

Rapport d'avancement scientifique BIODIVERSITE EDITION 2006

1. Identification du projet

Acronyme du projet : **ECOKELP**

N° Projet : ANR 06 BDIV 012

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

Coordonnateur (rédacteur de ce rapport) : **VALERO Myriam**

Mail : valero@sb-roscoff.fr

Tel : **02 98 29 23 28**

Durée du projet : 3 ans

Date de début du projet : **1 janvier 2007**

Date de fin du projet : **31 décembre 2009**

Equipes Bénéficiaires : (celles de l'annexe technique, y compris pour des aides inférieures à 15 k€)

Equipe N°	Nom Prénom du responsable scientifique de l'équipe	Organisme et unité* d'appartenance	Code postal / Ville
1	Myriam Valero	CNRS-UPMC, UMR 7144	29680 / Roscoff
2	Katia Frangoudes	CEDEM-UBO, EA 2221	29200 / Brest
3	Philippe Potin	CNRS-UPMC, UMR 7139	29680 / Roscoff
4	Pierre Arzel	IFREMER, Centre de Brest	29840 / Plouzané
5	François Gevaert	CNRS-USTL, FRE 2816	62930 / Wimereux

Equipes Bénéficiaires sous-contractant :

Equipe N°	Nom Prénom du responsable scientifique de l'équipe	Organisme et unité* d'appartenance	Code postal / Ville
6	François Siorat (sous-contractant 3)	LPO - Réserve Naturelle des Sept Iles	22560 / Pleumeur Bodou
7	Erick Marec (sous-contractant 4)	DANISCO	29800 / Landerneau
8	Ester Serrao (sous-contractant 5)	CCMAR	8005-139 Faro / Portugal
9	Sylvain Faugeron (sous-contractant 2)	CASEB/PUCCh	Santiago / Chile
10	Laurent Lévêque (sous-contractant 1)	CNRS-UPMC, FR 2424	29680 / Roscoff

* pour les UMR citer toutes les tutelles

Table 1 Gant Table

	first year					second year					third year												
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
coordination between chilean, portuguese and french teams																							
Task 1: characterization and monitoring kelp associated biodiversity																							
Task 1.1. Kelp associated biodiversity																							
Visual survey and destructive sampling the first year in Chile (Len)																							
Visual survey and/or destructive sampling the first year in Brittany and Portugal (Ld, Lh, Sp, Up)																							
Identification of main putative grazer associated to kelp in the lab (Chile and Europe)																							
Sampling for food web analyses in Brittany and Portugal (see Task 2.1)																							
Sampling for food web analyses in Chile (see Task2.1)																							
Analyses of spatio-temporal surveys																							
Task 1.2. Acoustic methods																							
Validate and calibrate acoustic method of kelp beds and biomass estimation																							
Task 2: Dynamics of species interactions (grazers associated to kelp)																							
Task 2.1. Food web analyses																							
Analyses of european samples																							
Analyses of chilean samples																							
Complementary sampling and analyses																							
Task 2.2. Molecular and Chemical ecology of grazing																							
Construction and screening of libraries of grazing-reponse genes																							
Setting up of a collection of individuals being under differential grazing intensity																							
Hybridization and analyses of the collection of samples																							
Task 3: Physiological and ecological approaches																							
Task 3.1. Physiological studies																							
In situ measurements of photosynthetic and physiological response (Ld, Sp)																							
Pigment HPLC analysis (Ld, Sp, Up)																							
Ex situ measurements of response to light and temperature variation (Ld, Sp, Up)																							
Task 3.2. Experimental ecology																							
Dynamics of recovery after experimental removal in Chile and Europe (Len,Ld, Sp)																							
Thermal (and light?) response(s?) in culture chambers (Ld, Sp, Lh, Lo, Up, Len, Let)																							
Task 4: Dynamics of dispersal and colonisation																							
Task 4.1. Phylogeography (historical reconstruction of colonisation since the last glaciation event)																							
Population sampling representative of the species range distribution in Europe (Ld, Lh, Sp Lo)																							
Population sampling representative of the species range distribution in Chile (Len,Let)																							
Molecular analyses of european and chilean samples (mtDNA intergenic regions)																							
Phylogeography analyses of european and chilean species																							
Task 4.2. Settlement (contemporary analyses of the origin of the recruits)																							
Sampling of recruits in Chile (Len)																							
Sampling of recruits in Europe (Up, Ld, Sp)																							
Genotyping of european and chilean samples (microsatellites)																							
First analyses of temporal genetic variation and assignement of recruits																							
Task 4.3. Theoretical modelling of the effect of harvesting																							
Estimation of the different demographic parameters from field surveys (Task 1, Ld, Lh, Len)																							
Modélisation of the connectivity between populations under different perturbation gradients																							
First analyses of the effect of perturbation on metapopulation connectivity																							
Task 5: Evaluating the economic and social relevance of kelp biodiversity																							
Task 5.1. Economic drivers of anthropic pressure																							
Task 5.2. Social determinants of institutional innovation towards sustainability																							
Task 6: policy recommendations																							
Task 6.1. Formulate policy recommendation for sustainability of kelp forests																							
Task 6.2. Spreading ECOKELP results to stakeholders & fishermen																							

Table 2: ECOKELP list of deliverables

	Deliverables:	Date	Resp	Pers/ month
1	Identification of main herbivores associated to kelp	12 months	D. Davoult and J. Correa	10
2	Reports / communications to stakeholders and fisherman on biomass estimation of L.d. resources	12 months	P. Arzel et E. Marec	0.2
3	Collection of samples for phylogeography analyses,	18 months	M. Valero and S. Faugeron	6
4	EST library from grazed <i>Laminaria</i> and <i>Lessonia nigrescens</i>	18 months	P. Potin	15
5	Economic drivers of anthropic pressures on Kelps	18 months	F. Alban	15
6	First validation of acoustic method of biomass estimation	24 months	F. Siorat and L. Lévêque	5
7	Food web characterization in different environmental conditions	24 months	P. Riera	10
8	Social determinants of institutional innovation towards sustainability	24 months	K. Frangoudes	26
9	Reports / communications to stakeholders and fisherman on biomass estimation of L.d. resources	24 months	P. Arzel et E. Marec	0.2
10	Phylogeography analyses in Chile and in Europe	30 months	M. Valero et S. Faugeron	55
11	Ex-situ photosynthetic and physiological responses	30 months	F. Gevaert / G. Levavasseur	10
12	Thermal and light response in culture chambers	30 months	C. Destombe	30
13	Transcriptomic and chemical profiles of algal responses against grazers	36 months	C. Leblanc	25

14	First comparison between molecular ecology of response to herbivory and food web analyses	36 months	P. Riera and P. Potin	5
15	Photosynthetic and physiological responses in relation to global change	36 months	F. Gevaert and G. Pearson	30
16	Featuring recruitment patterns in selected target species of kelps	36 months	F. Viard and E. Serrao	60
17	Compilation of data of <i>in situ</i> surveys and experiments: identification of pitfalls and perspectives	36 months	J. Correa, P. Potin, E. Serrao and F. Viard	50
18	Kelp demographic parameters and theoretical model on metapopulation connectivity and resilience for complex life cycles	36 months	P. Marquet and M. Valero	50
19	Preliminary proposals for design of networks of marine reserves connected to restricted access areas for sustainable management (such as MEARB)	36 months	JC Castilla, K. Frangoudes and F. Viard	2
20	Social determinants of institutional innovation towards sustainability	36 months	K. Frangoudes	26
21	Reports / communications to stakeholders and fisherman on biomass estimation of L.d. resources	36 months	P. Arzel et E. Marec	0.2
22	Preliminary proposal for guidelines for new policies for conservation and sustainable management of marine resources	36 months	O. Curtil, P. Arzel, JC Castilla and M. Valero	2
23	Plans towards a complex predictive model of biodiversity changes combining ecological, sociological and economical factors	36 months	All partners	1

2. Résumé du projet

En français

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 l'importance écologique, sociale et économique de quelques espèces emblématiques de Laminariales. Deux régions homologues seront étudiées : les côtes nord chiliennes et européennes.

Cinq axes de recherche sont proposés : (1) une caractérisation de la biodiversité (identification des principaux herbivores et validation d'une technique d'estimation de la biomasse) ; (2) une étude fonctionnelle des interactions herbivores/macro-algues (réseaux trophiques et base biochimique de la réponse à l'herbivorie) ; (3) une approche expérimentale écologique et physiologique en laboratoire et *in situ* de la réponse à la température et à la lumière ; (4) une analyse de la dispersion et de la colonisation via une approche de génétique des populations à différentes échelles spatiales et via le développement d'un modèle théorique métapopulationnel tenant compte du cycle de vie complexe des laminaires ; (5) une analyse des processus économiques et sociaux qui contribuent à réduire ou renforcer la durabilité de ces systèmes au Chili et en France. La diffusion des résultats issus des axes précédents se fera en partenariat avec des représentants des industriels et des gestionnaires de réserves afin de sensibiliser les différents publics aux politiques de gestion de la ressource et de conservation de la biodiversité associée.

Abstract in English

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 and resource exploitation) origins that can modify durably their sustainability, their distribution and the biodiversity of associated species. ECOKELP aims to characterize the ecological significance, social perceptions and economic drivers of few emblematic target species of Laminariales. Two homologous zones will be studied: northern Chile and European Atlantic coasts.

Five axes of investigation are proposed: (1) a biodiversity characterization (identification of main herbivores and validation of a method of biomass estimation); (2) a functional study of biodiversity focused on macro-algae/grazers interactions (food web characterization and biochemical profiles of algal responses against grazers); (3) ecological and physiological experimental approaches of temperature and light responses in controlled conditions and in the field; (4) an analysis of dispersal and colonisation processes through a population genetics approach at different spatial scales and through metapopulation modelling taking into account the complex life cycle of kelps; (5) an analysis of economic and social processes that contribute to

threaten or improve sustainability of these systems in Chile and in France. The dissemination of results of the previous axes will be implemented in association with industrial partners and protected area managers in order to improve end-users perception of policies for sustainable practices of kelp forest management and conservation.

3. Etat d'avancement par semestre (à compléter sur le même document chaque semestre)

SEMESTRE 1 (1^{er} janvier 2007 - 30 juin 2007)

A - DESCRIPTION DES TRAVAUX EFFECTUES ET CONFORMITE DE L'AVANCEMENT AUX PREVISIONS, PRINCIPAUX FAITS MARQUANTS, DIFFICULTES RENCONTREES ET SOLUTIONS DE REMPLACEMENT ENVISAGEES

Objectif(s) prévu(s)¹/objectif(s) réalisé(s),

No deliverables was due for the first six months but the activity has begun for most tasks as described below task by task and as originally planned.

Ecart éventuel prévu-réalisé : expliciter les causes

In response to the decrease of budget that resulted in a decrease of the duration of the project (3 years instead of 4 years) all partners have agreed on the following Gantt table (see Table 1) and list of deliverable (see Table 2).

As compared to the first proposal, we kept the same list of species (7 as a total, namely, *Laminaria digitata* (Ld), *Sacchoriza polyschides* (Sp), *Undaria pinnatifida* (Up), *Laminaria ochroleuca* (Lo), *Laminaria hyperborea* (Lh), *Lessonia nigrescens* (Ln), *Lessonia trabeculata* (Lt)). However, not all the tasks or approaches will be carried out on every species (cf. Table 1)

Principaux faits marquants du semestre y compris les difficultés éventuelles rencontrées et actions envisagées/engagées pour les surmonter (1 page)

1. Financial and administrative problems: The project was supposed to begin the first of January while the money is still not arrived for the associated partners (Six months after the starting date).

2. Pierre Arzel, the person responsible of partner 4 had a very important health problem and was not able to begin any activity during the first 6 months. We will examine during the second semester if we can find a rapid solution to solve this problem.

3. The progress task by task is described below:

Task 1.1-Kelp associated biodiversity For the first year, we agree on a rapid assessment survey of main herbivores and macro-algae by visual and destructive surveys (Partners 1, 6, 8, 9, 10). In Europe, we decided to focus on 4 species and in two regions: 1) Brittany, sites next to Roscoff for Lh, Ld, Sp, Lo, and 2) Portugal: sites in Northern Portugal have been started for Lo, at Viana and Esposende. Two assessments per year have been planned (one in Spring/summer and the second in Autumn/Winter). During the first 6 months the first assessments have been made. Outputs of these surveys will be used to decide if it is possible to perform these protocols in more than one area (e.g. south Brittany, Molene, Portugal) during the second year of the project. Concerning the invasive species *U. pinnatifida*, the work was focused on an experimental eradication (in relation to task 4.2) carried out in two sites (Aber Wrac'h & StMalo): a rapid diversity assessment was done and all macro-benthos/algae were removed on a 1.5x1.5m area. This area will be surveyed for recruitment twice a year. Concerning the Chilean species Len, a detailed protocol for visual surveys and destructive in-situ experiments was already applied in previous study of the Chañaral area (Northern Chile) during five years. It was proposed by the Chilean team to study another region located in central Chile (Las Cruces) by starting destructive quadrats that will be compared to ongoing visual survey of biodiversity in the region co-funded by another project (FONDAP). During the first 6 month visual surveys were continued in Chañaral area. In Las Cruces, visual and destructive samplings are planned for the next six months

Task 1.2-Acoustic methods Two areas of 100mx100m have been selected (partners 1, 6, 10) to validate the use of acoustic methods for kelp mapping and kelp biomass estimation: one area in the Archipelago of "7 îles" and one in Morlaix Bay. The protocol has been set-up. For the validation, it will include both visual surveys and destructive quadrants through scuba-diving in both areas. This experiment will be conducted twice a year every year over the course of the project and has begun in spring 2007.

¹ Tel que figurant dans l'annexe technique de la décision ou convention d'aide

Task 2.1-Food web: We all agree to focus on most abundant algal species (in term of biomass) together with the main herbivores during the first meeting. A detailed protocol for sampling and preservation of samples for isotopic analyses will be provided by Pascal Riera (Partner 1) to partner 3. Three sites have been selected in Brittany (Ile de Batz, Ar-Pourven and Bas-Sablons) and work has begun during the first six months. We decided to delay the study of the other sites/species in Portugal, Chile and France after the analyses of the first results. This will be discussed during the first year ECOKELP meeting when the first results will be analysed.

Task 2.2-Molecular chemical ecology: This task that has already begun and several important preliminary results were obtained by partner 3: 1) during the measurement of the kinetic of the oxidative burst in *L. digitata*, we have shown that this response is systemic. It also corroborates with the activation of a marker gene of defence responses. It appears that a signal is transported at a speed of about 10-18 cm/h in both directions (acropetal and basipetal) of Ld blade. This is of special interest in the context of herbivory, as it may be also the case for a kind of wounding response to herbivore damage. 2) During an attempt to investigate potential markers of defence responses in kelps, partner 3 had also developed a protocol using chemical derivation and GC-MS analysis to measure volatile short-chain fatty acids (VFAs) which are produced by lipid peroxidation in the first minutes following the perception of an attack, by a pathogen or a grazer, simulated using elicitors. This has allowed measuring for the first time in kelps, the liberation of aldehydes in both seawater and air. These compounds are potential signals to warn-off kelps and activate transcriptional responses as well as potential toxic compounds for herbivores. To go further in the investigation kelp-herbivore interactions, Partner 3 needs to have preliminary results of food web analyses (in order to determine the main herbivores). Nevertheless, a good candidate to begin with is *Patina pellucida* (helcion). Thus, kelps heavily covered (or not covered at all) by *P. pellucida* was sampled by partners during the work done in task 1.1. and task 4.3 has already begun.

Task 3.1-In-situ and ex-situ physiological studies During the first six months, Partner 5 set up protocols to measure photosynthetic activity in-situ and ex-situ (new oxymetric systems for the laboratory, creation of a benthic chamber allowing measurement of oxygen emission during immersion) but also to specify adaptive mechanisms involved to face light stress (pigments involved in the xanthophylls cycle measured by HPLC, ascorbate and glutathione). Some preliminary measurements have been performed on *Laminaria digitata* (Ld), *Laminaria saccharina* (Ls) and *Undaria pinnatifida* (Up) from the north of France (Master thesis of G. Delebecq). For the next six months, we planed to use the same protocols on the five kelps (Ld, Lh, Lo, Sp and Up) from Brittany which are exposed to higher light levels. Until now, most of the in-situ measurements have been cancelled due to the very bad weather forecast in May and June 2007. Concerning ecophysiological responses to temperature, it is planned to discuss with Partner 1 and to see how to complete (or couple with) the approach of task 3.2 and to test if it is possible to work on gametophytes (sensitivity of methods). A PhD student should also work on these various aspects from the 1st of September 2007.

Task 3.2-Experimental ecology Concerning recovery after experimental removal, see task 1.1. Concerning thermal responses, the experimental design has been set by partners 1 and 9, during the first six month for the Chilean species *Lessonia nigrescens* (Len). The first results show that temperature has an effect on the sex ratio of this species (Master thesis of Valeria Oppliger). They also demonstrated that temperature has a great effect on the spores germination, gametophyte growth and fertility (PhD thesis of Florence Tellier). Moreover, responses seem to be different between populations. The objective is to develop the same protocol on the kelps studied in Europe during the second year of the project (PhD project of Valeria Oppliger). The approaches will be coupled with Partner 5 to choose the range of temperature and light conditions to use in our future experiments in european species.

Task 4.1-Phylogeography. The mitochondrial inter-genic spacers markers developed by Partner 1 in previous study (Engel et al., submitted) will be used for this approach. Most of the sampling has been done for the Chilean species Len (Florence Tellier PhD thesis), and for the European species Ld and Sp (Partners 1 and 9). For Let, Lh and Lo, their location in subtidal habitat will probably limit the availability of a relevant sampling for phylogeography but some of the sampling done in tasks 1 and 3 could be use for this prospect. In particular, Partner 8 was very interested in working on Lo (this is of special interest since several reports are showing that this species is moving northward) and this partner has started to develop the genetic tools as well (see Task 4.2). Moreover, a sampling effort has been made by partner 9 in order to get Let samples from several localities distributed along the Chilean coast. Analyses have already begun the first 6 months on Ld, Sp, Len and Let (Partners 1, 9).

Task 4.2-Fine-scale genetic structure and settlement: Study sites were selected for Ld, Sp and Up and the sampling is mainly done for the three species over a fine scale (i.e. within or among close bays) in Brittany (Partners 1 and 10). The same holds for Len in Chile, sampling of the recruits in newly colonized sites after the

Niño events has begun (Partner 9). Spatial sampling has been done for Up within two sites in spring 2007 in order to examine very fine-scale structure (to examine relatedness within a site). Microsatellite markers are developed for the four species. During the first six months, temporal analyses have started for the two annual species (Up, Sp) plus fine-scale structure analyses for Up in two bays, St-Malo and Aber Wrac'h, in Brittany (master thesis, Daphnée Grulois; PhD thesis Marie Voisin). An interesting point would be to carry out a similar approach (recruits analysis and temporal analyses) in Portuguese populations of Sp for comparison with Brittany populations of Sp. The question of the development of microsatellites for the study of Lo was discussed with the Portuguese team (Partner 8) during the first meeting. It was agreed to test the transferability of microsatellite (and mitochondrial markers) on Lo. Depending on the availability of molecular markers for Lo, Portuguese populations will be sampled by Partner 8 for this task during the end of spring, at the expected peak of recruitment appearance. The same is true for the Chilean species Len, microsatellite markers development is in progress (Partner 9).

Task 4.3-Theoretical modelling

The target species for the modelling approach is Len (Partners 9 and 1). For Ld and Sp, demographic parameters had been already gathered but will still be monitored through field surveys carried out every six months in one site (Morlaix Bay). For Lo, individuals have been tagged at two sites in Portugal (Viana and Esposende) in order to get demographic information. The possibility to get such estimates for Len has been discussed during the 6-months stay of Myriam Valero in Chile and a survey in two sites has been initiated. A post-doctoral position has been open to work on this aspect. The call and the selection of the applicant were closed in June but the retained candidate found a permanent job and consequently the procedure has to be done again. Partners 9 and 1 hope that they will find someone else rapidly in order to begin this task.

The question of recruitment and survival of gametophytes is still opened as experimentally difficult to carry out in the field. The use of artificial substrates is one possibility. This question will be addressed during the next annual meeting.

Task 5.1-Economic drivers of anthropic pressure This task aims at assessing the diversity of uses that translate in extractive and non extractive pressures on kelp ecosystem. The concepts of total economic value (VET), including use and non-use values, is applied to structure the analysis. The market/non market differentiation of uses is important. Monetary values associated to commercial uses provide important background information to explain the intensity and variability of related anthropic pressures. The investigation of non commercial (leisure) activities relies more on qualitative analysis although associated market based activities can be surveyed in some cases. In other cases, contingent valuation or indirect monetary valuation of non market activities could be applied. Regarding budget reduction and strong epistemological criticism of these approaches, it has been decided limit the research to a large qualitative assessment and quantitative assessment of market based uses only. During the first six months the diversity of uses, including conservation, has been assessed by bibliographical review and interviews. More than 30 interviews have been conducted. Sources for economic information have been identified. Interviews have also discussed the main concerns of stakeholders in terms of sustainability and uses conflicts. A first analysis of this material has been produced under the master thesis of A. Delay.

Task 5.2-Social determinants of institutional innovation towards sustainability: We agreed that an international approach should be favoured concerning the perception, setting management and conservation policies in relation to kelp forests. It was suggested to compare the following regions: Chile, Europe, Japan and Canada. This task is planned to start during the second semester.

Task 6-Policy recommendations We agree that one possible outcome (and objective) of Ecolkelp should be that kelps have to be recognized at an international level as a major habitat in conservation issues. Besides, several activities/actions have been listed to make the importance of kelp forests more evident in the society. This includes talks in schools, public conferences, the setting of a dedicated web-page or the organization of a one-day meeting with the different commercial or leisure users as well as non-users of kelp forests.

Actions de coordination du projet (séminaires, groupes de travail, réunions transversales, outils d'interface).

1. First Meeting in Roscoff the 19 of January 2007 between all partners in order to discuss and plan the activity for the first year.
2. Myriam Valero, the coordinator of the project as well as Christophe Destombe (partner 1) spent the first 6 month in Chile. This allowed to discuss and to plan the activity with partner 9 as well as to actively participate to several Tasks in the field and in the lab. This will allow homogenising the protocol among the labs.

3. Because most of the field activities have to be done using diving, several meetings between partners 1 and 10 were carried out in order to prepare field surveys and experiments. Besides, as fine scale sampling of *U. pinnatifida* planned by partner 1 was done using a differential GPS, Partner 10 (L. Levêque) trained Partner 1 (several team members) to use this equipment and show/provide the outputs (spatial data) through dedicated software.
4. Protocols for *in-situ* (which requires diving as well) and *ex-situ* ecophysiological measurements were also discussed between Partners 1 and 5.
5. Meetings between Partners 2 and 6 were also held in order to discuss the protocol and coordinate the experiments to be done to validate the acoustic method in the field.
6. Meeting June 2007 for the PhD advisory committee of Gautier Schaal between P. Potin and P. Riera (Partners 1 and 3).

Perspectives semestre suivant (poursuite des objectifs ou éventuelle réorientation proposée)

See the details that are given above in the same time than the activity report for each task

The date of the next meeting was decided: it will be organized in Roscoff during the third week of January (January 14-19th 2008).

B - DELIVRABLES ET RESULTATS OBTENUS

Résultats et livrables obtenus pour la période concernée et indiqués dans le tableau ci-dessus. Ces livrables doivent être déclinés par tâches et Workpackage ou sous-projets, avec pour chacun la contribution des équipes impliquées - 1 page max/sous-projets).

Délivrables obtenus sur le semestre écoulé	2007		2008		2009		Commentaires
	S1	S2	S1	S2	S1	S2	
First Meeting in Roscoff	19/01/07		15/01/08				

Publications soumises ou acceptées, brevets.

1. Masters reports

Delebecq, G. "Etude du comportement photosynthétique et des mécanismes adaptatifs de trois espèces de laminariales : *Laminaria digitata*, *Laminaria saccharina* et *Undaria pinnatifida*" Master 2 mention « Sciences de l'Univers, Environnement, Ecologie », Spécialité « Océanographie et Environnements Marins », Université Paris VI), soutenu le 19 Juin 2007. (sous la direction de François Gevaert, Partner 5, Task 3.1)

Dehay, A., Valeur économique totale et durabilité des écosystèmes à laminaires de Bretagne nord, mémoire de Master « Economie des Ressources Marines et de l'Environnement Littoral », soutenu le 25 juin 2007. (Partner 2 Task 5.1.)

Grunois, D. "Modalités de la dispersion et du recrutement chez l'algue introduite *Undaria pinnatifida* : microstructure spatiale et apparemment à l'échelle d'une population », Master 2 Spécialité « Biodiversité et Ecosystèmes Continentaux et Marins », Université des Sciences & Technologies de Lille 1 & Université du Littoral Côte d'Opale. soutenu le 18 juin 2007. (sous la direction de Frédérique Viard, et Marie Voisin (Partner 1) en collaboration avec Laurent Lévêque (Partner 10), Task 1.1 and Task 4.2)

Oppliger, V. "Parthénogenèse chez l'algue brune *Lessonia nigrescens* Bory sur les côtes du Chili" Master 2 « Sciences de l'Univers, Environnement et Ecologie » spécialité « Océanographie et Environnements Marins », Université Paris VI, soutenu le 20 Juin 2007 à Paris (sous la direction de Christophe DESTOMBE (Partner 1) et Juan CORREA (Partner 9), Task 3.2)

2. Congress Presentations

Tellier F, Meynard A, Correa JA, Vásquez J, Valero M, and Faugeton S. 2007. Filogeografía de *Lessonia nigrescens* y *Lessonia trabeculata* a lo largo de la costa chilena: un ejemplo del impacto de los cambios ambientales pasados y recientes sobre el patrón de diversidad genética. XXVII Congreso de Ciencias del Mar. 28 May – 1 June 2007. Iquique, Chile.

Voisin, M. & Viard, F. 2007. Populations of the introduced alga *Undaria pinnatifida* suffering different anthropogenic pressures display dissimilar genetic properties. 7th International Marine Bioinvasions Conference. Boston, USA, May 2007.

C – AUTRES COMMENTAIRES : Aspects non scientifiques

Le cas échéant, liste des CDD recrutés dans le cadre du projet :

Unité d'accueil	Nom	Prénom	Niveau de recrutement	Date de recrutement	Durée du contrat (en mois)
UMR 7144	Vasseur	Marie	AI	1 ^{er} Mars 2007	7 mois

Commentaires particuliers du coordonnateur

SEMESTRE 2 (1^{er} juillet 2007 – 31 décembre 2007)

Tableau des taches et des livrables du projet : Indiquez dans ce tableau, à la fin du semestre concerné, si les livrables prévus dans le barchart ont été réalisés, reportés ou réorientés. Merci de détailler les raisons dans le texte ci-dessous.

Délivrables obtenus sur 2ème semestre écoulé	2007		2008		2009		Commentaires
	S1	S2	S1	S2	S1	S2	
Results							
Task 1.1., Deliverable 1 : identification of main herbivores associated to kelp (Ld)		12/07					Accomplished, but will be completed next year in connexion with Task 3.2
Task 6.1., Deliverable 2 : Reports/ communications to stakeholders and fisherman on biomass estimation of Ld resources		12/07					Partially accomplished but delayed due to the decease of Pierre Arzel.
Publications							
Congress							
MGE Crete, Greece, F. Thomas (PhD student, Partner 3)		10/07					Results related to Task 2.2
EPC, Oviedo, Spain, F. Tellier (PhD student, Partners 1 and 9)		07/07					Results related to Task 4.1.
PPD, Poitiers, V. Oppliger (PhD student, Partner 1)		08/07					Results related to Task 3.2..
Coordination							
Meeting between the coordinator of the project and partner 4 in order to face the absence of Pierre Arzel		11/07					
First annual meeting among all partners except partner 8			01/08				
Meeting between partners 2 and 9			01/08				Task 5.1. to coordinate the socio-economical approaches between France and Chile;
Meeting between partners 1 and 5			01/08				Definition of a common protocol for Task 3.2
Meeting between partners 1, 3, 4, 9 and 10 (Partner 8 could not reach the meeting but the main conclusions will be transmitted and discussed with him via the coordinator of the project)			01/08				Task 1.1: to establish the list of species associated to kelp Task 2.1 to define the main potential grazers Task 3.2: to agree on a common protocol to follow recovery after experimental removal
Meeting between partners 1, 5 and 9			01/08				Task 3.1.: to plan the measurement in situ in the different sites
Outils							

A - DESCRIPTION DES TRAVAUX EFFECTUES ET CONFORMITE DE L'AVANCEMENT AUX PREVISIONS, PRINCIPAUX FAITS MARQUANTS, DIFFICULTES RENCONTREES ET SOLUTIONS DE REMPLACEMENT ENVISAGEES

Objectif(s) prévu(s)²/objectif(s) réalisé(s).

Except the tasks involving Partner 4, all the deliverables were accomplished in time. Due to the illness of our colleague Pierre Arzel (leader of Partner 4), who died just two days before our first year meeting, the progress of ECOKELP was delayed. Pierre Arzel was a very important person for the community of fisherman living on algal resources in Brittany and his responsibility in ECOKELP was to make the link between fishermen, industrials and scientists. The absence of Pierre Arzel firstly resulted in a strong delay in the activity of this partner but also in the activities that were developed in interaction by Partners 1, 2 and 7 (this include Tasks 1.1, 3.2, 5.1 and 6). During the one year meeting, we find a way to re-organize ourselves in order to face the emptiness due to the decease of Pierre Arzel. Martial Laurans was identified as the new leader of Partner 4 (IFREMER) and he has already started to work on all the tasks for which Partner 4 was involved. Another problem is emerging for the second year: our colleague, François Siorat (sub contracting partner: partner 6) has found a new position in January 2008. A new person will be hired to manage the "Réserve naturelle des sept îles" and we decided to get in contact with this new person as soon as possible to discuss the continuity of the work in which partner 6 is involved. This includes mainly Tasks 1.2. and 6. Some contacts have been already established with Partner 4 (IFREMER) that could help us for (1) the analysis of the acoustic method results and (2) collecting the data as a boat equipped with the relevant material is available in the IFREMER site in Brest.

We want also to mention, several important political events that occurred during the year 2007: first, the creation of the first Marine Protected Area in France near Brest "Parc Marin Mer d'Iroise", second, the building of the French National Agency of Marine Protected Area in Brest. In this context, kelp forests are classified as a remarkable habitat, and we are discussing how the expertise of Ecolkelp partnership could be involved to participate to biodiversity assessments.

The details of the progress are given task by task below in addition with the perspective for the second year. Two deliverables (deliverable 1: identification of main herbivores associated to kelp and deliverable 2: reports/communications to stakeholders and fisherman on biomass estimation of *Laminaria digitata* (Ld) resources) were due for the first year. They are detailed in Section B of this report.

Task 1.1-Kelp associated biodiversity

Deliverable 1 was due for this task at the end of the first year. The details are thus given in chapter B (deliverable 1).

Task 1.2-Acoustic methods:

No deliverable was due concerning this task for the first year. Two areas of 100mx100m have been selected in spring (partners 1, 6, 10) to validate the use of acoustic methods for kelp mapping and kelp biomass estimation: one area in the Archipelago of "7 îles" and one in Morlaix Bay. A protocol of validation by dive sampling has been set-up, and implemented in spring. 18 controlled points have been sampled (10 in "7 îles" and 8 in Bay of Morlaix). Total fresh weight has been recorded for each kelp beds species in 234 quadrants of 0.25 m². A preliminary analysis of results would show a correlation between kelp biomass and acoustic index. These results also allowed to establishing a correlation between biometric measures (e. g. total length) and fresh weight of *Laminaria hyperborea*. Such relationship is necessary for biomass estimation by non-destructive dive sampling. A new acoustic survey was planned in autumn, but could not be realised for practical reasons (bad meteorological conditions). However, another method to explore the correlation between kelp biomass and acoustic index, using stationary ground truth sampling, has been tested in August (partner 6). These data have still to be analysed.

This second year, two acoustic surveys were originally planned with François Siorat in the same sites to evaluate the extent of temporal variation. However, this needs now to be discussed with the new manager of the "Réserve des 7 îles".

Task 2.1-Food web:

No deliverable was due concerning this task for the first year. Sampling has been carried out in both Ile de Batz and Ar Pourven sites (two *Laminaria digitata* sites in contrasted ecological conditions). Three samples were carried out in each site during 2007. The isotopic analysis of samples from Ile de Batz is now accomplished, for a total of 350 animal samples and 109 sources samples. In addition, after a period dedicated to adapt the

² Tel que figurant dans l'annexe technique de la décision ou convention d'aide

protocols to algal material, biochemical characteristics of food sources (i.e. total organic matter, C/N ratio, lipids content, proteins content, bioavailable amino-acids content) were also partly determined during this first year.

The stable isotope analysis of Ar Pourven samples is planned for the second year (700 samples scheduled) to allow a comparison between the two sites. Preliminary results seem to indicate that, among putative grazers, *Helcion pellucidum* is the only one to base the totality of his diet on *Laminaria digitata*. This is the reason why we decided to use this species as the model grazer species for the European kelps (see Task 2.2).

This second year will also be devoted to biochemical assays in order to estimate the relative nutritive value of Ld with respect to other co-occurring algae. During the annual meeting we discussed the possibility to analyse samples from Chile, but this will not be possible during the next semester.

Task 2.2. Molecular and Chemical ecology of grazing

They were no deliverable due for the first year, but we introduced several new objectives which were not included in the proposal because we did not expect that the molecular tools we used in *Laminaria digitata* would be available during the first year of the project. Therefore, we are far beyond our initial previsions, because we are not only involved in technological developments, as the characterization of a dozen of defense-related gene markers is available, we now for the first time can test gene expression in Ld in response to grazing.

The three following results were obtained by partner 3 (1) The first major result is the proof that a systemic defense seems to occur in macrophytic marine algae. To our knowledge, this is the first evidence of an intra-plant communication leading to defense reactions in brown algae. This project will be further investigated during the PhD thesis of F. Thomas by testing the concept of systemic acquired resistance against herbivore. It has already involved the development of a bioassay using the main herbivore identified on Ld and other kelps such as Lh, Sp, Up and Lo, *Helcion pellucidum*. (2) Following the development during the first semester of a reliable protocol using chemical derivation and GC-MS analysis to measure volatile short-chain fatty acids (VFAs), we have now analysed lipid peroxidation in the first minutes following the perception of an attack, by a pathogen or a grazer, simulated using elicitors. (3) By comparing the oxidative burst and selected defense-gene expression in response to oligoguluronates, in laboratory cultures of Ldig sporophytes and plantlets from the field, A. Cosse (Partner 3 Post-Doc) has shown important differences. Sporophytes from natural populations display a more transient and less intense emission of hydrogen peroxide than cultivated plantlets. We have also discovered the validity of a new concept which is linked to both gene expression studies and distance signalling in kelps which involves waterborne signals.

For 2008, in addition with the completion of some experiments to finalize at least three manuscripts corresponding to the 3 main results for Task 2.2, we will continue our effort to study gene expression in response to herbivory. Ld thalli heavily covered (or not covered at all) by *H. pellucidum* was sampled by partner 3 during field work done in task 1.1. These samples will be analyzed in the coming weeks, measuring the expression of defense molecular markers by qPCR. We will also analyzed samples for grazing experiments established in laboratory conditions in order to establish the kinetics of gene regulation in response to grazing. In parallel, we will conduct PCR amplifications on a range of DNA samples from other kelps species (Lo, Sp, Lh, Len), using Ld specific primers, in order to evaluate the possibility to develop heterologous approaches. These results will help us to select the best strategy to adopt for obtaining similar molecular tools for Len. The current experiments on Ld described above in the perspectives for 2008 will probably delay a little bit the development of similar molecular tools for *Lessonia nigrescens*. So, the deliverable 4 (EST library from grazed *Laminaria* and *Lessonia nigrescens*) may be delayed or a few months, principally for Len. This deliverable is dependent of strategic choices which are discussed with our chilean colleagues.

Task 3.1-In-situ and ex-situ physiological studies.

The new benthic chamber, developed by Partner 5 has been used in June and November 2007 in the Northern France to measure photosynthetic activity of Ld *in-situ* by the oxygen emission during immersion. The results showed a very stronger activity of this kelp during the early summer than in November. Due to the very bad weather conditions, only one day of *in-situ* measurement of fluorescence and pigment analysis could have been performed during the second semester in Brittany (September 2007) on Lh, Ld and Sp (Partners 1 and 5). Nevertheless, some differences in the adaptive mechanisms have been observed for the annual species Sp in comparison with the two other ones. The new oxymetric system was also used in the laboratory in complement of the xanthophylls pigment analysis to specify adaptive mechanisms involved to face light stress. A meeting between Partner 5 and 1 was held in Roscoff in order to develop a common protocol and to test the sensibility of the method used to study the gametophyte responses to different light and temperature conditions.

In addition, to the measure of ecophysiological responses to temperature planned for 2008, a more accurate survey of photosynthetic activity will start again in 2008 (PhD thesis of G Delebecq that has started in September 2007, Partner 5).

Task 3.2 Experimental ecology :**Dynamics of kelp recovery.**

In northern Brittany, the dynamics of kelps recovery was studied for the different species in closer sites located in Bay of Morlaix (Partners 1 and 10). For *Laminaria digitata*, two sites: Duons and ArPourvern separated by less than 2 km. In each site, 5 to 10 quadrats of 0.5m x 0.5m were totally eradicated experimentally by hand and sampled in April and in September in order to follow and compare the dynamics of recolonisation between seasons. In addition, five other quadrats were also monitored (all individuals were measured) as a control. The size and presence of new recruits are recorded each 6 month after eradication in manipulated and control quadrats. The first results show that the frequency of *Saccarhiza polyschides* increases significantly after eradication of Ld. For the species *Laminaria hyperborea* and *Laminaria ochroleuca*, the size of the quadrat was bigger because the density of kelps was lower. In addition, we establish a free zone of about 1m around the destructive area to follow the recruitment. The difference in the methods used between species was discussed during the first annual meeting. A common protocol was adopted by the partners 1 and 4 in order to carry the same surveys on the same species in the new sites that will be study during the second year for Ld (South Brittany, Molène, Porspoder and Normandy).

In Portugal, two populations located at Viana and Esposende were studied by Partner 8. Inside the *Laminaria ochroleuca* bed, two quadrates (50x50 cm) were totally scraped and sampled. Four other similar areas were marked, where only the *Laminaria* plants were removed (i.e. destructive treatment). The cleared quadrates were revisited one and four months after the induced disturbance, and two were sampled each time, scraping all the community inside. On each visit two, non destructive, control quadrates were also sampled. In Esposende, the sampling was done inside a tide pool with adult *Laminaria* plants. The quadrate method was used to sample vertical sides of the pool. In this location, the same initial replicates were revisited, one and three months after. The recruits observed in the scraped areas were marked for monitoring their growth. Do to the small size of the population in Esposende we decided to focus more on the demographic study and the destructive study was limited to the follow up of recolonization inside the two scrapped quadrates in April.

Concerning the invasive species *U. pinnatifida*, and following the experimental eradication carried out in two sites (Aber Wrac'h & StMalo, Partners 1 and 10), a rapid assessment survey was carried out on late summer in the two sites. A very different picture was observed in the two areas surveyed in St-Malo, in the population located along the shore, no individuals (recruits or adults) of the targeted species were observed and the area was heavily colonized by the macro-alga *Codium* sp.. Conversely in the second area (offshore), several individuals of *U. pinnatifida* have re-colonized the area; this pattern was also observed in the second site in the Aber Wrac'h. For each sites and surveys, a list of the main macro-invertebrates and macro-alga species present was constituted (Master and PhD thesis of D. Grulois). Because these experiments/surveys were not initially planned for *U. pinnatifida* and because destructive sampling are difficult to carry out in this species because of its depth location, the interest to repeat this protocol (one destruction followed by one survey in late summer) will be discussed during the annual meeting

In Chile, two complementary approaches were developed on *Lessonia nigrescens* by Partner 9. The first was a local harvesting of 2 quadrats of approximately 3x3m in each of 2 sites. This harvesting consisted in eliminating all the individuals which holdfast was bigger than 1cm in diameter. The monitoring of these quadrants is ongoing every 6 months. The second approach consisted in the transplant experiment. These transplants produced a number of recruits. The increase of population density and change in population structure is being monitored every 6 months, although, we plan to do only one survey per year from now on as the population growth is relatively slow.

Thermal/light responses in culture chambers.

In addition to the first results obtained during the Master thesis of Valeria Oppliger (see 6month report, collaboration between partners 1 and 9), supplementary experiments on *Lessonia nigrescens* were conducted on spores liberated from blades collected in 7 populations of central and northern Chile, with 10 sampled individuals per site. Spores from each individual were separated into 5 treatments: at stable temperature of 10, 15 and 20°C, and at variable temperature, changing every 3 days between 10 and 15°C and between 15 and 20°C (PhD thesis of Florence Tellier, Partners 9 and 1). Results were affected by the bad conservation during transport between the field to the laboratory, and generally produced abnormally few sporophytes. However, a tendency of observing a higher number of sporophytes at stable temperature of 10°C and a variable temperature between 10 and 15°C, even for populations were temperature can rise up to 20°C during summer (i.e. Iquique in northern Chile), which motivated us to repeat the experiment between april and june 2008, improving the logistic aspect of transporting samples to the laboratory.

The experimental approach of light and thermal responses of the microscopic stage will be measured in the different european kelps (Ld, Lh, Sp and Lo) coming from different populations in controlled culture chambers in Roscoff in February 2008 in collaboration between partners 5 and 1 (PhD thesis of G. Delebecq and PhD thesis of V. Oppliger).

Task 4.1 Phylogeography.

This approach is developed using mitochondrial markers on four European kelps (Ld, Sp and Lh by partner 1; Lo by partner 8) and two Chilean species (Let and Len by partners 9 and 1).

For Ld and Sp the sampling is almost completed with more than 900 individuals sampled in about 30 sites distributed over the range distribution. Sequences of mt DNA spacer (rpl-rns) have been almost completed for Ld. In 2008, the sequencing will be completed for Sp during the Master thesis of Thomas Lamy (Partner 1). Next year, we will try to complete the sampling (deliverable 3) for Lh (partner 1) and for Lo (partner 8). However, data are more difficult to obtain for these species because they are subtidal and sampling needs to be done by diving. Consequently, deliverable 3 will be probably delayed for these two species. To facilitate the sampling of Lo, its abundance was estimated along the Portuguese coast (Fernando Lima pers. comm.).

In Chile, the phylogeographic analysis is almost done (PhD thesis of F. Tellier, Partners 9 and 1). Sampling was completed for Len, with 39 sites sampled between 17°S and 42°S, and 28-33 individuals per site. These samples were already analysed with ATP8s (mitochondrial marker). A sub-sample has been analyzed with Rubisco spacer (chloroplastic marker) and ITS1 (nuclear marker) in order to confirm the observed phylogeographic pattern and to discard the potential effect of selection on the mitochondrial marker. Results show clearly a deep genetic divergence between populations situated north and south of 30°S. This pattern is consistent with a number of other species that are currently being analysed in tight collaboration between the Chilean and the French groups and corresponds to the biogeographic transition that has been proposed recently between the Peruvian Province and the Intermediate Area. A manuscript is in final steps of preparation to report preliminary results, and a second is in preparation to analyse the possible effects of selection on the mitochondrial markers. For Len, results show so far that there is no hybridization between the northern and the southern clades. Microsatellite markers will be used during the next 6 months in order to test for the occurrence of contemporary gene flow between these 2 groups. For Let, 218 individuals from 14 sites between 14°S and 43°S are available for genetic analyses. Preliminary results based on ATP8s suggest that there is no genetic discontinuity at all around 30°S.

Task 4.2. Settlement and contemporary analyses of the origin of recruits.

Demographic survey of marked individuals were initiated for Ld/Sp in two sites in Bay of Morlaix, in two sites in Northern Brittany for the invasive kelp Up, and in seven sites for Len in Chile. This demographic monitoring allowed identifying recruits during the first year. Material have been sampled and preserved in silicat gel to be genotyped for assignment analyses. Genotyping of the European species by partner 1 (Ld, Sp and Up) has already begun (PhD of D. Grulois, and CDD of C. Ribout) and will be completed next year. Genotyping for the Chilean species is planned by Partner 9 for the second year since microsatellite markers are now available.

In addition, the demography of two sites in Portugal was studied for Lo by partner 8 even if it was not originally planned. Microsatellites are under development and the genotyping of recruits will depend on the progress of markers development.

Task 4.3 Demographic survey and theoretical modelling.

For Ld, in addition to the sites monitored by Partner 1 (see Task 4.2), demographic survey will be initiated by Partner 4, in two other sites, one of which being heavily harvested (Molène). In Chile, for Len, the seven sites monitored by Partner 9 (see Task 3.2) include stable, recently founded and 2 experimentally harvested populations.

Partners 1 and 9 have been unable to hire a post-doctoral fellow to work on the links between demographic and genetic data and on modelling the demographic dynamics of kelp populations under different harvesting pressures. However, field data of population structure and dynamics are being collected both for European and Chilean species (see above). In parallel to the specific objectives of this Task, a metapopulation model for haploid-diploid life cycles has been constructed based on demographic projection matrices in collaboration between Partners 1 and 9. This model shall be used, among other possibilities, to analyse the connectivity of populations under different perturbation regimes.

Task 5.1 Economic drivers of anthropogenic pressure

Based on data collected in Northern Brittany during the first semester, the analytical framework of commercial/non commercial uses, extractive/non extractive uses, use/non use value and productive/aesthetic/conservation functions typical of a kelp ecosystem has been formalized for a generic application by Partner 2. Effort and production data on kelp fishery have been updated and access to economic data from the Fisheries Information System (SIH) run by IFREMER has been secured. Due to the difficulty encountered due to the absence of Pierre Arzel, this was confirmed later than expected and their processing could not be finalized during the second semester. The kelp processing industry and the seaweed based high added-value sector have been further investigated. At this stage, financial information is very scarce in these two

sectors. The proposition by the Commercial Chamber for Seaweeds to conduct a complete review of the seaweed industry in Brittany in 2008 might provide more information on processing industry and spillover effects through ancillary activities. The economic assessment of leisure commercial and recreational non commercial activities remains one of the main challenges of this kind of evaluation. Potential complementary sources of information have been identified and the transfer methodology has been retained for some items. A search of international databases for transfer in economic evaluation has shown that very little information is available worldwide in this area. This should be further investigated by interviewing the ecologist community so that, eventually, value transfer methodology can be used for a monetary valuation of the population not subject to extractive use. The cost of conservation tools (expenses of the MAB reserve and expected expenditures of the marine park) is another possible proxy that will be investigated. It is expected that the deliverable of this task, initially due for month 18, will be delayed towards month 22.

In Chile, the standing stock, stakeholders' community and alternative uses have been assessed by Dr. Julio Vásquez (Universidad Católica del Norte) who is tightly collaborating with Partner 9 on ecological drivers of kelp populations. This information has been made available to the ECOKELP team, and discussions are on going in order to get Dr. Vásquez more formally involved with the project, in particular with Partner 2.

Task 5.2-Social determinants of institutional innovation towards sustainability

This task has been initiated during the second semester starting with a bibliographic review of the history of kelp fishery in Brittany and marine protection initiatives in the area. Interviews conducted during the first semester has provided information on the present state of access management and emerging tensions. Today two major issues arise on the policy agenda. One is the regulation of the extractive pressure on the shell and finfish stocks. The extractive complex made of commercial and recreational activities is very difficult to regulate. The generalisation of the licensing systems and territorial rights based on spatial rotation in Northern Brittany has been a major innovation during the past decade. Cases like the abalone fishery are emblematic of that process. The second issue is the conservation issue. For the past decades birds and sea mammals have been the focus for biodiversity conservation. That has led to many initiatives starting with MAB reserves till the long process (15 years) leading to the creation of a Marine Park (Mer d'Iroise) in 2007. The controversies associated with the creation of the marine park have completely interlinked the two issues of fisheries management and nature conservation. It has also raised the question of tourist pressure on wild life. More generally the two questions of freedom of access to the sea and of local social and economic development have been central to the public debate. That is the role of preserved, or even enhanced, natural and cultural assets as a tool either against or in support to local economic development and local population well-being. The new issue raised by the scientific community is the impact of climate change on the richness and eventually existence of kelp ecosystems. For the time being local stakeholder appear dubious about that risk and there is a need to construct discourses and provide evidence of it. But it is of great interest to investigate the type of public policy initiative that may lead to, including local initiative but also global initiatives in climate change / sustainability international flora. Based on a systematic analysis of the Northern Brittany model, an analytical framework will be produced to conduct survey on these issues in other countries in the world. Discussions with partners during the second annual meeting have concluded that cases should be looked for in the following countries: Chile, Norway, South Africa and Japan, to find similar condition of temperate or cold water kelp ecosystem with extractive pressure on the kelp. That will be realised during the two coming semesters.

Task 6: Policy recommendations

Task6.2 : spreading ECOKELP results to stake holders and fishermen

All the stakeholders, the seaweed industry and the fishing industry know that the project ECOKELP has started (see deliverable 2). Partner 4 (Ifremer, research institute) and Partner 7 (Danisco, industrial company) will organize in June 2008 a meeting in order to disseminate the ECOKELP first results. All the stakeholders, the seaweed industry and the fishing industry will be invited to the meeting on the kelp ecosystem status. For most of them, a large part of their activities depend of the availability of *Laminaria hyperborea* and *L. digitata* resources. In parallel, the importance of kelp ecosystem is taken into account by different activities:

- the local and regional fishing industry committees
- the delegates of the algal stakeholders
- the delegates of the "Agence des Aires Marines Protégées" (AAMP, the French agency for protected marine area).
- the fishermen.

B - DELIVRABLES ET RÉSULTATS OBTENUS

Résultats et livrables obtenus pour la période concernée (déclinés par tâches et Workpackage ou sous-projets), avec pour chacun la contribution des équipes impliquées - 1 page max/sous-projets)

Deliverable 1: Identification of main herbivores associated to kelp

This task can be now considered as achieved. The biodiversity results obtained for each site were compiled to establish a unique list of species associated to kelps.

The species diversity associated to kelps was studied in 7 different sites. 3 sites were dominated by *Laminaria digitata*, 1 by *Laminaria ochroleuca* and 3 by *Undaria pinnatifida* (Table 1). The total animal diversity was determined to the lowest possible taxonomic (generally specific) level. A total of 147 taxa was found, 136 of them being associated to *Laminaria digitata*, 50 to *Laminaria ochroleuca* and 30 to *Undaria pinnatifida*.

A bibliographic study was carried out to assess the trophic group of each species and identify the grazers in kelp associated communities. A total of 20 grazers was found, all sites confounded. The ratio “grazers specific diversity / total specific diversity” was remarkably constant (around 13%).

Table 1: Specific diversity found in different kelp sites.

Site	dominating kelp	specific diversity	filter-feeders	grazers	deposit-feeders	predators
Ar Pourven	<i>Laminaria digitata</i>	102	41	13	9	35
Duons	<i>Laminaria digitata</i>	44	20	6	1	17
Ile de Batz	<i>Laminaria digitata</i>	66	23	10	9	23
Ile Pigned	<i>Laminaria ochroleuca</i>	50	29	6	2	13
Aber Wrach	<i>Undaria pinnatifida</i>	18	2	2	2	12
Thermes	<i>Undaria pinnatifida</i>	12	5	1	0	6
Grande Conchée	<i>Undaria pinnatifida</i>	10	6	1	0	3

The food sources of these grazers is currently being studied (task 2.1: Food web) for *Laminaria digitata*-associated grazers. Preliminary results seem to indicate that, among putative grazers, *Helcion pellucidum* is the only one to base the totality of his diet on *Laminaria digitata*. Another gastropod grazer, *Gibbula cineraria*, is likely to display a seasonal feeding behaviour, including a consumption of *Laminaria digitata* during spring months.

For 2008, as more sites will be studied for destructive analyses (Task 3.2) species diversity associated to the kelps will be recorded and compared to the data described above. A total of 5 more sites will be studied for Ld: by Partner 8 in Portugal (two sites located at Viana and Esposende); by partner 4 in Northern Brittany (two sites located at Molène: an heavy exploited area and in Porspoder: an area that was surveyed since 10 years by Pierre Arzel) and by Partner 1 in Southern Brittany (Quiberon: the southern range limit of Ld),.

In Chile, according to the literature, 20-25 gastropod species and a number of crustacean species are generally reported as herbivores associated to Len. However, it seems that the main grazers of Len are the limpet *Scurria scurra* which lives permanently on the stipes, and the sea urchins *Loxechinus albus* and *Tetrapygus niger*. These species will be analysed with isotopic characterization in order to confirm the degree of specificity on Len.

Finally, during the first year meeting, we decided to increase our effort during 2008 to analyse herbivore fishes in order to determine if they feed on kelps (Ld, Lh, Lo, Sp and Len), by including several potential species into isotopic analyses.

Deliverable 2: Reports / communications to stakeholders and fishermen on biomass estimation of Ld resources.

This deliverable is due at the end of each year.

Monthly in two sites, Partner 4 performed 10 destructive 1mx1m quadrats of *Laminaria digita*. The two sites have been chosen in the main harvested area: Molène. In each quadrat, the total biomass and the total number of individual were recorded. This information was used to estimate a biomass index each month. A complementary sampling design was planned to be developed in coordination with Partners 1 and 10 within the Ecokelp project to improve the survey of *Laminaria digitata* population. Unfortunately, the disease of Pierre Arzel has generated some delay and this new sampling will be performed in 2008 (See tasks 3.2, 4.2 and 4.3).

All the information related to the management of harvesting was provided to the stakeholders and the fishermen, three times a year in 2007 during meetings.

1. The first meeting took place at the end of April 2007 in order to inform the stakeholders and the fishermen on the biomass state. This is important to adapt the quota for the first period of harvesting, from the 15 of May to the 30 of June.

- In July 2007, the second meeting was scheduled at the mid-time of the harvest season. At this date, the estimated biomass production was lower than the average calculated over the last years. The biomass index revealed a decrease of 35 % in comparison with the previous years (Figure 1). Consequently, the recommendation was to decrease the harvesting pressure on *Laminaria digitata* resource by reallocating some boats to the harvesting of *Himanthalia elongata* and *Laminaria hyperborea*.
- The last meeting was held in October 2007 in order to evaluate the outcome of the Ld production. The low production of the year 2007 was explained mainly by the weak CPUE (Catch Per Unit Effort) of the boat, that is the important decrease in the annual biomass index.

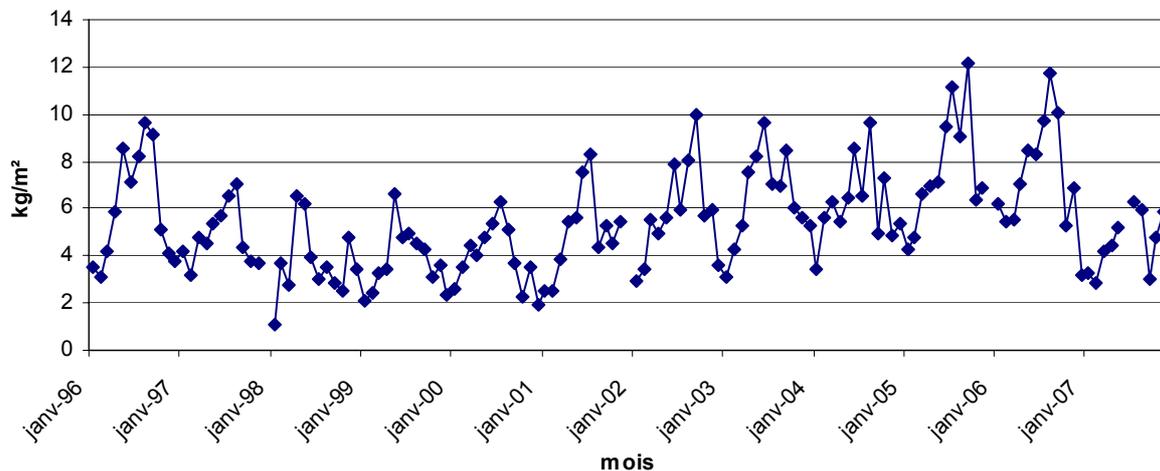


Figure 1 : Evolution of the *Laminaria digitata* biomass (kg/m²) month by month since 1996.

This publication list only reports for the last 6 month.

Publications soumises ou acceptées, brevets.

Task 2.2 : F. Küpper, E Gaquerel, F Adas, A F. Peters, D G. Müller, B. Kloareg², J-P. Salaün, P. Potin. Free fatty acids and methyl jasmonate trigger defense reactions in *Laminaria digitata*. *Seconde révision dans Plant cell Physiol. Design, experiments and writing conducted by partner 3, in collaboration for analysis fatty acids derivatives with a former team of UMR 7139 and some culture experiments conducted in Germany.*

Communications

Task 2.2: F.Thomas, C. Leblanc et P. Potin Systemic signalling in the brown algal kelp *Laminaria digitata*, Marine Genomics: An Ocean of Techniques, an MGE workshop for PhD students & post docs, Greece, October 8-11, 2007, Affiche.

Task 4.1: S. Faugeron. 2007. Filogeografia dos kelps da região subantártica. 58° Congresso Nacional de Botanica, Sao Paulo, Brazil. 28 October-2 November 2007. Plenary lecture.

Task 4.1: S Faugeron, M Valero, S Navarrete, JC Castilla, M Fernandez, F Viard, J Correa, P Haye, E Poulin, L Cárdenas, F Tellier, A Brante, G Peralta, A Varela. 2007 Patrones filogeográficos concordantes en diversas especies apoyan un origen antiguo de la zona de transición biogeográfica marina a 30°S. 50° Reunion Anual Sociedad Biología de Chile, 21-24 November 2007, Pucon.

Task 4.1: E. Macaya, J. Plana, G.C. Zuccarello, A. Mansilla, S. Faugeron 2007. Phylogeography of the giant kelp *Macrocystis* (Phaeophyceae) from Chile and New Zealand using a mitochondrial marker. New Zealand Marine Sciences Society Conference, 29th - 31st August 2007, University of Waikato, Hamilton, Nueva Zelanda

Spreading

Les algues brunes sont-elles en danger? Article présentant le projet d'ECOKELP, rédigé par Emilie Haentjens, Sciences et Vie, Septembre 2007 : 116-121.

C – AUTRES COMMENTAIRES : Aspects non scientifiques

Le cas échéant, liste des CDD recrutés dans le cadre du projet :

Unité d'accueil	Nom	Prénom	Niveau	Date de recrutement	Durée du contrat (en mois)
UMR 7144	Vasseur	Marie	AI	01/03/2007	7 mois

UMR 7139	Cosse	Audrey	IE	01/07/2007	7 mois
EA 2221	Frangoudes	Katia	CR	01/07/2007	3 mois
UMR 7144	Perez	Cécile	AI	15/09/2007	3 mois
UMR 8187	Delebecq	Gaspard	AI	01/09/2007	27 mois

Etat annuel et indicatif des dépenses (La production de ce tableau est demandée à l'issue de chaque année de réalisation du projet et non à chaque semestre afin de mettre en cohérence l'avancement des travaux et des dépenses)

Les partenaires de statut privé devront également fournir annuellement, à l'unité support de leur programme, une synthèse de leurs dépenses selon le modèle ci-dessous.

PROJET ANR-06-BDIV-012	EQUIPEMENT	FONCTIONNEMENT				TOTAL
		PERSONNEL		AUTRES DEPENSES	PRESTATIONS	
		Personnel	Déplacements	DE FONCTIONNEMENT	DE SERVICE	
ANR-06-BDIV-012-01	1 225	20 176	2067	gestions de contrat 2 944 6 785	SC1 : 7 655 SC2* : 10 491 SC3* : 2 163	40 852
ANR-06-BDIV-012-02	0	25 844	2682	0	0	28 526
ANR-06-BDIV-012-03	0	13 625	0	gestions de contrat 1 328	SC5 : 8 786 SC4* : 1125	23 739
ANR-06-BDIV-012-04	0	496	0	gestions de contrat 25 119	0	640
ANR-06-BDIV-012-05	0	7 528	513	62	0	8 103
	1 225	67 669	5262	11 263	16 441	101 860

SC1 : sous contractant 1 : CNRS UPMC FR2424 Service Mer Roscoff

SC2 : sous contractant 2 : CASEB / PUCCh Chili

SC3 : sous contractant 3 : LPO / Réserve Naturelle des 7 îles

SC4 : sous contractant 4 : Danisco

SC5 : sous contractant 5 : CCMAR Portugal

Les montants indiqués par une asterix dans le tableau correspondent aux montants initialement prévus pour reversement aux différents prestataires de service pour 2007. Ces montants, n'ont pas été prélevés car les factures ne sont pas arrivées avant la cloture du budget 2007, ils le seront en 2008. C'est pour cette raison qu'ils n'entrent pas dans le calcul des dépenses 2007.

Commentaires particuliers du coordonnateur

Pour le partenaire 1 :

Le montant demandé au titre de l'équipement soit 7000 € a été dépensé comme prévu dès la première année pour l'acquisition du PAM nécessaire aux mesures de fluorescence dès le début du programme. Comme seulement 1225€ nous a été alloué pour cet équipement la première année, nous avons été obligé d'avancer la somme complémentaire nécessaire pour l'achat de ce matériel, à l'aide d'autres crédits. Aussi, nous demandons que la somme restante à verser en équipement soit 4900€ (2100€ pour la 2^{ème} année, 2100 pour la 3^{ème} année et 700 pour solde 10%) soit à justifier dans la rubrique fonctionnement et non plus équipement.

Pour le partenaire 5 :

Remontée de crédits de fonctionnement en salaire (58380 € au lieu des 43253 € initialement alloués au salaire) pour pouvoir engager G. Delebecq sur une durée de 28 mois à partir du 1er septembre 2007.

Cette année, aucune dépense n'a été effectuée sur les crédits mis en place au titre des pôles de compétitivité.

Pour le partenaire 5 :

Une demande de remontée de crédits de fonctionnement en salaire (soit 58380 € en salaire au lieu des 43253 € initialement prévu) est demandée pour pouvoir engager Gaspard. Delebecq sur une durée de 28 mois à partir du 1er septembre 2007.

SEMESTRE 3

Idem

ATTENTION : Lors du compte-rendu de l'avant dernier semestre du projet, Merci de préciser également les actions envisagées pour la valorisation du projet.