consommables : 7 Missions : 3	22	10
Partenaire 7 CSNAM	Chambre Syndicale	9					Consommables : 4 Missions :2	15	6
TOTAL		**695**	**31**	**311**	**259**	**145**	**194**	**1635**	**765**

[55] Insérer autant de lignes que nécessaire

[6] Laboratoire public (hors EPIC dans projet partenarial), Fondation, Association, Très Petite Entreprise, Entreprise (hors TPE, EPIC dans projet partenarial)

IV/ EXPERTISE

Experts susceptibles d'évaluer cette proposition

Nom et Prénom	Discipline	Institution d'appartenance	Mail
Sandberg Audun	Sociology	University College of Bodoe, Norvège	Audun.sandberg@hibo.no
Gliddon Chris	Theoretical population genetics and conservation biology	University of Wales Bangor, UK	chrisg@bangor.ac.uk
Graham Michael H.	population dynamics of benthic macrophytes	Moss Landing Marine Laboratorie, USAs	mgraham@mlml.calstate.edu
Hawkins Stephen J	Rocky shore community ecology	Marine Biological Association of the UK, UK	sjha@mba.ac.uk
Olivieri Isabelle	Theoretical and experimental evolutionary biology	Université Montpellier 2	olivieri@isem.univ-montp2.f
Farmer Edward	Transcriptomics/plant -insects	Département de Biologie Moléculaire Végétale (DBMV), Université de Lausanne	Edward.Farmer@unil.ch

Le cas échéant, experts à qui l'évaluation de cette proposition ne doit pas être confiée) */ Name of experts you would not like to participate in the evaluation of the proposal*

(indiquer leurs noms et leurs appartenances, justifiez ces demandes)

Nom et prénom	Institution d'appartenance	Motif de refus

---

* * *

Cette lettre d'intention est à retourner par courrier électronique à

ifbanr2006@gis-ifb.org **avant le 4 mai 2006 et par voie postale en trois (3) exemplaires à l'IFB, cachet de la Poste 04/05/06 minuit faisant foi**

Institut Français de la Biodiversité (IFB)
Programme Biodiversité ANR 2006
57 rue Cuvier - CP 41
75231 Paris cedex 05
FRANCE