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CRISP
Coral Reef InitiativeS for the Pacific
Initiatives Corail pour le Pacifique

Building on the results of six years of research, collaboration and education



Conservation, management, and development of coral reefs in the Pacific

AGENCE FRANÇAISE DE DÉVELOPPEMENT

Author: Catherine Gabrié

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C. GABRIE

In collaboration with:
M. DUFLOS, C. DUPRE, A. CHENET

Under the coordination of:
Eric CLUA, Project Coordinator

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Foreword

The goal of the Coral Reef InitiativeS for the Pacific (CRISP), sponsored by France and prepared by the Agence Française de Développement (French Development Agency–AFD) as part of an inter-ministerial project that began in 2002, was to develop a vision for the future of these unique ecosystems and the communities that depend on them. CRISP's aim was to identify and implement strategies and projects designed to preserve coral reef biodiversity and to develop the economic and environmental services that they provide both locally and globally.

CRISP was designed as a vector of integration between Pacific countries and the French Pacific territories. From its implementation in 2005, this ambitious programme had the support of two regional organisations, i.e. the Secretariat of the Pacific Community (SPC) and the Secretariat of the Pacific Regional Environment Programme (SPREP), which played key roles in getting Pacific countries and communities involved in the success of the initiative.

After six years of work, the time has come for a final review. That is the main reason behind this report about building on its results, a report which is both descriptive and forward-looking and whose goal is to present the main outcomes that should serve as the basis for the development of Pacific Island peoples and the conservation of natural resources in the Pacific, particularly coral reefs and the surrounding environments.

CRISP, whose funding from the AFD and French Global Environment Facility (FGEF or FFEM) amounted to 5 million and 2 million euros respectively, had a very significant spill-over effect by mobilising additional resources from a large number of donors. In that way, it allowed funding for about 80 projects in 17 countries in the Pacific and the involvement of about 40 partners, for a global sum of about 15 million euros.

This report covers an impressive number of examples of very concrete outcomes in the field, from the establishment of some 50 marine protected areas in 11 countries covering a surface area of more than 400,000 sq km, to the development of sectors using fish and crustacean postlarvae to make the profitable aquarium trade market sustainable. It also provided training for hundreds of technicians, students and doctoral candidates along with the dissemination of technical, scientific, economic and legal information on coral reefs, particularly through the CRISP website (www.crisponline.net). The report also presents the progress made in terms of assessing the economic value of reef resources and increasing scientific knowledge about these rich and complex environments. More than 200 technical reports are now available to cover all this progress.

But above and beyond this overview, what we really want to take from this initiative is the unexpected partnerships that have continued since CRISP came to an end and which are also valuable an assets. We are referring to the wide range of collaborative efforts between local and international partners as diverse as research agencies, NGOs, private consultancies, associations and public institutions. We also include the closer ties, which are both necessary and vital, between the French-speaking and English-speaking parts of the Pacific, a multicultural and multilingual region.

Finally, we would like to highlight the quality of the work carried out to demonstrate the economic value of coral reefs and to identify funding to ensure their sustainable management. Undoubtedly programmes for the protection of coral reefs and their exceptional biodiversity represent the safest investment that can currently be made in the Pacific for the benefit of Pacific Island communities.

Jimmie Rodgers
Director-General
SPC

Odile Lapierre
Director of the OCT Division
AFD

David Sheppard
Director General
SPREP

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Acronyms

AAMP	Agence des Aires marines protégées (French Marine Protected Areas Agency)
ACP	African, Caribbean and Pacific Countries linked to the European Union via The Cotonou Convention
AFD	Agence française de Développement (French Development Agency)
ANR	Agence nationale de la Recherche (The French National Research Agency)
ASMPA	Aleita and Safata Marine Protected Areas
AusAID	Australian Agency for International Development
CARE	Collect by Artificial Reef Eco-friendly
CBA	Cost-Benefit Analysis
CBD	Convention on Biological Diversity
CBFM	Community-Based Fisheries Management
CBRM	Community-Based Resource Management
CCU	CRISP Coordination Unit
CI	Conservation International
CIRAD	La Recherche agronomique pour le Développement (Agricultural Research for the Development)
CNRS	Centre national de la Recherche scientifique (French National Center for Scientific Research)
COM	Collectivités d'outre-mer (Overseas communities)
COWRIE	Towards Coastal and Watershed Restoration for the Integrity of Island Environments
CPUE	Catch per Unit Effort
CRIOBE	Centre de Recherches insulaires et Observatoire de l'Environnement
CRISP	Coral Reef InitiativeS for the Pacific
CROP	Council of Regional Organisations in the Pacific
CTOM	Collectivités territoriales d'outre-mer françaises (French Overseas Territorial Communities)
DTSI	DTSI (Direction des Technologies et des Services de l'Information; Information and Technologies Department)
ELMA	Efate Land Management Area
ENSAR	Ecole nationale supérieure agronomique de Rennes
ENSAT	Ecole nationale supérieure agronomique de Toulouse
EPHE	Ecole pratique des Hautes Etudes
ERA	Ecoregional Analysis
ERP	Extinction Resistance Project
EU	European Union
FCRMN	Fiji Coral Reef Monitoring Network
FED	Fonds européen de Développement (European Fund for Development)
FGEF	French Global Environment Facility
FLMMA	Fidjian Locally-Managed Marine Area
FSP Vanuatu/FSPV	Foundation for the Peoples of South Pacific Vanuatu
FSPI	Foundation of the Peoples of the South Pacific International
GCRMN	Global Coral Reef Monitoring Network
GEF	Global Environment Facility
GIS	Geographic Information System
GIZC	Gestion intégrée des Zones côtières
HSL	Hawaiian SeaLife Inc
ICM	Integrated Coastal Management
ICRAN	International Coral Reef Action Network
ICRI	International Coral Reef Initiative
ICRS	International Coral Reef Symposium
ICZM	Integrated Coastal Zone Management
IFRECOR	Initiative française pour les Récifs coralliens (French Initiative for the Coral Reefs)
IFREMER	Institut français pour l'Exploitation de la Mer (French Institute for the Exploration of the Sea)
IMPAC	International Marine Protected Areas Congress
IRCP	Institut des Récifs coralliens du Pacifique (Institute for Pacific Coral Reefs)
IRD	Institut de Recherche pour le Développement (Research Institute for Development)
ITMEMS	International Tropical Marine Ecosystems Management Symposium
IUCN	International Union for Conservation of Nature
KBA/KBAs	Key biodiversity area(s)
LMMA/LMMAs	Locally-Managed Marine Area(s)

MAE	Ministère des Affaires étrangères (Ministry of Foreign Affairs – France)
MAT	Marine Aquarium Trade
MEDD	Ministère de l'Ecologie et du Développement durable (Ministry of Ecology and Sustainable Development)
MERIP	Marine and Environmental Research Institute of Pohnpei
MMA/MMAs	Marine Managed Area(s)
MNHN	Muséum national d'Histoire naturelle (National Museum of Natural History – France)
MOM	Ministère de l'Outre-mer (Ministry for the Overseas and Territories)
MPA/MPAs	Marine Protected Area(s)
NGO/NGOs	Non-Governmental Organization(s)
NOAA	National Oceanographic and Atmospheric Administration
NTZ/NTZs	No-Take Zone(s)
NZAID	New Zealand Agency for International Development
OCTs	Overseas Countries and Territories [of the European Union]
PCC	Postlarval capture and culture
PGEM	Plan de Gestion de l'Espace maritime (Management Plan of the Maritime Space)
PICs	Pacific Island Countries
PL	Postlarvae
PNG	Papua New Guinea
PROCFish	Pacific Regional Oceanic and Coastal Fisheries
RoI	Return on investment
SCRFA	Society for Conservation of Reef Fish Aggregations
SEM-Pasifika	Socioeconomic Monitoring for the Pacific
SILMMA	Solomon Islands Locally-managed Marine Area
SocMon	Global Socioeconomic Monitoring Initiative for Coastal Management
SOPAC	Applied Geoscience and Technology division of SPC
SPC	Secretariat of the Pacific Community
SPP	Secrétariat permanent pour le Pacifique (Permanent Secretariat for the Pacific)
SPREP	Secretariat of the Pacific Regional Environment Programme
TEV	Total Economic Value
TNC	The Nature Conservancy
UNC	Université de Nouvelle-Calédonie (University of New Caledonia)
UNF	United Nations Foundation
UNFIP	United Nations Fund for International Partnerships
UR	Unité de Recherche (Research Unit)
US	Unité de Service (Department Unit)
USAID	United States Agency for International Development
USP	University of the South Pacific
UVC	Underwater Visual Census
VBRMA/VBRMAs	Village-Based Resources Management Area(s)
VFMP	Village Fisheries Management Plans
WCS	Wildlife Conservation Society
WFC	WorldFish Center
WRI	World Resource Institute
WWF	World Wildlife Fund for Nature

Executive summary

The Coral Reef InitiativeS for the Pacific (CRISP) came about through France's political commitment to contribute to the development of the region's island nations and to promote integration of the French overseas territories into their regional environment. This initiative was set up by the Agence française de Développement (French Development Agency – AFD) as part of an inter-ministerial approach that began in 2002 and then several other partners joined the project. Its goals were to:

- improve knowledge about the biodiversity, current status and functioning of coral reefs;
- conduct operations to protect and manage coral ecosystems on a broad scale;
- promote economic potential based on the biodiversity and use values of coral ecosystems;
- share information and knowledge, build capacities and manage local, national and international networks.

The programme spanned a period of six years from 2005 to 2010 with more than 17 countries involved to varying degrees along with a large range of political, funding and technical partners. Support from AFD (5 M€) and the French Global Environment Facility (FFEM) (2 M€) made it possible to get funding from numerous other partners, e.g. AusAID[1], NZAID[2], French Pacific Fund, French Ministry of Foreign Affairs, CI[3], WWF[4], resulting in an overall amount for the programme of some 15 M€.

The document about building on CRISP's results will summarise all the documents produced over those six years, about 500 in all, and will report on the programme's outcomes.

A better understanding of the biodiversity, current status and functioning of coral reefs

CRISP resulted in very significant progress in knowledge about biodiversity in the Pacific: 14 reef zones which had not yet been studied were prospected, i.e. more than 350 newly explored stations and a total of several thousand species described, e.g. coral, seaweed, fish, crustaceans and sponges, several hundred of which were new for the prospected areas, and more than 50 species described that were new to science.

All of the region's reefs were mapped except those in Fiji. This work, which was part of a project to map reefs worldwide, revealed the extremely diverse nature of reef formations in the region, particularly in Papua New Guinea and New Caledonia. It also made it possible to update the statistics on reef surface areas in the region.

The many environmental studies provided results that were sometimes innovative, with concrete applications in regard to marine protected areas (MPA) or fisheries management. Work covered the recruitment and survival of larvae in the reefs, their dispersal from the reefs to neighbouring zones and gaining a better understanding of their connectivity, on species genetics in the geographic continuum from west to east, and even the sounds produced by fish in different regions of the world.

This work showed that recruitment of fish larvae in reefs is, in the end, more local than what had previously been thought but that larvae could also disperse over dozens of kilometres (35 km, the longest distance ever observed in reef fish). It also showed, for one fish species, a high gradient of genetic diversity from New Caledonia to Polynesia or the low dispersion capacity of black-tip shark populations. It even showed that a single species produces different sounds in Madagascar and in Polynesia, so as to locate other specimens of the same species.

1 Australian Agency for International Development
2 New Zealand Aid Programme
3 Conservation International
4 World Wildlife Fund for Nature

All these studies allow us to think that the spatial scales to be considered for coral reef conservation could be smaller than those previous studies had suggested, and they provided new information for setting up effective MPA networks, a stated objective at the international level. This work also covered understanding and quantifying erosion processes in watersheds which is one of the major causes of reef degradation and must be controlled.

Information on indigenous knowledge and traditional management modes, still very much alive in the region, helps develop modern management tools adapted to the Pacific's cultural context. Nevertheless, studies show that these traditional values and knowledge are being lost – that respect for traditional leaders is declining. Work to reacquire ancient custom uses and knowledge, as long as they are sustainable, is what older people want and this should be taken into consideration in modern law.

CRISP's support as part of the Global Coral Reef Monitoring Network (GCRMN) and "Reef Check" (a voluntary monitoring network) was decisive for ongoing reef monitoring activities in the region. Several monitoring campaigns allowed a better view of the health status of the region's reefs and the changes they are subjected to through man-made and climate hazards. Such monitoring demonstrated, for example, the remarkable resilience of the reefs in Fiji, which, over a period of six years, recovered from the wide-spread bleaching that had affected them in 2000.

Fisheries resources are vital in this region and they are on the decline. CRISP provided an opportunity to develop a particularly wide-scale level of work on methods for monitoring the resources used by fisheries and to review their use as part of MPA monitoring.

The value of having fishers, divers or even students take part in resource monitoring is increasingly recognised as a way to make it possible to extend monitoring while reducing costs and raising awareness among a wider audience. Therefore methods must be simple but reliable. Several studies reported on monitoring carried out by and with local communities and compared their results with scientific approaches to measure their validity. The studies agreed on how valuable the educational and training aspects of such participatory approaches are. However, they indicated that while communities generally felt their MPAs were beneficial for them, scientific studies were less conclusive. Such research also found that fishing pressure is visible at almost all study locations – that fish are decreasingly used for subsistence and are increasingly marketed. New monitoring methods were developed, based, for example, on a study of household fish consumption.

CRISP supported the adaptation, to Pacific Island circumstances, of the SocMon method of socio-economic monitoring used worldwide. This led to the "SEM-Pasifika", method, whose purpose is to explain certain results from biological monitoring in terms of the socio-economic context and to measure the impact that changes in the reef's health status have on fish or invertebrate populations. This method allows communities to measure changes to the resources their reefs provide them so as to adapt their management in response, particularly in the event of any deterioration of the indicators.

Besides work in the field, CRISP's work in monitoring led to several workshops to exchange methods as

well as a significant increase in know-how through workshops and training session in the field. The Coral Reef CSI (Crime Scene Investigation) method was also introduced in the South Pacific by CRISP. This approach makes it possible to improve the legal acceptability of actions against any natural person or corporate body responsible for damaging the integrity of coral reefs, e.g. boat groundings, chemical pollution.

Protecting and managing coral reefs at a broad scale

International goals – e.g. Convention on Biodiversity, Durban Decisions – target for 2012 development of coherent and representative networks of marine protected areas managed nationally and regionally, covering 20 to 30% of marine habitats. Planning analysis for MPA networks helps identify sites of environmental interest that should be integrated into these networks.

The analyses conducted as part of CRISP allowed identification of more than 100 outstanding sites in the Pacific, i.e. 19 in New Caledonia, 60 in French Polynesia, 50 in Cook Islands and 7 in Samoa. Developed in close partnership with all the stakeholders familiar with the setting (scientists, managers, local communities), these approaches have led to collecting, compiling and summarising all the information on the region's biodiversity and making it available to decision-makers. Support was also given to the Government of Palau as part of the Micronesia Challenge that targets management of 20% of this country's marine areas by 2020.

CRISP allowed the establishment or strengthening of 50 marine protected or managed areas in seven countries and in the three French territories, i.e. a surface area of nearly 1,000 sq km involved. With the immense Phoenix Islands MPA in Kiribati, the protected surface area developed under the auspices of CRISP totalled some 411,138 sq km. These MPAs vary greatly in terms of size (the smallest is less than 1 sq km); maturity and status. For the most part, they are managed by local communities. Today, most have formulated a management plan and ensure regular monitoring of their resources. The network of small community reserves in the Pacific ("LMMA") was strengthened. CRISP also generously contributed to the Aleipata and Safata MPA trust fund in Samoa, designed to ensure their financial autonomy.

Given the wide range of experiences, CRISP made it possible to build on the various modes of governing MPAs, participatory and institutional approaches, and coordination between local communities and national technical services. More than 40 local communities were involved and trained along with

about 100 managers and members of government services in seven countries. In particular, CRISP helped arrange meetings and exchanges of experience designed to enhance the skills of managers.

For the past few years, reef restoration and coral transplant operations have been developed around the world. The originality of CRISP was to develop low-cost and low-tech techniques so as to make them accessible to Pacific Island communities. These methods were tested in Tuvalu and Fiji. In both cases, transplantation was initially a success, but after a few months the transplants experienced high levels of mortality from bleaching or pollution. In spite of these failures, this testing was useful and has been reported on in a document jointly published with the World Bank's research programme, i.e. "Coral Reef Targeted Research & Capacity Building for Management", the most recent and most comprehensive work worldwide on restoration techniques.

In island areas with sharp slopes, there is a very direct link between watersheds, a source of pollution, and the marine environment, which acts as a basin for such pollution. So it is vital to develop a very integrated approach in terms of actions in the field and in the area of governance. This was one of CRISP's objectives. Community activities to restore watersheds took place in Vanuatu and Fiji: local communities worked on formulating management plans that integrated both the watershed dimension and the marine areas downstream; nurseries were created and eroded slopes were restored and replanted with local species.

The research on MPA governance and integrated management provided some interesting perspectives: the families most at risk economically and socially are those most affected by the creation of MPAs, which, by strengthening the hegemonic positions of certain players or groups of players, can lead to an increase in social tensions. Methodological approaches were explored, aimed at giving priority to the issues of local societies (cultural, social, economic, etc.) before dealing with environmental issues, which were then seen in the light of a threat to be overcome without placing social issues at risk. In another area of governance, work was developed in Vanuatu to create exchange dynamics within government services. Tools for sharing data between departments were designed to make these organic links sustainable, such as an interoperable information system created by the University of New Caledonia and transferred to Vanuatu.

Economic development of reef resources

Developing reef resources and promoting sustainable activities was one of CRISP's ongoing concerns, through the development of sustainable alternate fishing techniques such as postlarval capture and culture (PCC), identifying active substances from marine organisms or promoting sustainable tourism, with an outline for an eco-friendly certification approach.

Postlarval capture and culture (PCC) of fish or invertebrates for the aquarium trade market, food or to reseed natural settings

Development of this activity was one of CRISP's key actions. Several possibilities were studied: research and development, in the areas of larvae capture and raising, practical and economic feasibility studies, skills transfer from French Polynesia (which first developed the technique), product promotion and financial support to private partnerships in order to develop sustainable export sectors.

Scientific knowledge about the recruitment of fish, crustacean and mollusc larvae increased significantly. Work focused on the factors that determine the larvae's choice of habitat for colonisation and then their survival and growth. Several very innovative research projects studied the sensorial mechanisms that lead larvae to their colonisation habitat in the lagoon. The idea would be to develop new postlarval capture techniques based on smell and hearing, by creating a bank of the chemical and sound signals responsible for attracting larvae.

Capture techniques were perfected, and this activity could be implemented in the various countries in the region and in the French territories. Overall, the most promising market has been the one for the aquarium trade. Studies showed that the islands possess a potential for the ornamental fish market. Pohnpei in Federated States of Micronesia, the Marshall Islands, Christmas Island in Kiribati seem to be interested, and private parties are ready to become involved. Transfer of this technique began in several of those countries and the first shipments have been exported from Pohnpei to Hawaii.

CRISP succeeded in motivating several private companies, which took on PCC technology and improved its long-term economic viability. This progress involved developing more efficient gear and formulating low-cost feed that local fishers can make themselves. The major advance involved the formulation of a strategy to sell postlarval to children as full-fledged products and not simply as future adults whose production costs are currently much higher than those for harvesting adult specimens from the wild. This strategy, combined with the development of an eco-friendly label for postlarval products, should allow these environmentally sustainable sectors to succeed over the long term.

PCC was promoted both in the region and throughout the world and information about it was shared widely through a large number of technical reports and scientific publications and strong participation in nearly 10 symposia and meetings, some of which were supported or even directly organised by CRISP. Rich exchanges and partnerships were built between the various parties involved in the region and work led to significant levels of capacity building.

The results CRISP obtained with this innovative technique are promising. There are still many issues in convincing private operators to become involved in this activity and the project is currently continuing with FFEM funding.

In addition, several countries are already involved in producing other sustainable marine products farmed locally for the aquarium trade market, e.g. coral or sponge grafting, giant clam farming. This is the case in Solomon Islands, where a cooperative of some 40 fishers today exports such products around the world with support from the WorldFish Center funded by CRISP.

Research on active marine substances

The natural environment is an important source of research on substances for therapeutic use, and most of the medicines placed on the market come from substances of natural origin. Active marine substances are active ingredients (e.g. anti-inflammatory, anti-malaria, cancer-fighting) identified in marine organisms. Activities in this area were conducted by the French Research Institute for Development (IRD), with a wide range of scientific partners.

IRD conducted bioprospecting operations in Solomon Islands and Fiji, allowing collection of nearly 3,000 samples. In addition to work on active marine substances, such collection work resulted in large-scale taxonomic work, with more than 30 species that were new to science.

The work to extract and test substances and to isolate and identify active ingredients, carried out by many laboratories in Europe, led to the discovery of 30 new active substances that had anti-malarial, anti-inflammatory, and neuroactive properties. This raises hopes that new medicines can be developed on this basis over the long term. This is, then, an important **outcome to IRD's credit carried out under the auspices of CRISP.**

In addition, this part of the programme emphasised improving the legal framework in those countries that have resources, in terms of protection and rules for accessing biodiversity, intellectual property, and the equitable sharing of potential financial gains. It also helped train a large number of Pacific Island students in this promising area.

Economic value of coral reefs and the economic effectiveness of MPAs

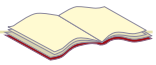
Economic assessment of the services provided by ecosystems, analysis of the costs and benefits brought about by reef protection and management and evaluation of returns on investments are approaches that today are being increasingly developed. They bolster arguments in favour of the protection and sensible management of ecosystems and their resources or for evaluating compensation in the event of damages. And finally, they facilitate decision-making by managers.

Several assessments were carried out as part of CRISP: literature review of the use value of coral reefs in the Pacific (4,643 to 33,305 €/sq km/year depending on the study); total value of an MPA in Fiji (73,600 €/sq km/year), value of fisheries activities in traditional fishing zones in Fiji, use value of reefs in New Caledonia (39,411 €/km/year to 66,561 €/sq km/year) or even the life value of a lemon shark used in eco-tourism (about 2 M€). The results of these studies range widely and raise the issue of methods, but all prove the existence of a vital value. All the studies show that results depend in large part on fishery activities and tourism. The value of protecting the coastline, often neglected, has sometimes proven to be very high (up to 80% of the total economic value).

While methods on the total economic value are still those most widely used, CRISP wanted to combine them with more dynamic methods such as cost/benefit analysis or other approaches to funding conservation. A very in-depth study developed in Vanuatu on five MPAs threw light on the benefits linked to MPAs. It showed that every 1 € invested in an MPA produced, on average, 2 €, with an estimated potential between 4 and 21 €; that village MPAs play a significant role in the village's gross domestic income, with a potential that may be between 15 and 30%; that they increase the productivity of reef fishing, strengthen the stability of catches and promote an increase in the average sizes of fish.

Above and beyond these studies, CRISP wanted to lend some new dynamics to this topic in the region: two workshops and the creation of a working group on the issue of economic evaluation brought together the main national and international specialists in this area.

Summarising and disseminating knowledge



The programme produced a total of more than 500 publications, including 50 scientific publications in scientific journals; 15 dissertations; 150 grey literature reports; 35 methodology guides, summaries and scientific extension documents; 150 meeting papers; and 60 posters, flyers, press releases, etc. The dissemination of the knowledge and results acquired during the programme is one of CRISP's biggest achievements.

The results were presented at more than 40 events, through 150 talks. Among the most important events were the 21st Pacific Science Congress (PSC21, Okinawa, 2007), 11th International Coral Reef Symposium (ICRS 2008) and the 11th Pacific Science Inter Congress (PSI2009) in Papeete. At each event, more than 20 papers or posters were presented on CRISP's results.

In addition to simply participating in events, CRISP held or gave financial support to a certain number of them: regional scientific cooperation on Moorea (2006), regional technical cooperation in Townsville (2007), International Coral Reef Symposium (ICRS) in Florida (2008), and Pacific Regional Conference on Marine Managed Areas on Moorea (2010).

To ensure that CRISP touched as wide an audience as possible, its Coordinator took part in all the events on coral reefs in the region and internationally, which allowed him to develop collaborative efforts with partners or regional and international initiatives. In particular, he regularly attended the meetings of ICRI (International Coral Reef Initiative) and IFRECOR (French coral reef initiative). CRISP gained an independent seat on ICRI as early as 2006 as a French satellite entity and acquired the prestigious status as a "network" of that organisation. Within that framework the CRISP Coordinator promoted discussions and a sustainable development approach to reef fisheries at the international level.

The creation of the Web portal "ReefBase Pacific" by the WorldFish Center was a major step forward for sharing information in the region. Thousands of documents have been scanned, indexed, classified and posted online, and the database now contains about 10,000 documents. In addition, CRISP's website also brings together a very large portion of the documents produced (e.g. reports, methodology guides) About 200 reports and manuals available in French and in English.

CRISP the main source of support behind arrangements in the Pacific in response to the International Year of the Reef (IYOR 2008), sponsored by SPREP (Secretariat of the Pacific Regional Environment Programme), which mobilised local stakeholders for one year. It allowed development of original teaching tools for children (DVDs, teaching kits). The programme supported the production of six televised documentaries for the general public on reef conservation. In addition to these direct awareness activities, training and education for those involved in the region was ensured indirectly through work on the coral reef economy destined for decision-makers and work on MPA management for local communities.

Building capacities and developing partnerships

CRISP played a decisive role in capacity building in the region and in mainland France: 90 students, including 25 Pacific Island students, were able to earn their degrees, mainly in the areas of active substances (30% of the students), fish ecology and PCC fisheries management (24%). Of those 90 diplomas, 16 were upper tertiary (dissertations and post-doctoral).

The programme was also very active in capacity building through training exchange workshops; with 54 workshops, a total of more than 1,600 participants benefitted from such training or technical support. Finally, through its various components (e.g. MPA, integrated watershed management, PCC, reef monitoring and restoration) CRISP made it possible to strengthen 40 local communities in the field, i.e. nearly 3,000 people.

The work to create partnerships and synergies in the region was a major focus of CRISP's philosophy from the very start of the programme. It is because CRISP was able to create connections between very diverse partners in the Pacific region and establish sustainable partnerships that it is so well recognised today.

When the project was being set up, financial partnerships were created first, i.e. AFD/FFEM (the initiative's founders), the United Nations Foundation, WWF, CI, the French Pacific Fund, the French Ministry of Foreign Affairs and IFRECOR. Such partnerships were then developed with other donors that are very active in the Pacific, e.g. the McArthur and Packard Foundations, AusAID and the New Zealand Aid Programme.

On the scientific level, a large number of partnerships were created between SPC, CI, CNRS[5], IRD and other French, European or regional (Japan, Australia, New Zealand) universities and research institutes. In all, some 40 research agencies contributed in one way or the other. Partnerships were formed, in particular, between the University of the South Pacific (USP) in Fiji and IRD or the CRIOBE (French Island Research Centre and Environmental Observatory) joint CNRS–EPHE[6]–UPVD[7] 5244 research unit on Moorea. CRIOBE and USP signed a framework agreement that ensures ongoing scientific collaboration between these two agencies.

CRISP made possible the first exchanges between MPAs in the French territories and the locally-managed marine areas (LMMA) network, for the mutual benefit of their managers.

In addition:

- French consultancies were able to work in partnership with NGOs;
- private participants were involved, particularly in terms of PCC;
- various international NGOs had to work together (WWF, CI, UICN[8], WCS[9], TNC[10], Reef Check), and with a large range of local or regional associations: FSPI (Foundation of the Peoples of the South Pacific International) and its national offices; Wan Smolbag (Vanuatu), PCDF (Partners in Community Development Fiji) and TANGO (Tuvalu Association of Non-Governmental Organizations);
- relations were strengthened between the public services of different countries and territories, e.g. French Polynesia Pearl Culture Department; Vanuatu, Fiji, Solomon Islands Fisheries Departments; bilateral cooperation between the IRD and Vanuatu, begun as part of CRISP, will continue and two IRD researchers set up offices in Vanuatu to support the Fisheries Department;
- cooperative efforts were set up between programmes and initiatives: the World Bank's "Coral Reef Targeted Research & Capacity Building for Management", Micronesia Challenge, Reefs at risk, Crime Scene Investigation, ICRAN/ICRI[11], WorldFish Center.

CRISP contributed in a notable way towards the creation of closer relations between SPC (whose mandate covers fisheries and reef resource management) and SPREP (whose mandate covers the environment and conservation). It also played a key role in strengthening SPREP's activities in the French territories. Finally, it made it possible to strengthen ties between the English-speaking countries and the French territories and between developing and developed countries.

Above and beyond CRISP, several of these projects will continue thanks to other existing or upcoming funding, e.g. MacArthur and Packard Foundations for Solomon Islands and for Vanuatu; the trust fund in Samoa. As for AFD, it has reaffirmed its investment in the socio-economic assessment of the benefits of MPAs. The PCC project has been extended with FFEM funding. Work on integrated management and MPAs will continue as part of the INTEGRE (Pacific Territories Initiative for Regional Management of the Environment) programme of the 10th regional European Development Fund (EDF) for Pacific OCTs and possibly as part of FFEM's PICMAC (Pacific Islands Integrated Coastal Management for the Enhancement of Adaptation Capabilities to Climate Change) project.

5 French National Scientific Research Centre
6 École pratique des hautes Etudes
7 Université de Perpignan Via Domitia

8 International Union for the Conservation of Nature
9 Wildlife Conservation Society
10 Nature Conservatory
11 International Coral Reef Action Network /International Coral Reef Initiative

Introduction

1. Project background

1.1 Importance of coral reefs

Coral reefs are distributed over 101 countries or territories and cover a total surface area of 284 300 sq km, 50% of which is located in four countries; i.e. Indonesia, Australia, the Philippines and France (with 14,280 sq km in the French overseas departments and territories). Four developed countries, i.e. Australia, France, the United Kingdom and the USA, together hold more than one-quarter of the world's reefs, which gives them a special responsibility. In addition, France is the only country that has jurisdiction of over coral formations in three different oceans, including, in French Polynesia, one-fifth of the 410 atolls listed and, in New Caledonia, the second largest barrier reef in length after the Great Barrier Reef in Australia.

At the local level, coral reefs are vital for economic development:

- they account for 25% of developing countries' fisheries potential and provide direct subsistence to 30-40 million people;
- in addition to fishing, aquaculture is growing and can generate substantial amounts of income (e.g. pearl oyster, seaweed, aquarium fish);
- tourism is experiencing steady development: 2,500 dive centres in 91 countries that take some 15 million divers out to the coral reefs every year.

In the Pacific, where coral reefs provide 80% of the protein needs of people living along the coasts, they play an irreplaceable role in identity and culture. They are also vital for protecting coasts and urban and port infrastructures from damage caused by tropical cyclones and from the risks of erosion due to sea surge.

In spite of their limited surface areas, coral environments are an immense reservoir of biodiversity worldwide, equivalent to tropical forests. There may be more than a million new species to be discovered in addition to the two million already identified. Economic development of this biodiversity is mainly based on its potential to provide active pharmaceutical substances, but biodiversity is vital for the coral ecosystems themselves. Their resistance to disturbances and their long-term resilience depend on it (capacity to re-establish the ecosystem services they provide after a disturbance).

1.2 The multiple types of stress coral reefs are subjected to

In 2008, it was estimated that reefs had lost 20% of their surface area and that 35% were at risk in the short – or long term (Wilkinson, 2008). The most affected area was Southeast Asia; in the Pacific region, reefs are, overall, less at risk, but dangers are growing.

Some of the localised disturbances that explain this state of affairs are natural (cyclones), but, for the most part, they are of human origin. Depending on the site, they may be:

- public works, mining and deforestation that bring about soil erosion and sediment deposits that lead to coral asphyxiation;
- overfishing, fishing with destructive techniques such as explosives or poison, and changes to the balances between species that compromise the ecosystems' ability to resist disturbances;
- uncontrolled tourism (disturbances to the environment, damage from anchoring equipment and divers' movements, pollution);
- agricultural and urban pollution, which brings about an accumulation of solid wastes and the spread of toxic substances (e.g. pesticides, heavy metals);

- removal of materials for construction (coral blocks, sand), which undermines the reefs and changes the hydrodynamics of the areas involved;
- destruction of mangroves, with a disappearance of their role as a reservoir of diversity, cleaner the environment and as provider of reproduction and nursery areas for a multitude of reef and lagoon species; and changes to coastal hydrodynamics.

While those effects are visible and immediate, coral reefs are also endangered by the greenhouse effect and global climate changes:

- an increase in CO2 levels in the atmosphere could alter the calcification process for coral skeletons, the basis of their formation;
- warming waters and El Niño-type events could be the origin of coral bleaching that would lead to irreversible damage to the reefs;
- new diseases, in addition to the massive spread of the *Acanthaster* starfish, have been decimating reefs since the 1980s;
- an increase in the frequency and intensity of cyclones following climate changes, if confirmed, will be sure to cause increased damage to reefs, whose ability to re-establish balance has been lowered by the different types of stress they are subjected to.

1.3 Inadequate protection for coral reefs

In 2003, there were very few protected coral reefs; 70% were located in Australia's Great Barrier Reef; elsewhere, official protection was too often ineffective and isolation of the reefs seemed, for many, to be the best way to protect them.

However, since the 1990s, a wide range of initiatives had been launched, including ICRI, begun in 1995, which France took an active part in and which it extended through the French Coral Reef Initiative (IFRECOR), which is the version of ICRI in each French department and territory. IFRECOR, jointly funded by the French Ministry of Ecology and Sustainable Development (MEDD) and the Ministry for the Overseas Departments and Territories (MOM), accounted for an annual contribution of 60,000 € for each French department and territory, reserved for actions that were supposed to take place locally.

France also played a role in the creation of SPREP, which was founded in Noumea in 1972 and which then set up offices in Apia, Samoa in 1995 as the Pacific regional organisation for the environment. The Pacific nations' small sizes and geographic spread encouraged them to create a number of different Pacific regional organisations that are political or technical in nature so as to combine their interests, make their voices heard and serve as support for international aid. France and the French Pacific territories are members and partners of SPREP.

The only Pacific regional initiative related to coral reefs – introduced in the early 2000s – was the European Union-funded PROCFish project (Pacific Regional Oceanic and Coastal Fisheries Development Programme). Implemented by the Secretariat of the Pacific Community (SPC), a Pacific regional organisation based in Noumea in charge of general fisheries development issues, the project supplied support in terms of reef fish resource information and data analysis.

Aside from that project amounting overall to 7 M€, and apart from Australia and French territories, international funding for reef protection was almost the only funding available given the limited resources of the region's small island states, and it only amounted to a few million US dollars at most and was, therefore, no match for what was at stake. In addition, work in English- and French-speaking areas remained separate, each in its own spheres of influence, whereas possible synergies obviously existed.

1.4 Growing awareness by governments and the French Pacific territories

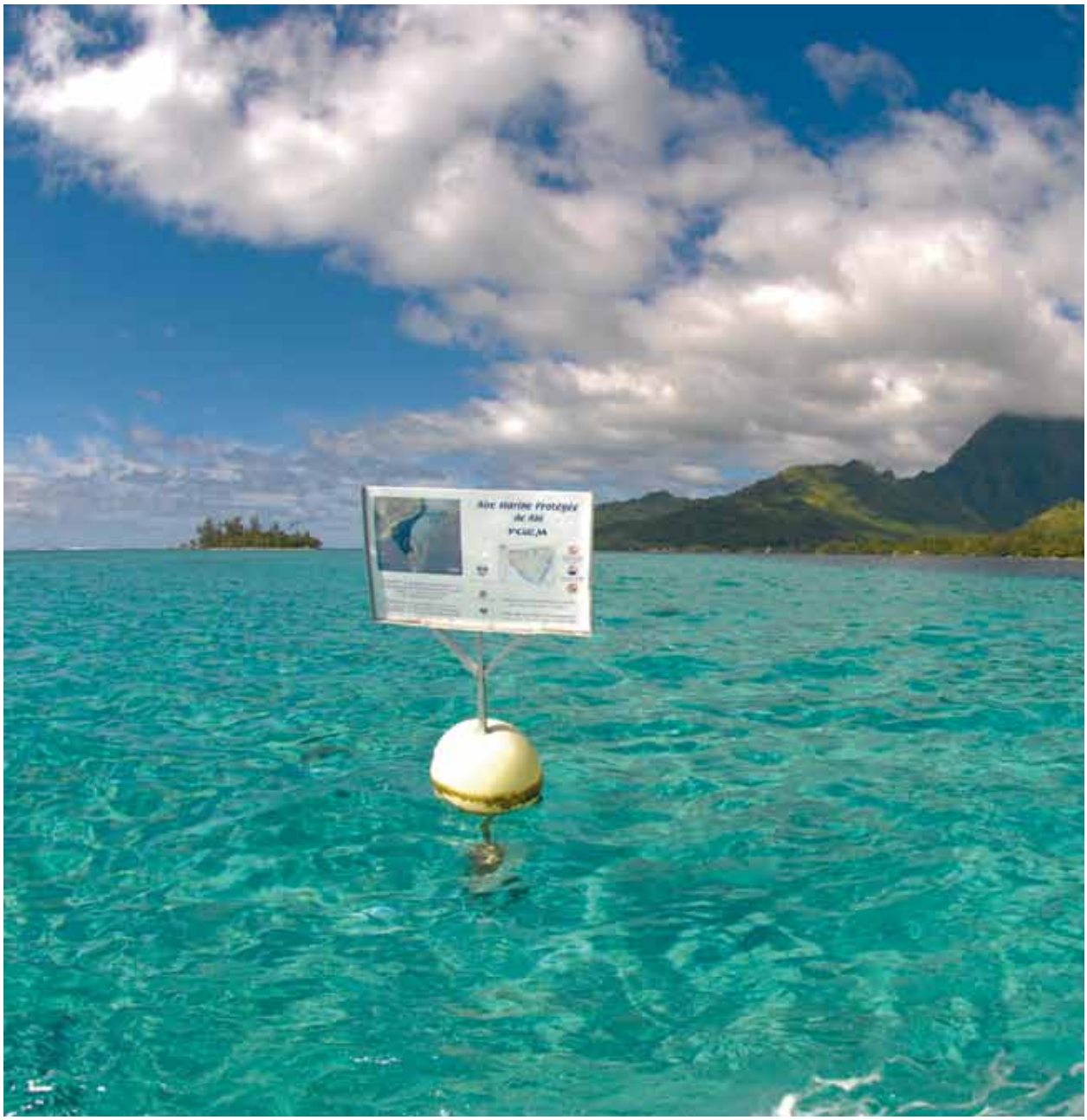
Aware of the economic, ecological and cultural interest of their coral reefs, Pacific countries requested outside assistance in protecting and sustainably managing these ecosystems. This desire was expressed by Pacific regional organisations, in particular SPREP, under the "making the most of our coral reefs" concept designed to serve as a platform to collect financial contributions. SPREP became a partner to the initiative along with the SPC and the University of the South Pacific (USP) in Fiji, which is also a Pacific regional organisation. The collaboration between these three organisations during project preparations demonstrated their interest in the future and the use of coral reefs.

Close neighbours but not entirely integrated into the English-speaking environment, the French Pacific territories were also aware of the need to work more closely with the other island nations of the region

which share the same issues concerning sustainable development of coral reefs. This pressing need was strengthened by their attachment to France and, the resulting obligation to contribute to certain international commitments such as:

- implementation of the **Convention on Biological Diversity,** which set out "the sustainable use of biodiversity and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources";
- fisheries and the marine environment, which are subjects of growing concern at the international level, as shown by the **Johannesburg Summit** (September 2002) and the **Durban World Congress** (October 2003) on protected areas.

Finally, with the encouragement of agencies, such as AFD, which are present in the French territories, it appeared increasingly necessary to develop an economy of the environment and renewable resources so as to justify investments in ecosystem conservation and in the optimal and sustainable use of resources in a manner other than through ethical considerations about biodiversity and its value as a public good for the entire world.



2. The programme

2.1 Background

The French Regional Initiative for the Protection and Management of Coral Reefs in the Pacific was sponsored by France and prepared by the French Development Agency (AFD) as part of an inter-ministerial project which began in 2002.

The initiative was prepared through a series of interministerial meetings chaired by the Ambassador, Permanent Secretary for the Pacific, beginning in June 2002; a joint AFD/FFEM mission in February and March 2003; and a call for proposals in the form of a log frame (project brief) that allowed partners to formulate the detailed contents of their proposals themselves and to demonstrate their relevancy, their contribution to the initiative's objectives and their feasibility. The mission in February-March 2003 was used to inform potential partners, i.e. New Zealand and Australia, of the possibility of joining in this process.

The call for proposals was issued in June 2003 to partners identified during the preparatory mission for 15 topics covered by the initiative; non-exhaustive mailing lists were copied to a "core group" of advisors including B. Salvat (France), C. Wilkinson (Australia), C. Payri (French Polynesia), C. Chauvet (New Caledonia), G. David and J. Ferraris (IRD), C. Gabrié and A. Collin (WWF–France) as well as to IFRECOR's representatives in French Polynesia and New Caledonia and those of FSPI Samoa (for Aleipata and Safata).

The selected procedure allowed a certain amount of control over the initiative's formulation process by requiring a standard presentation for contributions. It also made it possible to accommodate the cost-effectiveness requirement of AFD and to ensure transparency, openness and flexibility in preparing the initiative as well as equal opportunity for all the partners.

The 17 responses to the call for proposals were evaluated according to criteria from the project briefs and then recombined to give a smaller number of more substantial projects divided into three sectors (see project description below).

As explained by the specialists during the preparatory mission in February-March 2003, the initial funding on which the call for proposals was based gave priority to Pacific island countries and excluded operations in the French Pacific territories except if they included a regional aspect. This funding only allowed export of expertise from French Pacific territories to targeted Island countries. Additional amounts from funding partners such as CI, WWF or UNF, which did not include the same eligibility constraints, allowed activities to be planned in the French Pacific territories. These new provisions and possible activities were considered when an AFD specialist attended the IFRECOR committee meeting in Mayotte in May 2004. Hence, the French Pacific territories joined the dozen South Pacific island countries benefitting from the programme.

The French Regional Initiative for the Protection and Management of Coral Reefs in the Pacific was given the acronym CRISP in September 2004. It was officially launched during the annual SPREP meeting and the Ministers of the Environment Meeting in Papeete in September 2004 by the French Minister of Ecology and Sustainable Development, Mr. Serge Lepeltier. The choice of an English acronym CRISP, which stands for "Coral Reef InitiativeS for the Pacific", and the deliberate removal of the word "French" came about through the firm desire of the founding countries that this programme, open to all contributions from the very start, become as multilateral as possible and owned by the Pacific Islands.

The programme's technical launch took place with a workshop held at SPC Headquarters in Noumea from 24 to 28 January 2005. After defining an action plan, bilateral funding agreements were signed in 2005 between AFD and, respectively, SPC, CI, CNRS, IRD and UNF. The AFD–SPC agreement principally managed the creation of a coordination and monitoring - evaluation unit within this Pacific regional organisation. The other agreements provided frameworks for project management by the agencies involved, which joined together with other partners (see the list of the main ones below) for project implementation.

A mid-term review of CRISP was carried out in mid-2008 by the firm Oréade-Brèche. It was accompanied by the signature of a new agreement between AFD and SPC, aimed at keeping the CRISP Coordination Unit operational and supporting the implementation

of additional activities. It also led to the extension of all the funding agreements from December 2008 to December 2010. The programme, initially planned for a period of three years, had an effective lifespan of nearly six years.

2.2 Objectives and expected outcomes

CRISP's goal was to support the **sustainable development** of coral reef environments and the communities that depend on them and to introduce strategies and projects to conserve their biodiversity while developing the economic and environmental services they provide both locally and globally.

The initiative was also designed as a **vector of regional integration** between the developed and developing countries of the Pacific.

To achieve these overall goals, CRISP set the following more specific goals:

- Objective 1: Improve knowledge about the biodiversity, status and functioning of coral ecosystems;
- Objective 2: Protect and manage coral ecosystems on a broad scale;
- Objective 3: Develop the economic potential represented by the use values and biodiversity of coral ecosystems;
- Objective 4: Disseminate information and knowledge; capacity-building and a leadership role with local, national and international networks.

By the end of the project period, understanding of coral ecosystems, including the effects of global climate change, was supposed to evolve towards a more multi-disciplinary approach and be available to decision-makers and land development managers; significant portions of these ecosystems would be protected or subject to participatory and sustainable management regimes after priorities at the regional level had been identified through harmonised methods; their economic potential would be demonstrated by examples covering their main functions (fisheries and aquaculture, tourism, biodiversity development), and joint projects between the region's developed countries and small island states would be strengthened or created.

2.3 Overall approach

The initiative developed a specific approach designed to:

- associate network activities and in-country projects;
- bring together research, management and development endeavours;
- combine the contributions of a range of scientific disciplines, including biology, ecology, economics, sociology, law and anthropology;
- address the various land and marine factors affecting coral reefs (including watershed rehabilitation and management);
- supply financial resources to existing operational partners wishing to develop their activities in a spirit of regional cooperation, rather than setting up any new body.

This is why the initiative was prepared on the basis of a call (2004) for proposals to all interested institutions and networks.

2.4 Programme structure

The initiative was organised in three main components, made up of various sectors.

Component 1 – Implementation of sustainable management tools for coastal ecosystems:

- Formulating a marine biodiversity strategy at the regional and sub-regional levels;
- Developing marine protected areas (MPAs) or supporting existing MPAs;
- Strengthening regional networks of MPAs and stakeholders for sustainable coral reef development;
- Supporting watershed management and better coastal ecosystem governance.

Component 2 – Contribute to a better understanding, restoration, management and economic development of reef ecosystems:

- Developing postlarval capture and culture (PCC);
- Supporting reef ecosystem knowledge, surveillance and management activities;
- Developing techniques to restore reefs in the Pacific;
- Supporting marine bioprospecting and improving the potential benefits for island countries;
- Compiling and disseminating information about coral reefs (website).

Component 3 – Coordination, institutional strengthening and building on the results of the programme:

- Programme coordination, monitoring and evaluation;
- Supporting socio-economics and the coral reef economy;
- Promoting coral reefs and interest in their sustainable management;
- Supporting the conservation of species that are key for coral reef resilience;
- Building on results and supporting their further use through bridge funding.

2.5 Institutional partners (political, financial and technical)

On the political level, the initiative was launched by France in 2004, before other Pacific regional organisations, in particular the **SPC** and the **SPREP**, gradually took it over beginning in 2007. On the French side, France maintained overall political guidance through the **French Permanent Secretariat for the Pacific;** locally, the French Embassies in Australia, New Zealand, Papua New Guinea, Vanuatu and Fiji served as focal points with varying levels of involvement linked to the volume of activities spread out differently depending on the country involved. By integrating the CRISP Coordination Unit in April 2008 and inheriting supervision of different additional projects, SPC strengthened its policy guidance over the programme while, at the same time, ensuring better use of the results and the continuity of certain actions through bridge funding, that it now intends to implement in as close a partnership as possible with SPREP.

Financially, the **core funding** for the activities conducted under CRISP was provided by AFD (5 M€), the French Global Environment Facility (2.5 M€) and the French Ministries of Foreign Affairs, Overseas Departments and Territories and Ecology, Sustainable Development and Land Management (1 M€). In 2004, this initial funding was combined with **joint funding** from the United Nations Foundation (UNF) (0.9 M€), Conservation International (CI) (0.8 M€) and the World Wildlife Fund for Nature (WWF) (0.4 M€). When the programme was implemented, **matching funds** were generated on the basis of a wide range of partnerships with other donors such as the New Zealand Aid Programme, AusAID, the Packard Foundation, the McArthur Foundation, the World Bank, the governments and provinces of the French Pacific territories, etc. During the mid-term review of the programme in mid-2008, these matching funds were pooled with core funding and joint funding, resulting in a funding base of about 15 M€ (cf. Fig. 1). This figure will probably rise as part of the *ex post* evaluation of the programme to be carried out in 2011.

Technically, CRISP's originality comes from the diverse nature of its participants both in terms of their own specific characteristics and their membership in either the English- or French-speaking worlds. They should also be differentiated according to their involvement in the programme, i.e. either direct, most notably through their proposals during the initial call, or indirect, through the partnerships generated by implementation of activities in the field. The first group is highlighted in the list below (which is not comprehensive):

- **Non-governmental organisations** (NGOs) **such as** like CI, WWF, Foundation of the Peoples of the South Pacific International (FSPI), International Union for Conservation of Nature (IUCN), Reef Check, etc.
- **Research agencies** such as CNRS–EPHE, IRD, INSERM (France), USP, University of New Caledonia, Griffith University, Australian Institute for Marine Science (AIMS), James Cook University (JCU), CSIRO (Australia), New England Aquarium, Smithsonian Institution, GUMP Marine Station – Univrsity of California Berkeley (USA), University of Ryukyus (Japan), University of Newcastle (United Kingdom), etc.
- **Governmental organisations** such as the French Polynesia Public Works Ministry, the Samoa Ministry of the Environment, NOAA (USA), the Australian Ministry of the Environment, Fisheries Departments (Vanuatu, French Polynesia, etc.), IFRECOR (France), etc.
- **Technical development agencies** such as the WorldFish Center, Marine and Environmental Research Institute of Pohnpei (MERIP), Reef and Rainforest Research Center (RRRC, Australia), SCRFA (Hong Kong), Landcare Research Center (New Zealand), etc.
- **Associations** such as ProScience, Te Mana O Te Moana (French Polynesia), Alofa Tuvalu, etc.
- **Consultancies** such as Ginger, GIE–Océanide, Biocénose, Aquaterra, Ibulu (New Caledonia), PTPU (French Polynesia), ARVAM (Reunion Island), Marine Ecology (Fiji), etc.
- **Projects related** to CRISP such as CRTR, Reefs at risk, SANTO 2006, etc.

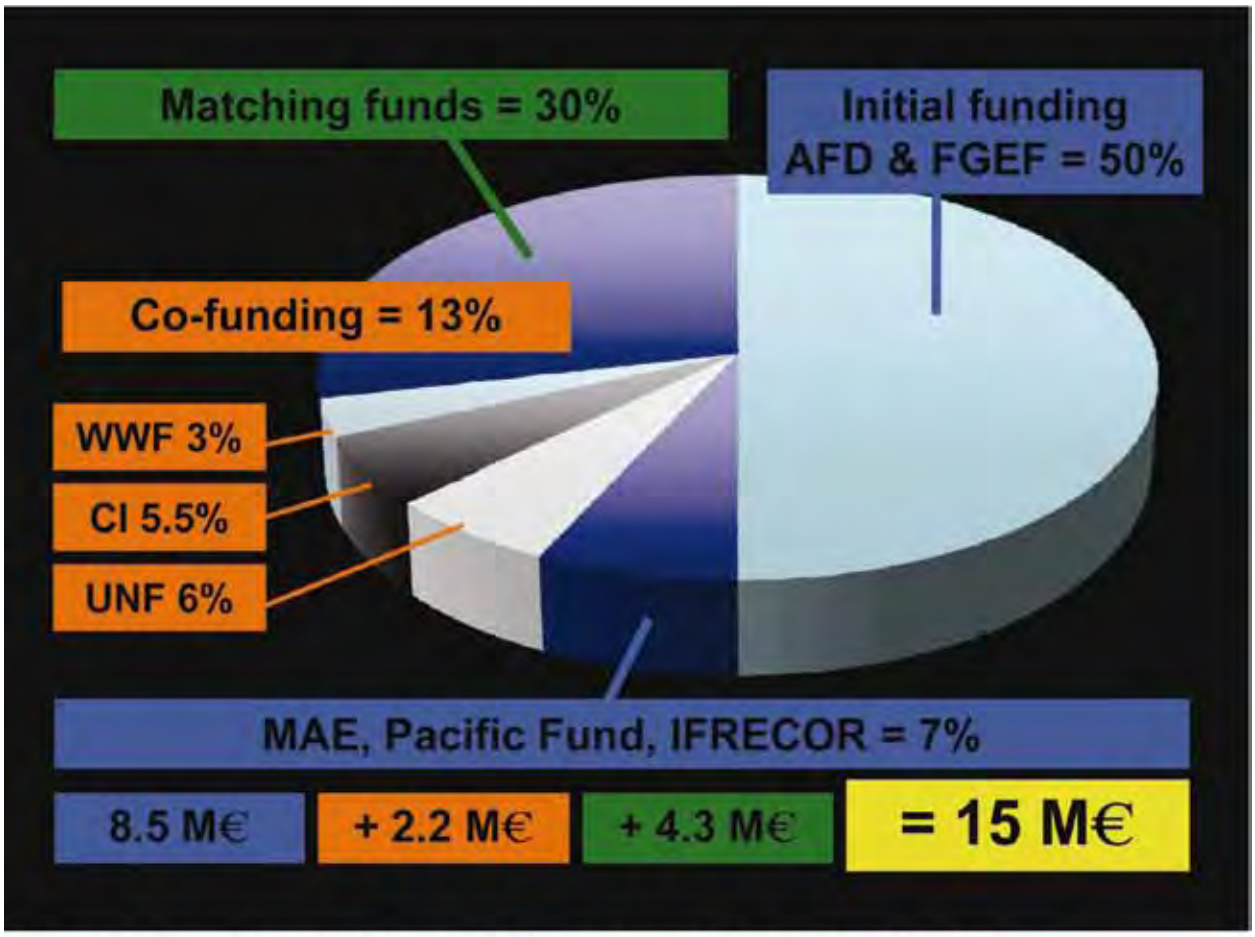


Figure 1: Synoptic presentation of the different types of funding and their origins.

- **Commercial companies** such as Hawaiian SeaLife, Inc (USA), Tropical Fish Tahiti, BoraEcoFish, TahitiEcoClam, Hotels Intercontinental (French Polynesia), Ecocean (France), etc.

Programme's geographic scope

The programme's geographic work zone was subject to the uncertainties of the field projects proposed by the various technical partners. In this regard, the zone was very mixed but extremely wide (more than 17 countries involved to different degrees). In terms of coordination, New Caledonia, where the SPC has its headquarters, and Samoa, home to SPREP, played key roles in CRISP's field of influence.

While all the countries were not involved in the same way by field projects, a feedback phase for all 25 Pacific Island countries is planned at the end of the programme via SPC and SPREP using appropriate media such as an interactive DVD.

Above and beyond the countries themselves, CRISP participated in creating or strengthening regional networks. This networking concept is shown on a symbol map, in addition to the activity areas in each country (see map of the CRISP Programme activities p.26-27). Finally, the details of the geographic work scope are given in Table 1, which provides an overview of the programme associating countries with funding, technical partners and the activities carried out.

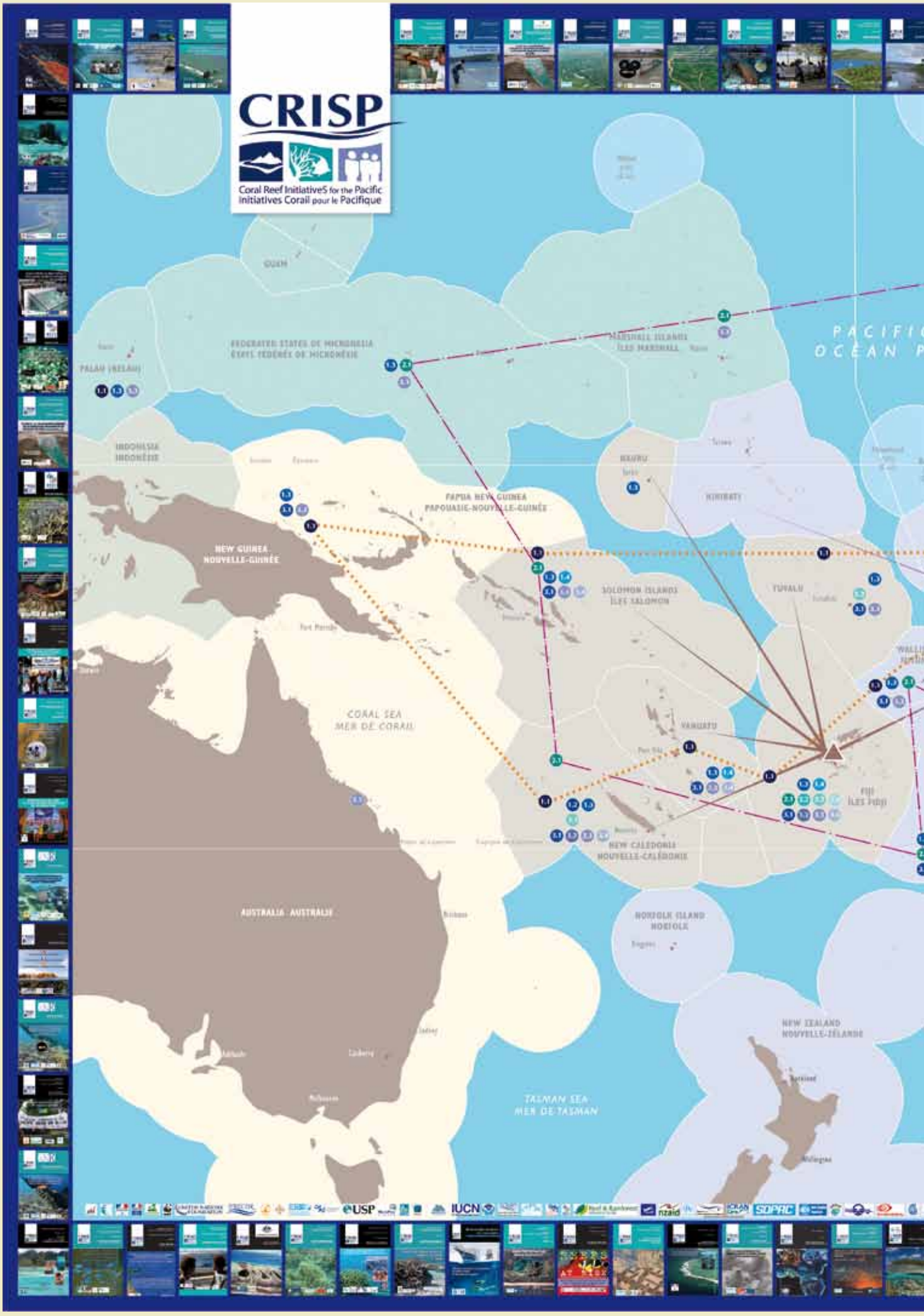
This document about building on the results summarises all the work given to CRISP and reports on the programme's outcomes.

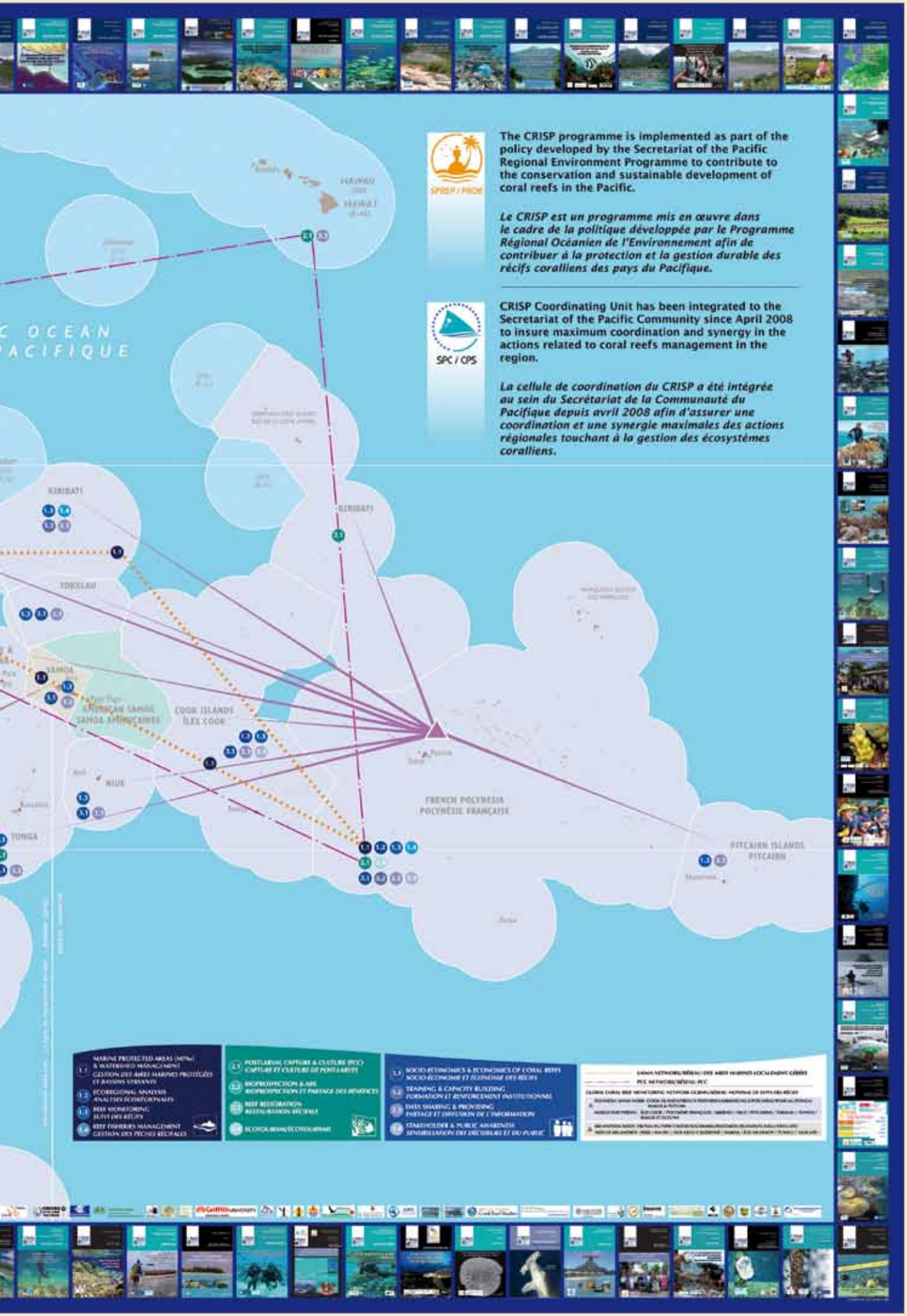
Table 1: Synoptic table of the CRISP Programme

Grantees	AFD/FGEF (K€) Amounts	Cofunding (K€)	Main donors	Implementing agency	Action field	Action theme	Technical partners	Recipient countries and territories
CI	2 000	2 500	CI, WWF, IFRECOR WF, IFRECOR PF, French Pacific Fund, NZAID, AAMP	CI	Marine conservation planning, MPAs and watershed management, Governance	Marine conservation planning	WWF, CI, AAMP, SPREP	New Caledonia, Polynesia Fiji, Samoa, Palau and Pacific region
						Supoprt to existing MPAs and setting up of new MPAs	WWF, CI, FSPI, ASMPA, IFRECOR PF	Tuvalu, Vanuatu, Tonga, New Caledonia, Samoa, Kiribati, French Polynesia, Solomon Islands, Cook Islands, Wallis & Futuna
						MPAs networking	CI, FSPI	All
						Integrated coastal management and governance	IRD, USP, SPREP	Vanuatu, Fiji and French Polynesia
CNRS	1 000	250	IFRECOR PF, Reef Check, French Pacific Fund	CNRS	Knowledge, management and development of coral reef ecosystems	Capture and Culture of Postlarvae (PCC)	EPHE, USP, Ecocean	Fiji French Polynesia, Wallis & Futuna
						Support to coastal fisheries	IRD, USP	Fiji, French Polynesia, New Caledonia, Vanuatu, Wallis & Futuna
						Support to coral reef monitoring	EPHE, USP	Melanesia and Polynesia
						Capacity building and students training	IRD, USP, EPHE	All Pacific countries
						Specific stufies on CO2 impact and Ecotourism	EPHE, USP, TMTM	
	300	150	CRTR, IFRECOR	SPI-INFRA	Reef rehabilitation	Implementation of pilot sites	GINGER, FSPI	Fiji and Tuvalu
						Publication of technical manuals	GINGER, FSPI, Newcastle Univ.	All Pacific countries (+ French OCTs)
IRD	500	600	IRD	IRD	Development of active marine substances	Improving legal frameworks for better benefit sharing	Univ. of Nantes-CDMO	Solomon Islands, Fiji and Vanuatu
						Taxonomy of new species	IRD, USP	
						Collecting and screening	IRD, CNRS	
						Capacity building	IRD, USP	

UNF	400	400	UNF, AAMP, CI, OCTs	WFC	Coral reefs website	Data collecting and formating	WFC, EPHE, SPREP	All Pacific countries
						Implementation of ReefBase Pacific website		
						Support to GCRMN		
						Outputs dissemination		
	500	750		SPREP	Capacity building	Extension of activities to the French OCTs	SPREP, ICRAN, UICN, FSPI, USP	
						Pilot studies (socioeconomics, governance...)		
						Support to regional networks (GCRMN, LMMA...)		
						Coral reefs awareness campaign and promotion of CRISP results		
SPC	300	850	MAE, French Pacific Fund	SPC	Coordination and development	Coordination and monitoring/evaluation	CCU, CI, CRIOBE, Griffith Univ., NIWA, CSIRO, ICRI, UICN, IDDRI, SCRFA, WFC, Biocénose, HSL, MERIP, Ecocean, BEF, TEC, TMTM, IRD	
						Promotion and communication		
						International institutional coordination		
						Partnership development		
	2 500	2 000	HSL, MEDD, French Pacific Fund, New Caledonia Provinces, IRD, CNRS, French Polynesia Government		Implementation of complementary actions and lessons learned	Support to coral reef resources monitoring		
						Reef fish and sharks conservation		
						Coral reefs economics		
						Capture and Culture of Postlarvae (PCC) & Ecotourism		
						Building on the CRISP Programme		
Sub-total (K€)	7 500	7 500	Total Amount = 15 M€					

Map of the CRISP Programme activities




The CRISP programme is implemented as part of the policy developed by the Secretariat of the Pacific Regional Environment Programme to contribute to the conservation and sustainable development of coral reefs in the Pacific.
Le CRISP est un programme mis en œuvre dans le cadre de la politique développée par le Programme Régional Océanien de l'Environnement afin de contribuer à la protection et la gestion durable des récifs coralliens des pays du Pacifique.
SPREP / PROE
CRISP Coordinating Unit has been integrated to the Secretariat of the Pacific Community since April 2008 to insure maximum coordination and synergy in the actions related to coral reefs management in the region.
La cellule de coordination du CRISP a été intégrée au sein du Secrétariat de la Communauté du Pacifique depuis avril 2008 afin d'assurer une coordination et une synergie maximales des actions régionales touchant à la gestion des écosystèmes coralliens.
SPC / CPS
KIRIBATI
TOKELAU
SAMOA
AMERICAN SAMOA
SAMOA AMÉRICAINES
COOK ISLANDS
ÎLES COOK
NIUE
TONGA
FRENCH POLYNESIA
POLYNÉSIE FRANÇAISE
PITCAIRN ISLANDS
PITCAIRN


CRISP
COMPONENT 1A - Project 1A4
Integrated Coastal Management - GERSA Project
Spatial Approach - Remote Sensing
June 2007
Methodological analysis
OVERVIEW OF METHODS FOR MODELLING EROSION IN ISLAND SETTINGS
Authors:
Ahmed Batti
Christian Depraetere
IRD
PTPU
IFRECOR
COMPONENT 1A - Project 1A4
December 2007
TECHNICAL REPORT
Comparison of classification methods (SPOT Image) for land cover mapping in Efate (Vanuatu)
Author:
Valérie LAURENT,
under the supervision of Marc DESPINOY
FONDATION TOTAL
COMPOSANTE 1A - Projet 1A4
Gestion côtière intégrée - Projet GERSA
(GEstion des Récifs, du Satellite à l'Acteur)
Décembre 2007
RAPPORT TECHNIQUE
Développement méthodologique et spatialisation du risque d'érosion hydrique à Efate (Vanuatu)
Auteur:
Maxime FOSSEY
sous la direction de Pascal DUMAS
Marine Protected Area
SAFATA
MANAGEMENT PLAN
2008 - 2010
Governance towards Coastal Management
Author: V.VACELET
COMPOSANTE 1A - Projet 1A2
Appui aux aires marines protégées
RAPPORT TECHN
ÉTAT ZÉRO DES COMMUNAUT
BIOCÉNOTIQUES AVANT LA MISE
PLACE DE ZONES DE TYPE I.
AIRE MARINE PROTÉGÉE DE
YAMBÉ-DIAHOUÉ
EVALUATION RAPIDE D
BIODIVERSITE ET DU CON
SOCIO-ECONOMIQUE D
ZONE MARINE DU
DIAHOT-BALABIO
TUVALU MARINE LI
COMPONENT 1A - Project 1A4
COWRIE Project - Integrated coastal
TRAINING
BEST PRACTICE GUID
FOR
WATERSHED MANAG
IN PACIFIC ISLANDS
What is a Waters
&
Why look after
SCOPING OF CRISP SU
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PRELIMINARY
USP
IFRECOR

Ecosystem protection and management

3. Conservation planning

3.1 Identifying keys sites to create MPA networks

For 2012, international goals, e.g. Biodiversity Convention, Durban Decisions, target the development of coherent and representative networks of marine protected and managed areas covering 20 to 30% of marine habitats. In order to identify sites for inclusion in these networks, approaches concentrated on the main overall objectives of biological diversity conservation:

- represent and maintain all the distinct ecosystems, habitats and communities of a given ecoregion in an ecological network of protected areas;
- conserve biodiversity hot spots (the richest and most endangered sites);
- maintain ecological processes;
- maintain viable populations of species of special interest, e.g. endangered, key;
- conserve natural habitats that are large enough to resist large-scale disturbances and long-term changes.

3.2 Methods

While in principle they target the same goals, the methods used by the different NGOs vary slightly:

WWF works by ecoregion (homogenous region in terms of communities). Ecoregional analysis (ERA) is designed to identify sites of special interest within a single ecoregion. An initial stage focuses on site identification on the basis of the environmental criteria set out by the Convention on Biological Diversity (CBD), e.g.: scarcity, uniqueness, richness, productivity, iconic species. The second identifies the social and economic issues (uses) and the pressures affecting the identified sites. The third step attempts to create a common vision among the stakeholders on both the ecoregion and the strategy to be implemented to set up an MPA network.

As part of CRISP, two ecoregional assessments were carried out: one for New Caledonia's marine ecoregion, carried out by WWF–France from 2005 to 2007 in collaboration with the Noumea IRD Centre, and one for the French Polynesia-Cook Islands eco-region, conducted by WWF–France and the French Agency for Marine Protected Areas in French Polynesia from 2008 to 2010 and in Cook Islands by WWF–South Pacific.

In New Caledonia, sites were identified mainly by expert opinion during a workshop (August 2005) attended by 40 scientists from various agencies in the Territory (IRD, UNC, SPC), various local associations, consultants and provincial government officers.

In French Polynesia, the ERA was based on both expert opinion and an analysis of island and reef geomorphology, on the assumption that species diversity correlates closely to habitat diversity and is related to the geomorphologic complexity of the reefs.

In both cases, a use and pressure analysis was carried out (Junker, 2006 in New Caledonia and Lagouy, 2009, in French Polynesia).

Conservation International (CI) specifically focuses on species and works on global biodiversity "hot spots". As part of CRISP, in association with SPREP, CI carried out three analyses:

In **Fiji**, the Extinction Resistance Project (ERP) was designed to determine if the current network of marine protected areas is effective for conserving endangered species (as defined by IUNC) and associated critical habitats. An assessment was carried out to identify and locate populations of species of major interest for the conservation of global biodiversity (endangered or rare species) with reference to the current MMA network.

In **Samoa**, the key biodiversity area (KBA) approach was used. An area is considered to be a KBA when it meets one or more of the following requirements: it has one or more threatened species; it has species that are endemic to the site or the region; it has significant concentrations of one species (migration/breeding/nursery area); it has unique habitats or groups of species.

An initial assessment of hot spots at **the Pacific region level** was done.

In partnership with CI, CRISP also provided support to the NGO The Nature Conservancy (TNC) so that it could carry out an ERA in Palau as part of the Micronesia Challenge, a commitment made by the governments of Palau, Federated States of Micronesia, Guam, Marshall Islands and Northern Mariana Islands, to protect 30% of their marine costal zones. The goal for Palau is to identify priority zones for marine and coastal conservation, to assess gaps and to provide a long-term strategy for setting up a network of marine and land protected areas.

3.3 Outcomes of eco-regional assessments and other planning exercises

New Caledonia ERA

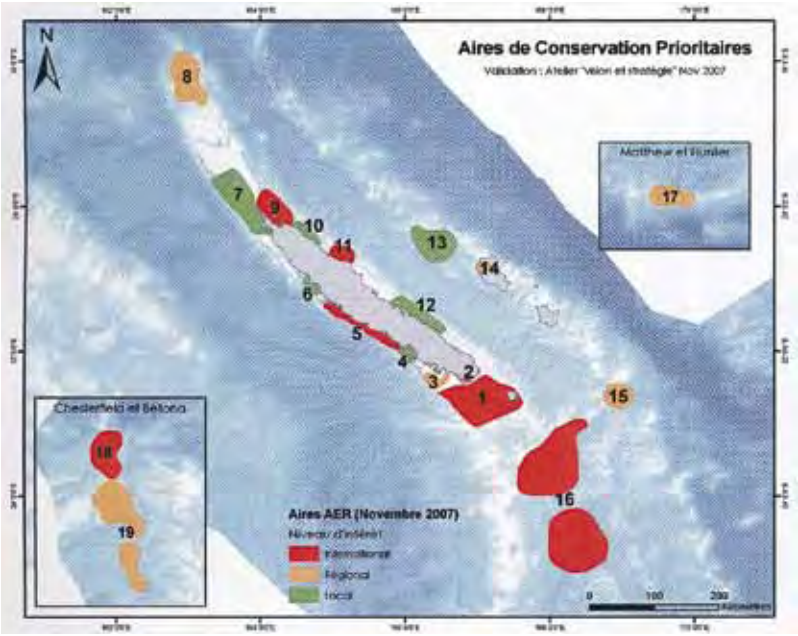


Figure 2: Priority conservation areas in New Caledonia

A variety of factors explain the great richness and unique nature of New Caledonia's lagoons: its geographic position in the South Pacific, near the centre of dispersion; its occupation of a broad latitudinal range; and the diversity of its environments, geomorphologic structures and habitats, which produce high species richness and very diverse communities, endemism, and unique fauna and flora. Its species richness figures suggest that New Caledonia could be part of the optimal species distribution zone.

Some 19 key conservation zones were identified (Gabrié et al., 2005), four of which are of global interest, six of regional interest and nine of local interest (see Fig. 2). Taking into account both the size of areas and the intensity of human pressures (Junker, 2006), it was proposed that priority be given to actions in Prony Bay, the central-western lagoon, and then the Greater Noumea lagoon and the Hienghène site. Guidelines for an action plan were formulated during a workshop attended by 150 people (representatives of public agencies, companies, associations, research institutions, traditional leaders, civil society and volunteers). The action points were consolidated into three broad strategic areas:

- institutional strengthening and MPA management;
- MPAs' contribution to resource management and sustainable development;
- Scientific research in MPAs.

French Polynesia – Cook Islands ERA

French Polynesia's uniqueness lies in its extreme extension over both latitude and longitude; its relative poverty in terms of species due to its isolation in the eastern portion of the biogeographic province, with relatively homogenous communities, nevertheless featuring original flora and fauna, with endemism in certain isolated zones or those at the edges of the region (Rapa, Marquesas); and in the great diversity of the 120 component small islands and atolls. The island groups' locations and the islands' geomorphology play a vital role in community richness and distribution. The ERA identified 60 key islands or atolls, i.e. nearly 50% of all the islands in French Polynesia (see Fig. 3):

- 16 of top priority interest due to their key ecological importance (protection and management issues);
- 31 of priority interest (priority 2), due to their ecological importance (protection and management issues and/or knowledge);
- 11 potentially important islands and atolls for which little knowledge is available (knowledge issue);
- 2 islands with specific status, i.e. Mururoa and Fangataufa, former nuclear testing sites belonging to the French Government.

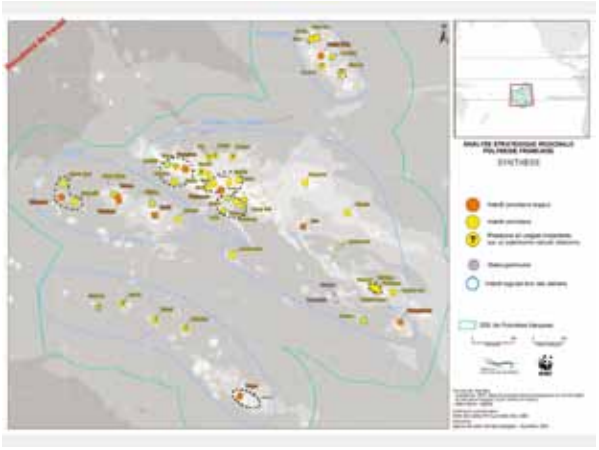


Figure 3: Summary of the regional strategic analysis for French Polynesia

Pressures arise from activities in marine settings but more particularly from activities on land, in the watersheds. In French Polynesia as a whole, where many islands are uninhabited, pressures on the marine environment are relatively low and localised, except in the Society Islands.

Four main strategic areas were identified during the final strategy workshop attended by about 50 stakeholders from the Territory (December 2009):

- research/expanding knowledge;
- developing a coherent network of marine protected areas throughout French Polynesia, based on the identified sites;
- management and governance: need to set up an MPA management agency, importance of joint management and integrating traditional management practices;
- integrated management and the land-sea link.

In **Cook Islands**, the assessment was mainly based on expert opinion expressed during workshops. The islands were categorised on the basis of their importance in terms of one or more groups of species identified as priorities. Some 47 sites spread over 17 islands were identified. The islands in the north, e.g. Penrhyn, Rakahanga, Suwarrow, Manihiki, Palmerston and Pukapuka, were given priority due to the still very virgin nature of their sea beds, the large numbers of spawning grouper aggregations (*Cheilinus undulatus*) or the existence of unique habitats.

In **Fiji** (P. Anderson, 2010), about 100 marine species are listed as vulnerable, endangered or critically endangered on the IUCN Red List. On the basis of existing information (GCRMN, WCS, Fisheries Department reports and other reports), the distribution of certain sites was mapped (e.g. turtle egg-laying sites, location of threatened species recognised by WCS, occurrence of *Cheilinus undulatus* in fishing grounds or *iqoliqoli)*, and this distribution was cross-referenced with the location of the *iqoliqoli*, Fijian LMMAs (FLMMA) and their no-take zones (NTZ). More than 200 sites or sectors were identified as having at least one species on IUNC's Red List in Fijian waters at least at some point each year. This very preliminary study indicated that the disparate nature of the data does not allow any conclusions to be drawn as to the effectiveness of the managed area network in Fiji.

In **Samoa** (P. Anderson, 2010), the key biodiversity areas (KBA) were identified on land and in marine settings, on the basis of the existence of coral and fish (humphead parrotfish, napoleon wrasses, sharks), along with sea turtles or coconut crabs. A total of eight land KBAs (970 sq km) were identified seven marine KBAs (173 sq km, i.e. about 23% of the coastal waters): Aleipata, Apolima, Vaisignano, Safata, Five Miles Reef, Vaotupua, Palolo Deep. Among these seven marine sites (see Fig. 4), three are already partially protected by either the government or communities, and two include small community fishing grounds. These KBA include six of the 17 vertebrate species on the IUNC's Red List, 48 species of coral, and 17 types of coastal habitats. Pressures are mainly related to fishing, poaching at turtle egg-laying sites and, more infrequently, tourism or pollution. But the realities of managing protected/managed sites vary and most need to be strengthened to ensure effective protection. The Five Mile Reef and Apolima sites, which are not yet protected, should be given priority.

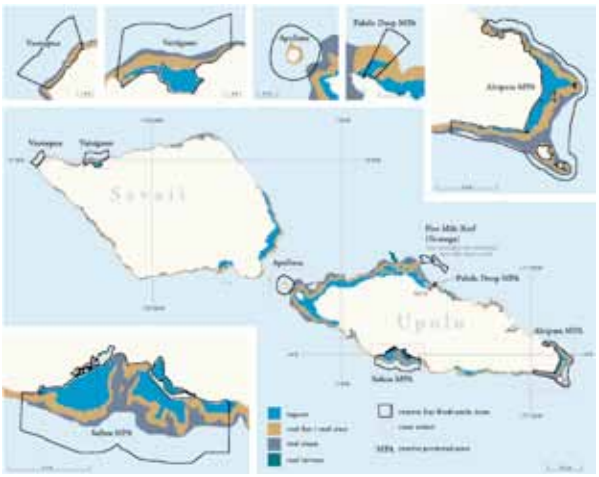


Figure 4: Marine KBA in Samoa (Anderson, 2010)

For the **South Pacific,** i.e. the 21 SPREP countries and territories, work was based on an analysis of various SPC documents (PROCFish programme), the SPREP database, national strategies and action plans for biodiversity and various documents from the Convention on Biodiversity (CBD), as well as on meetings with scientists and a variety of stakeholders. The 2010 IUNC Red List for the region's marine species, endangered worldwide, included 231 species (Paul Anderson, et al., 2010). Particular attention was paid to the distribution of so-called iconic species, sea turtles, cetaceans and endangered fish species listed as such by the PROCFish programme. But this analysis was very preliminary and did not allow any sites to be identified.

In Palau, 28 conservation areas with varying statuses are protected for resource management purposes. As part of the Micronesian Challenge, a strategic workshop was held in 2006, designed to summarise existing knowledge, help with planning and set up a national network of marine and land protected areas. Various scenarios were proposed.

Key points

For 2012, international goals, e.g. the Biodiversity Convention, the Durban Decisions, target the development of coherent and representative networks of marine protected and managed areas covering 20 to 30% of marine habitats. MPA network planning assessments and the eco-regional analyses carried out by WWF or CI's endangered species approaches ("Key Biodiversity Area", "hot spots") are designed to identify the sites that are vital for maintaining biodiversity and the populations of threatened or rare species to be included in those networks.

As part of CRISP, under the leadership of WWF and CI, these assessments identified 19 priority conservation areas in New Caledonia, 60 key islands in French Polynesia, 47 sites in Cook Islands and seven key marine biodiversity areas (KBA) in Samoa, i.e. more than 100 key sites in the South Pacific .

Two eco-regional assessments were carried out, with the support of many local participants, i.e. in the marine ecoregion of New Caledonia, which WWF–France carried out from 2005 to 2007, in collaboration with the Noumea IRD Centre; and in the ecoregion of French Polynesia-Cook Islands, conducted in French Polynesia from 2008 to 2010 by WWF–France and the French Agency for Marine Protected Areas and in the Cook Islands by WWF–South Pacific. They made it possible to work with all those involved in these territories on developing conservation guidelines for the identified sites.

In New Caledonia, the ecoregional analysis was carried out in close coordination with the process to have New Caledonia's lagoon added to UNESCO's list of World Heritage Sites. This work helped identify and describe the sites to be listed, gather information on their exceptional and universal value and provide the scientific basis for formulating the submission for their inclusion on that list.

In French Polynesia, the ERA has just been completed and can now inform the policies of the French Polynesian Ministry. One of the major recommendations, i.e. to strengthen MPA management, was approved and the French Polynesian Government has decided to create a "Conservatory of Managed Areas", with the support of the French Agency for Marine Protected Areas and the Coastal Conservatory. This Conservatory will cover managed and protected maritime, coastal and land areas.

SPREP and CI worked in Fiji on the Extinction Resistance Project (ERP), which makes it possible to assess the effectiveness of the current network of marine areas for the conservation of endangered species (as defined by the IUNC) and related critical habitats. In Samoa, land and marine KBA were identified; three are already protected, and two sites that are not protected yet have been given priority for action. A rough assessment of the "hot spots" at the Pacific region scale was done.

In partnership with CI, CRISP also provided support to the NGO The Nature Conservancy (TNC) to carry out an ERA for Palau as part of the Micronesia Challenge, a commitment the Governments of Palau, Micronesia, Guam, Marshall Islands and Northern Mariana Islands made to preserve 30% of their coastal marine areas. The goal in Palau is to identify priority zones for marine and coastal conservation, assess the gaps and provide a long-term strategy for creating a network of marine and land protected areas.

Developed in close partnership with all the players familiar with this area, e.g. NGOs, scientists, managers and local communities, these approaches enable the collection, compilation and summarising of all the published or expert information on the region's biodiversity and make it available to decision-makers. They bring scientists together and lead them to review current knowledge and to themselves determine the vital zones in their study regions; in this way, for the first time, in New Caledonia, French Polynesia and Samoa, the ERAs provided an overall picture of the distribution of the key elements of biodiversity and the threats. These assessments also brought the NGOs that carried them out and the scientists who possess the knowledge and data closer together.

But all this work demonstrated the difficulty of obtaining scientific data, particularly georeferenced locations for species or habitat data which are needed for more in-depth analysis, either because the data do not exist, which is still the case in a great many Pacific Islands, or because they are spread out over the many research agencies in the region and are thus difficult to assemble in a short period of time. Nevertheless, CRISP did make some significant contributions to improving the situation.

Bibliography

Anderson P. (2011a). Findings for Fiji Extinction Resistance Project. Scientific report, 24 pp.

Anderson P. (2010b). Priority Sites for Conservation in Samoa: Key Biodiversity Areas. Conservation International – Pacific Islands Programme, Ministry of Natural Resources and Environment, Secretariat of the Pacific Regional Environment Programme. Apia, Samoa. 32 pp.

Anderson P., Kinch J. (2011). Threatened marine biodiversity in the Pacific Islands Region. Scientific report, 33 pp.

Brugneaux S., Lagouy E., Alloncle N., Gabrié C., 2010. Analyse écorégionale de Polynésie française. Rapport CRISP/AAMP/WWF. Volume 1. synthèse des connaissances « écosystèmes et patrimoine naturel »: 67 p; volume 2 : synthèse des connaissances « usages et pressions » : 38 p; volume 3 : document de synthèse : 135 p.

Downer A., Gabrié C., Preliminary results of the eco-regional analysis (ERA) of the marine systems of New Caledonia for the conservation of marine biodiversity. Biodec Symposium, Nouméa, Nouvelle-Calédonie, 30 oct. – 04 nov. 2006, Poster.

Gabrié C., Bouvet G., Chevillon C., Cros A., Downer A., Juncker M., Lévy-Hartmann L., You H. et al. (2008). Analyse écorégionale marine de la Nouvelle-Calédonie. Rapport CRISP, 104 p.

Gabrié C., Chevillon C., Bouvet G., Cros A., Downer A. et al., Analyse écorégionale marine de la Nouvelle-Calédonie. 11th Pacific Science Inter-Congress 2009, Tahiti, Polynésie française, 02–06 mars 2009, Poster.

Gabrié C., Allen G., Bouilleret F., Downer A., Garrigue C., Géraux H., Herrenschmidt J.-B., Ody D., Petit M., Pichon M., Seguin F., Virly S., You H. (2008). Evaluation rapide de la Biodiversité et du contexte socioéconomique de la zone marine du Diahot-Balabio. Rapport WWF, 152 p.

Juncker M., Bouvet G. (2006). Analyse écorégionale de Nouvelle-Calédonie – Introduction à l'étude des pressions et menaces sur les écosystèmes littoraux de Nouvelle-Calédonie. Rapport CRISP, 68 p.

Gabrié C., Cros A., Downer A. et Chevillon C., Analyse écorégionale de Nouvelle-Calédonie – Atelier d'identification des aires de conservation prioritaires, Nouméa, Nouvelle-Calédonie, 10–11 août 2005, Rapport d'atelier CRISP, 2005, 96 p.

Lagouy E., Gabrié C., Brugneaux S., Clua E., Aubanel A. Analyse écorégionale marine de Polynésie française. 11th Pacific Science Inter-Congress 2009, Tahiti, Polynésie française, 02–06 mars 2009, Présentation PowerPoint, 6 p.

Lévy-Hartmann L. (2007). Analyse écorégionale de Nouvelle-Calédonie – Atelier Vision et Stratégie, Nouméa, Nouvelle-Calédonie, 13–15 nov. 2007. Compte rendu d'atelier CRISP, 51 p.

Matepi M., Gabrié C. (2008). East Polynesia Ecoregion: Cook Islands & French Polynesia – objectives 1.1a & 1.2a & b. CRISP report, 22 pp.

Martel F., Miller S., Scoping of the CRISP support to Palau and the Micronesian challenge. Preliminary mission report, 2007, 10 pp.

Table 2 : Characteristics of the main MPAs developped amongst the CRISP framework (updated source from T. Clement)

Created amongst CRISP	Additional surface km²	Additional support km²	CRISP partner	Country	Name of MPA	Status	Budget K€	Budget per MPA	Budget per add. created km²	Budget per add. supported km²
Yes	410,500		CI	Kiribati	Phoenix Islands PA	Functioning management plan	725	725	0.002	
No		63	Govt Samoa	Samoa	Aleipata MPA	Revised management plan + Support to trust fund	200	100		1.72
No		53	Govt Samoa	Samoa	Safata MPA					
Yes	50		FSPI	Solomon	Guadalcanal – 8 MMAs from Marau	Management plan established	67	4,8	1.22	
Yes	3.1		FSPI	Solomon	Malaika – 8 MMAs from NGela					
No		1,65	FSPI	Solomon	Malaika – 7 MMAs from Langa Langa	CRISP support after creation				
Yes	?		FSPI	Tuvalu	Nukufetau	Management plan established	54	27		
Yes	?		FSPI	Tuvalu	Nanumea					
Yes	5		FSPI	Vanuatu	Mistery Island		31	4.4	1.91	
Yes	11.2		FSPI	Vanuatu	7 MPAs from North Efate					
Yes	?		FSPI	Kiribati	Tarawa	Awareness; capacity building	32	32		
Yes	84		WWF	New Caledonia Northern Province	Yambe Diahoué Pouebo	Baseline surveys done; management plan in prep.				
Yes	7		WWF		Yeega Hienghène					
Yes	37		WWF		Dohimen Hienghène					
No		167	WWF	N.C South. Prov.	Yves Merlet reserve		93	93		0.56
No		49	CCU	French Polynesia	PGEM from Moorea (10 MPAs and 2 fishing zones)	CRISP support after creation	Limited funding			
Yes	?		WWF	Cook	Muri lagoon	?				
Yes	?		WWF	Cook	Mitiaro	?				
In creation	0.82		WWF	Cook	4 Ra'ui	Ongoing baseline surveys	92	23	112.2	
Yes	?		IFRECOR	Cook	Aitutaki - new MPAs	Environnemental diagnosis	Impossible to assess given the early stages			
In creation	243		IFRECOR	Wallis and Futuna	PGEM from Wallis, Futuna and Alofi		97	32,3	0.40	
Total	411,138	334					1 564	23 / 41	0.0038 / 1.31	

4. Marine protected/managed areas and integrated management

4.1. Introduction to MPAs

A wide range of terms is used in describing marine protected areas, reflecting different statuses and governance modes. In this section, we will use the generic term, marine protected areas (MPA), taken in the widest sense.[12]

Over a period of six years, CRISP assisted in the creation or strengthening of 46 MPAs, from the smallest to the largest one in the world, covering a total surface area of 411,138 sq km in seven countries and the three French Pacific territories (or 638 sq km if we exclude the Phoenix Island MPA, which, by itself, totals some 410,500 sq km). Of these MPAs, 34 are community-based management areas (LMMAs, see inset). Their surface areas vary widely but they are generally small: less than 1 sq km for LMMAs and up to 84 sq km for the Pouébo MPA in the Northern Province of New Caledonia (see Table 2, preceding page).

12 In this document, the term MPA covers any marine or intertidal area that is clearly marked out (physically or otherwise), recognised legally or by any other effective means, including traditional and custom means, designed to protect biodiversity and the environment, maintain fisheries resources, and safeguard the services provided by ecosystems and cultural values. It covers all the generally recognised categories from marine areas that are protected and managed by regulations (MPA in the strict sense) and small community areas that are protected/managed locally (MMAs/LMMAs); see inset on following page).

The definition of MPAs and MMAs (Marine protected and managed areas, according to Govan, 2009)

In his final summary document on marine protected areas, H. Govan (2009) provides a definition of community-based conservation areas, LMMAs and MPAs:

Community-based management and/or conservation areas (CCAs): zones that are voluntarily protected by indigenous communities through custom law or other effective means (Fijian *vanua*, Polynesian *ra'ui*).

Local management areas (locally-managed marine areas or LMMAs): areas that are managed, entirely or in large part, at the local level by coastal communities, landowners, partner organisations and/or the local government; management approaches, often based on existing customary practices, range widely from species reserves, temporary or revolving reserves and/or restrictions on fishing efforts (via restrictions on gear or seasons) and do not necessarily involve a total ban on use of the resources.

Marine protected area (MPA): any clearly defined (physically or otherwise) marine or inter-tidal area recognised legally or by any other effective means designed to ensure long-term conservation of the environment, as well as protection of the services provided by the ecosystems and of cultural values.

- In New Caledonia, WWF, with the support of the Northern Province, created two MPAs in the north-eastern part of the Northern Province, i.e. the MPA at Pouébo (Pweevo) and the Hienghène MPA. Work was also carried out in the Yves Merlet Reserve in the Southern Province.
- In Wallis, Futuna and Alofi, the NGO ProScience performed feasibility studies on three 'PGEM' (Maritime Area Management Programmes) using the PGEM model implemented on Moorea.
- In French Polynesia, support was provided to the Moorea PGEM.
- The NGO FSPI (Foundation of the Peoples of the South Pacific International) worked on a large number of MPAs in Vanuatu (8 sites), Solomon Islands (3 groups of MPAs totalling 23 sites in 3 provinces), Tuvalu (2 sites) and Kiribati (1).
- In Samoa, CRISP helped the Ministry of Natural Resources and Environment formulate management plans for the MPAs of Aleipata and Safata which existed already and provided support to an existing trust fund, whose revenues pay for part of the MPAs' operating costs.
- In Cook Islands, two MPAs are being set up by WWF–South Pacific and the NGO ProScience has proposed a management plan for the island of Aitutaki, along the same lines as PGEM.
- In Fiji, studies were carried out on the existing MPA in Navakavu, using fishers' views as part of participatory resource management, along with an economic assessment of the value of MPAs.
- In Kiribati, Conservation International (CI) supported, through a matching funds arrangement, the creation of the largest MPA in the world in the Phoenix Islands group (see Fig. 5).

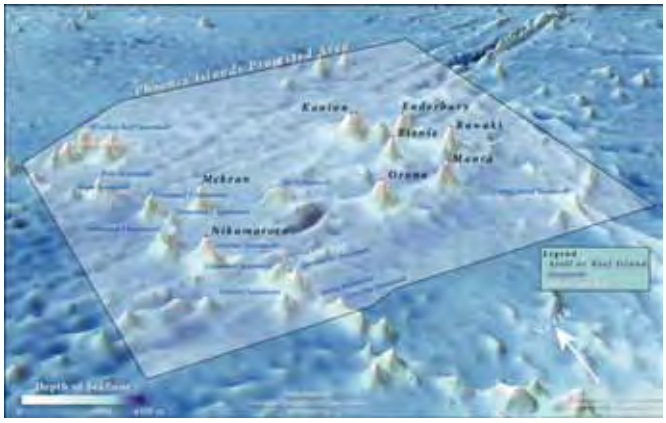


Figure 5: Phoenix Islands MPA

4.2. The various MPAS created or supported

Process for creating protected and managed areas

A variety of community management/protection projects designed by stakeholders within CRISP were developed using a participatory process (with local variations) that was very similar to the one used around the world:

- communities volunteer;
- they are most often supported in the process by NGOs with the collaboration of local authorities;
- an initial phase consists of informing and educating the population;
- the participatory work begins, designed to develop a participatory diagnosis, e.g. identifying the elements of natural heritage, resources and uses; identifying threats and proposing solutions along with participatory mapping; determining the area's boundaries and marking them with buoys with zoning, where necessary (zones with varying levels of protection); defining management directions and producing a management plan; and choosing a management committee.

Adaptive management, which is most often used, allows the management plan to be revised on a regular basis in light of the results of monitoring the resources and the environment (baseline study) and the community's expectations. The most important component is community ownership. Where appropriate, alternative activities are selected and implemented. An exit strategy is sometimes formulated so that the MPA can continue to operate independently.

Pacific Island community management areas

The NGO FSPI supports a network of 10 civil society organisations in 10 Pacific countries (national FSPs) who provide support in the area of land and marine resource management and contribute, in particular, to the creation of small community MPAs called Locally-Managed Marine Areas (LMMAs), Village-Based Resources Management Areas (VBRMAs), Community-Based Resource Management (CBRM), Community-Based Fisheries Management (CBFM), or Village Fisheries Management Plans (VFMP) (Govan, 2009). Herein, all of these areas will be referred to using the generic term MMA. These are areas under the control of villages, in which fishers have special or even exclusive rights of entry, which are managed by the community and within which small areas where fishing is completely banned, i.e. "no-take zones" (NTZ), are created. There are about 500 locally managed areas throughout the Pacific in 15 countries (Govan, 2009; see map p. 46).

As part of CRISP, 34 MMAs at eight sites and in four countries – Vanuatu, Solomon Islands, Tuvalu and Kiribati – have benefitted from funding either for their creation or, when they already existed, to strengthen their management. All the sites (except Kiribati) have formulated and implemented management plans.

A large number of these MMAs are part of national networks: Fiji (FLMMA), Vanuatu (VBRMA), and the Solomon Islands (SILMMA), which, in turn, are federated into one regional network (LMMA network) designed to pool experience and seek synergy. This network benefits from the support of the American MacArthur and Packard Foundations.

The LMMA model is based on customary marine and land tenure and traditional local governance systems, particularly on the ra'ui, temporary restrictions or bans on catching a species or in a zone declared tabu, where fishing is prohibited, often until the stock recovers, and the reserve is then reopened. The modern LMMA mode of protection is based on these now-revived practices. The model's interest lies in its very low management costs (volunteering and using the traditional solidarity and power structures within the villages) and a high degree of ownership of the approach by local communities. Although the size of protected marine areas is still below the size needed to constitute ecologically significant spaces,[13] this approach has the advantage of educating and mobilising communities.

Figure 6: The Marau MPA

In Solomon Islands, CRISP supported actions in three provinces, i.e. Marau (eight MMAs created, grouped into one MPA) (see Fig. 6), LangaLanga (seven MMAs

13 Given the mean dispersal of benthic organisms, over about 10 km, several studies recommend that MPAs be 10 to 20 km in diameter, e.g. about 500 sq km, located 10 to 20 km from each other, in zones with high habitat diversity including zones that cover species' life cycles, (Mora et al, 2006. Coral Reefs and the Global Network of Marine Protected Areas, Science vol 312; 23.)

created) and NGela (Sandfly: eight MPAs created or supported). The participatory management process involved about 20 communities; very pragmatic management plans, in terms of the problems and solutions chosen, were drawn up for each of the three provinces. Marau, with the financial support of CRISP, is now part of the Solomon Islands' LMMA network; the MMAs were marked out with buoys. LangaLanga created a committee for the environment to manage the MPA sites. Activities were carried out to reduce the amount of coral collected for lime, to engage in restoration and to set up coral farms. In Ngela (Sandfly) the communities have secured legal recognition of their MMAs by provincial authorities. Young volunteers trained by FSP Solomon Islands and the Fisheries Department carry out monitoring. The FSPI and Reef Owners Association, (ROA) would like to set up a managed zone to link all the MPAs created. The surface area would then go from 3 to 72 sq km.

- In **Vanuatu,** two sites in two provinces were involved in the creation of a total of seven VBRMAs, i.e. North Efate (six MPAs: Paonangisu, Marou, Sama, Takara, Emua and Sivir) and Mystery Island on Aneityum (one MPA). Village management plans incorporating traditional management and governance methods (*tabu*) were formulated and endorsed in all the communities, with the support of the Fisheries Department, the Wan Smolbag association and FSP Vanuatu. In all, some 25 communities were involved and trained in management plans and biological monitoring for fisheries and turtles. A network of village reserves (VBRMA) is being set up at the country level; it currently covers 100 villages. Exit strategies are being formulated for those sites that have demonstrated sustainability and self-sufficiency qualities.

- In **Kiribati**, the process of creating MMAs has begun (community information and training) at a site in northern Tarawa, and is also beginning in Betio and Bonriki, where participatory workshops have been held. But FSPI's modest budgetary capacities are likely to limit actions.

- In **Tuvalu**, two sites are involved, i.e. Nanumea and Nukufetau, with traditional MPAs being strengthened and action plans being prepared to manage marine resources and watersheds, including waste management. In isolated atolls, communities have been educated about protecting their resources with the support of the NGO TANGO.

Baseline biological studies and monitoring have been carried out at the sites; knowledge has been enhanced on a variety of topics such as reef restoration, coral bleaching, *Acanthaster* invasions and reef resilience; and information has been provided to local communities on the impact of MPAs, and, notably, on the usefulness of fishing management measures, e.g. no-take zones, revolving reserves, catch sizes, seasonal closures, connectivity.

But the major benefit has been community capacity-building and empowerment (see inset).

Overview by FSPI of the main conclusions from and lessons learnt in establishing and providing and support to LMMAs as part of the CRISP Programme (FSPI, 2010)

Within CRISP, most communities have received support from FSPI to expand knowledge, revitalise traditional governance modes and integrate traditional knowledge and scientific data.

Adapting models: in terms of resource management and conservation, the immediate priorities of small island communities differ from those of big countries. In Kiribati, the communities give higher priority to waste management and issues related to climate change. Strategies to lead communities to better manage fisheries must therefore be reviewed. Priorities and actions to improve subsistence resources in Tarawa (Kiribati) and Funafuti (Tuvalu) have yet to be identified.

Biological monitoring: the goal is to implement a protocol that allows the community to easily monitor the effects of its management options, such as the "Learning Framework". Indicator species are chosen by the communities and differ from one community to the next, which makes it difficult to standardise methods. The monitoring technique must be easy to implement and specific to the biological indicators. Teams have noted that even in so-called "autonomous" zones support to communities for biological monitoring must continue.

Effect of the LMMAs: monitoring data for the sites indicate an increase in the abundance of target species within protected areas as well as in nearby fishing zones.

Project management: capacity building in project management is needed for local NGOs and FSP national coordinators. Work at sites in Tuvalu and Kiribati is on hold due to a lack of funding. The change in CRISP's priorities had a major influence on support for the network's activities and the sites.

Some of these communities can be considered to be self-sufficient and sustainable (examples in Vanuatu). On the other hand, for sites where traditional values and respect for custom leaders are on the decline, with conflicts, it is a slow process to set up MPAs and formulate management plans, and the results are unstable (Kiribati and Tuvalu).

The development of alternative activities has been more modest to date, but guides have been written on developing subsistence resources in the region (Govan, 2011).

Phoenix MPA (Kiribati)

In 2006, the largest MPA in the world was created in Kiribati, with the support of Conservation International (CI) and the New England Aquarium. The protected area covers all the islands and surrounding waters of the Phoenix Island group (PIPA: Phoenix Islands Protected Area), i.e. some 408,250 sq km, including 30% as no-take zones. PIPA includes the eight atolls and low coral islands in the Phoenix Island group (Rawaki, Enderbury, Nikumaroro, McKean, Manra, Birnie, Kanton and Orona) and two coral banks, Carondelet Reef and Winslow Reef, located at depths of 3-4 metres. It has been estimated that there could be more than 30 seamounts, only nine of which were previously known. Most of the zone's surface area consists of ocean with average depths of more than 4000 m.

Discussions between the Governments of Kiribati and the United States have led to an even broader vision known as the "Pacific Ocean Arc Initiative", which CI plans to support over the long-term as part of its "Pacific Oceanscape" strategy. In that regard, CI, along with the Government of Kiribati, supports the creation of a trust fund (Calas J., 2009).

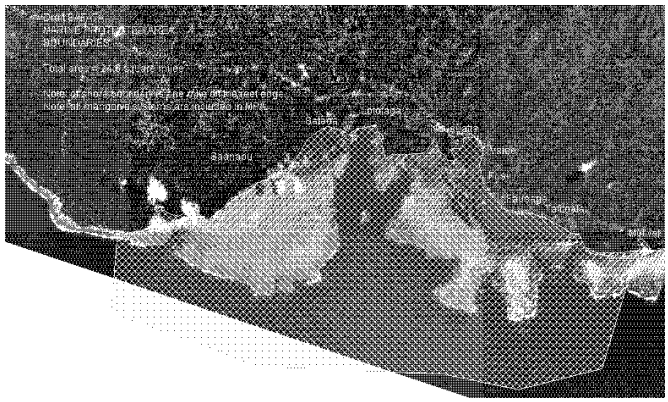


Figure 7: The Aleipata (left) and Safata (right) MPAs

Aleipata and Safata MPAs (Samoa)

The MPAs of Aleipata (63 sq km) and Safata (53 sq km) were created in the 2000s, with initial funding from the Global Environment Facility (GEF/World Bank); 11 villages in Aleipata district and nine villages in Safata district were involved, with the support of the Samoan Government and IUNC. For each MPA, CRISP made it possible to update the management plan for the 2008–2010 period (see Fig. 7 and box below).

Both sites benefit from a small trust fund (ASMPA – Aleipata and Safata Marine Protected Areas) whose income from interest covers their operating expenses. This trust fund, created by the government, received some € 72,000 in support from CRISP.

Unfortunately both sites were hit by a tsunami in October 2009, which particularly devastated Aleipata. Most of the villages in the zone covered by the Aleipata MPA were destroyed and the reef was heavily damaged. It will take many years to rebuild these sites. Safata, where the mangroves are more extensive, did not suffer as much. CRISP set up a fund to assist with the restoration of these sites.

The main areas covered by the Aleipata and Safata management plans

These management plans emphasise:

- cultural aspects;
- strengthened management of fisheries and coastal areas;
- restoring and managing distant islands;
- creating a turtle conservation programme in Aleifata and a mangrove protection programme in Safata;
- developing sustainable fair-trade tourism;
- carrying out feasibility studies on developing aquaculture and repopulating the reef (three target species);
- public awareness and education;
- zoning for the MPA.

Cook Islands

WWF–South Pacific supports two MPAs in Cook Islands, i.e. Mitiaro and Muri Lagoon, covering a total surface area of 0.83 sq km over the two projects. Community and school meetings were held along with training workshops; management plans were revised (Muri Lagoon) or formulated (Mitiaro), along with a monitoring programme (Mitiaro). A sustainable funding plan is due to be formulated for these two MPAs, along with a project to restore Avana (Muri).

In Aitutaki, about 10% of the lagoon's surface area is managed through three ra'ui.[14] Consultants Pae Tai Pae Uta (French Polynesia) conducted a participatory diagnostic of the environment and uses (Egretaud, 2010). WWF is providing community training and drafting initial management plans for the ra'ui.

Fiji

In Fiji, Navakavu LMMA, near Suva, was the focus of studies examining several topics, including using fishers' views as part of participatory resource management, assessing the scientific reliability of underwater visual census surveys conducted by local communities and NGOs, and making an economic assessment of the value of this MPA (see corresponding sections).

New Caledonia

The Northern Province and WWF–France initiated a project to create an MPA on the north-east coast of New Caledonia in June 2006, in collaboration with ADECAL, IFRECOR, IRD and UNC.

Three MPAs were created in 2009, accounting for a total surface area of 12,785 ha (including 5,705 ha of high-level protection), with zoning consisting of tabu zones, i.e. temporary no-fishing areas, or open access zones:

- Yambé Diahoué MPA (AMPYD) in the township of Pouébo, (8,407 ha including 1,327 ha of high-level protection zones);
- Yeega-Hienga MPA (AMPHI) in the township of Hienghène (660 ha);
- Dohimen MPA AMPDO (Doïman), township of Hienghène, (3,718 ha).

These MPAs are all part of the area included on UNESCO's World Heritage List.

14 A ra'ui involves implementing temporary restrictions or bans on human activities such as fishing, collection or farming, often covering specific species, e.g. coconut, turtles

This very participatory creation process lasted about two years. A mapped inventory of customary uses (e.g. tabu zones) and traditional knowledge was made and basic scientific knowledge was enhanced (e.g. habitat mapping, baseline status, meta-database). The MPA boundaries were laid out with the tribes and traditional leaders, and rules and co-management arrangements were discussed. A co-management committee was created for each MPA as a non-profit-making association under the Law of 1901; they involve the Northern Province, the townships, tribes and traditional authorities, representatives of fishers and tourism companies. Management plans are being formulated; topic-based working groups and notebooks have allowed all the local communities to be involved.

In addition, this process has been accompanied by several development and educational activities, many of which were quite innovative (see inset).

Activities to accompany the establishment of MPAs

- Creation of trails, with educational materials, over about 1.8 km in the mangrove; tourist facilities on Yéga Island (underwater trail, botanical trail, tourist facilities, snorkelling);
- Educational projects on the environment and sustainable development: coral spawning monitored each year since 2007; regular monitoring of turtle hatching, activities to restore reefs, numerous visits to local schools;
- A six-monthly newsletter (the MPA Journal) is published and includes forms for completion encouraging readers to take part in collecting information;
- Horsehoof/bear claw clam (*Hippopus hippopus*) repopulation operations by the management committees. Some 300 giant clams from a local farm were tagged and placed on the reef. Monitoring of the operation at the first site showed that, after nine months, mortality was about 10% (natural predation by turtles). These activities, which were greatly appreciated by the local communities, created ties between the management committees.

Exchanges were held with the Fijian LMMA community. They made a strong impression on the participants.

Southern Province MPA

The Yves Merlet Reserve is the oldest in the Southern Province (created in 1970; only 167 sq km) and one of the oldest in France. As part of the project to have this reserve reclassified, in relation to a nearby mining project, its current status was reviewed (see section on "Expanding knowledge" [p.83]). The reclassification project was, however, not pursued further.

Wallis, Futuna and Alofi Marine Management Plan (PGEM)

As part of CRISP, the Wallis and Futuna Environment Department, with support from the ProScience association, decided to research the prospects for a PGEM (see box for definition) for the islands of Wallis, Futuna and Alofi. An initial feasibility study was carried out in 2007 (Verducci et al.). It revealed the advanced state of degradation of the reefs of Alofi,but more particularly those of Futuna, and a decrease in resources due to destructive fishing practices. It identified four key zones in Futuna and Alofi. It highlighted the need to formulate two different PGEMs, one covering both Futuna and Alofi (Kingdom of Alo) and the other for Wallis, where the context differs. One of the team's main recommendations concerned the need to inform the currently unaware community of the causes of this degradation of both resources and the marine environment.

Following this initial visit, environmental diagnostics were done for Wallis (Egretaud, 2007a), and Futuna and Alofi (Egretaud, 2007b). Two atlases were produced. The study concluded that PGEMs were vital but not sufficient and that they needed to be combined with an integrated watershed approach.

Moorea PGEM

The Moorea PGEM (49 sq km) was officially approved in 2004. Management has been mandated to a non-profit-making (French Law of 1901) association. CRISP funded the purchase of a boat. With SPREP, a funding plan was proposed for the PGEM to try to provide financial autonomy (see chapter 8).

PGEM (Marine Management Plan)

A PGEM (marine management plan) is a specific marine area management tool from French Polynesia that has recently been extended to Wallis and Futuna. It covers maritime areas from the coast to beyond the barrier reef with boundaries that vary depending on the island involved. There are a number of objectives: participatory management, protection, sustainable resource management, use conflict management. This regulatory tool includes zoning and regulations. Zoning marks out the different types of area, e.g. marine protected areas, regulated fishing areas. The regulations set out the specific conditions for use, development and exploiting resources and for protecting and conserving each one of the zones. It is formulated by local government departments in close collaboration with local communities.

Protecting spawning aggregations in Palau

CRISP supported the work of SCRFA (Society for Conservation of Reef Fish Aggregations) to protect spawning aggregations by devising extension materials and holding a regional workshop that brought together fisheries department technicians from six countries in the zone to train them in sustainable management of reef fish spawning aggregations: identifying spawning areas and implementing specific management rules, e.g. quotas, temporary closures. A film on the value of these aggregations was produced (Y. Sadovy).

4.3 Expanding knowledge on establishing and managing MPAs

Several basic and applied research projects were carried out as part of CRISP, directly concerned with developing MPA networks and creating and managing MPAs (see section on "Expanding knowledge" [p.83] and Chapter 8). These studies covered:

- **Connectivity and larvae dispersion**, in Papua New Guinea (Almany et al., 2007; Planes et al., 2008, 2009; Saenz-Agudelo et al., 2009) and, at a larger scale, in the Pacific (Swarup, 2008);
- **Resource monitoring in MPAs**, community monitoring and the impact MPAs have on resources or the "reserve effect" (Navakavu, Léopold et al., 2009; Comley, 2007; Dumas et al., 2009; Emmanuelli, 2006, etc.);
- **Assessing the social and economic benefits** of MPAs (Pascal, 2010; O'Garra T., 2007).

Socioeconomic monitoring - "SEM-Pasifika", developed under the auspices of CRISP, studies the social, cultural and economic conditions of communities living near an MPA (see section on "Expanding knowledge").

Example of an integrated approach: Vanuatu

The northern part of Vanuatu, in the region of Efate, can be considered a "showcase" site for CRISP, where the integration of various watershed/MPA approaches was the most advanced, governance was the most rational and strong and there was the greatest number of activities by the various programme components:

- Creation of LMMAs (FSP Vanuatu);
- Development of MPA monitoring, with identification of appropriate methods (Dumas, Léopold, Pascal);
- Strengthening governance at the national level with the creation of an inter-departmental steering committee to pool data from the various government agencies (IRD's GERSA programme);
- Study on customary structures, territoriality and management arrangements for the MPAs FSPV set up in North Efate (IRD's GERSA programme);
- Socio-economic survey in the villages of North Efate, which made it possible, in particular, to evaluate the effects of MPAs on families (IRD's GERSA programme);
- Assessment of the economic impact of the five MPAs in the Efate region (Pascal, 2010);
- Land use mapping and study of erosion processes (IRD's GERSA programme);
- Participatory approaches to better manage watersheds, e.g. community education, participatory diagnostics, revegetation (COWRIE Project, USP);
- Sharing information: creating multi-stakeholder steering committees and developing a GIS to share information between departments.

4.4 Integrated territory management and governance

In the high islands of the Pacific, watersheds are short and steeply sloping and flow down into marine waters. MPAs are therefore the direct recipients of all natural and human-generated runoff. Natural erosion processes, intensified by human activities (deforestation for land development or agriculture) are the major causes of coral reef damage. It is vital, therefore, in these islands, to consider the entire territory of a watershed, from the top of the mountain all the way through to the outer reef slope, which is the traditional territory of most Pacific Island communities. With reference to territorial units (geographic, ecological, social), the approach therefore considers conservation of the environment, use management, governance, etc. in a coherent, collaborative and integrated manner.

The goal of CRISP's "Integrated Management" component, in particular the GERSA project (Reef Management, from Satellite to Stakeholder), was to understand management of these units in an integrated manner and to implement appropriate governance methods. The GERSA programme had two specific objectives:

- To understand local governance systems, both official and less formal, in order to propose appropriate and equitable work methods for local management of coastal areas;
- To identify conditions and improve the exchange of geographic information between public services, in order to promote a cross-sectoral approach to coastal area management.

IRD's "Espace" Unit in Noumea is the main participant in these projects, carried out on the islands of Efate (Vanuatu) and Tahiti (French Polynesia).

In **Vanuatu**, research was carried out in order to gain a proper understanding of local governance systems:

- A study on customary structures, territoriality and management arrangements for the MPAs set up by FSPV in northern Efate;

- A socio-economic survey in the villages of North Efate, which made it possible to evaluate the effects of MPAs on families.

On the **Tahiti** peninsula (Teahupoo), IRD established a partnership with the CNRS–EPHE team's ongoing research programme (called "Rahu"), to take part in a study on territoriality and local knowledge as well as a critical analysis of the consequences, in terms of local governance, of the environmental programmes carried out by international institutions and partner organisations in the field.

In addition, the work focused on exchanging geographic information and cross-sectoral management of coastal areas:

- Creating and running GERSA multi-stakeholder steering committees;
- Training session on "Governance and sharing information" (Vincent Vacelet);
- Developing an interoperable GIS tool for the Government of Vanuatu (Land Department and IT Service);
- Reporting on results and recommendations.

Main outcomes (Herrenschmidt, 2010)

Governance systems: difficulties and prospects

Existing MPAs are often just reserves where all fishing is banned (no-take zones). The social cost of marine reserves is highest for the most economically and socially vulnerable families: a decrease of up to one-third of their incomes, problems with the quantity of food and the balance in their diets, increased time spent looking for food and reduced capacity to develop other economic activities, etc.

MPAs that are too small, particularly at the village scale, strengthen the hegemonic positions of dominant groups, e.g. traditional authorities, religious leaders, business people, the mayor. Outside involvement is manipulated by stakeholders who embody the institutionally recognised local authority and can formulate problems in a way that is intelligible to these outside participants. Decisions are made in such contexts without any counterbalance and are generally the result of power struggles between "power centres", rather than being collective. This situation has the major effect of preventing the issue from being seen at an environmentally relevant scale.

In terms of integrated management of coastal areas, local communities and stakeholders have a good idea of the interactions between land and marine settings. In contrast, on the institutional, legal and administrative levels, there is a high degree of segmentation and cross-sectoral communication is poor. Sectoral approaches dominate without any coordination between these approaches.

A strong trend towards vertical governance differentiates the French territories from independent Pacific Island countries: very (too?) "top-down" in the French territories, very (too?) "bottom-up" in the independent countries. In both models of governance, real efforts need to be made in terms of better vertical governance.

Environmental management processes, in particular, are based on conservation ideologies that deal with management from the angle of "environmental issues", and so they are designed to identify and act on the man-made hazards that influence these issues. This approach tends to stigmatise and blame specific social groups and so it is rejected by part of the population. For that reason, its effectiveness is questionable.

The GERSA programme explored methodological approaches designed to give priority to the issues of local societies, e.g. cultural, social and economic matters, and to understand which environmental changes (hazards) were likely to endanger them. On the basis of this involvement by the communities, environmental concerns can be addressed in a participatory manner while trying to minimise the human hazards likely to affect them.

These processes cannot be completed by just carrying out three-to-four year environmental projects. They must be defined and supported over the long term by public policies which the projects contribute to. So it is vital to first better define public integrated management policies for island environments so as to identify methods and adapt and coordinate the multitude of projects proposed from the outside world to public authorities.

Exchanging geographic information in support of cross-sectoral management of coastal areas: results of the experience in Vanuatu

Creating an interoperable tool to exchange geographic information is a good way to encourage cross-sectoral dynamics, but it is not enough. It must be accompanied by inter-departmental activities via a structure, a committee or working groups, and by clear work protocols. A framework document setting out the county's public strategy is vital for defining a joint work framework and creating ties between all those involved. In order to ensure an adequate level of leadership, training in leadership and cross-sectoral activities has been identified as a priority.

Providing geographic information should make it possible to accompany management protocols using the logic described above "Social issues/ environmental hazards/environmental issues/social hazards". The GERSA programme focused (based on work carried out in French Polynesia) on determining which type of information would be useful at each stage of the proposed methodological protocol.

The project's foundations were successfully laid over the long-term:

- Partners from the Government of Vanuatu have taken ownership of cross-sectoral process and inter-departmental dynamics for the GIS have continued very actively six months after the end of the GERSA project;

- The GERSA programme also invested in a server to install the interoperable geoserver prototype the programme created. Vanuatu agreed to set it up and to carry out full-scale testing as part of cooperation between the Lands Department, the IT service, IRD (computer department) and the University of New Caledonia after the GERSA programme ended. So GERSA helped create cooperation dynamics between New Caledonia and Vanuatu, which will continue after CRISP.

Reporting on the results in Vanuatu and French Polynesia: how the recommendations were received

GERSA's results were reported on in 2010, in both Vanuatu and French Polynesia, to local stakeholders in the villages and those institutions that had been involved. The programme was praised for its operational nature and for meeting the expectations of local participants. Significant follow-up seems to have been given to the programme's outcomes in terms of governance:

- Villages in North Efate have begun to work together to create an inter-village committee to manage the whole zone.
- The exchange dynamics between various government departments demonstrate that the government has realised the importance of cross-sectoral work in terms of land and environment management.
- Regional GIS cooperation has been strengthened and new programmes are being formulated and negotiated based on this work, particularly between New Caledonia and Vanuatu.
- The 10th EDF regional programme for Pacific OCTs covers integrated management of coastal areas. The GERSA-CRISP research programme on the Tahiti Peninsula and the EPHE–CNRS (CRIOBE) "Rahui" programme serve as models; the site has been selected as a pilot site for the operational phase over the next four years.

4.5 Participatory watershed management

At the same time as part of the USP-Fiji's COWRIE project (Coastal and Watershed Restoration for the Integrity of Island Environments), pilot watershed management sites were selected in Vanuatu (Efate and the northern part of the island of Aneityum) and Fiji (two sites in northern Viti Levu: Rakiraki and Nakorotubu, in Ra Province). For each site, after community information and education activities, a participatory diagnostic was carried out based, where possible, on information provided by the GERSA programme. This led to a community action plan for the watershed. A management committee was then set up to coordinate the activities (see Chapter 5).

4.6 Building Capacity, connecting managers and capitalising on experiences

Building capacity, connecting managers and capitalising on experiences are among CRISP's most important objectives and were, in large part, met for MPAs.

In terms of capacity building, very significant progress was made locally. In each MPA, many local communities and members of local governments were trained in the processes for formulating management plans, monitoring MPAs, or even restoring reefs (see corresponding section). These training sessions took place either directly in the field or through a variety of training workshops. It is difficult to make a full report on them but we can consider that all the communities that benefitted from the creation or strengthening of an MPA received training and education. This probably involved about 40 communities, i.e. at least 3,000 people.

FSPI, in particular, directly trained 107 managers (Samoa, 25; Solomon Islands, 26; Cook Islands, 2; New Caledonia, 25; Vanuatu, 23; Tuvalu, 2 and Kiribati, 4) in applied use of scientific information, participatory planning, improving joint management, funding requests, monitoring and adaptive management. At least two or three of the managers who were trained can, in turn, act as trainers in their own countries. There were exchanges between managers, e.g. between Solomon Island and Vanuatu on Mystery Island, or between New Caledonia and Fiji.

Training workshops

At least 11 training workshops were held on the theme of MPAs (also see Chapter 14).

In particular, CRISP helped organise a **regional workshop to exchange experiences between LMMAs in the Indo-Pacific network** in Fiji in November 2008, one of the most important of its kind, and facilitated the participation of certain members of the network at that event. The workshop brought

together about 100 participants from 16 countries in order to share the lessons learnt and the progress made in the area of marine resource management and environmental protection. The forum led to the formulation of guideline and suggestions for better management (see inset below).

The main recommendations from the LMMA workshop (Fiji, 2008)

- Meet the needs of the community.
- Ensure all the partners have a clear understanding of the objectives.
- Combine traditional knowledge, the principles of good practice and participatory assessments to develop community management plans.
- Develop community monitoring with a view to adaptive management.
- Be aware of the importance of cultural and social considerations in all aspects of resource management.
- Strengthen the participation of the ministries involved.
- Consider the aspect of compliance with laws and their enforcement from the outset.

Among the other important events CRISP contributed to, we should mention:

- a **capacity building workshop** on management held in Fiji (September 2008), with the support of Ocean Learn, USAID, and NOAA. It was attended by nine managers (Aleipata in Samoa, WWF in Cook Islands, and the fisheries departments of Kiribati, Solomon Islands, Vanuatu and Tuvalu);
- A **university course on MPA management modes** given at USP, in Fiji (2008). 24 students took part through joint funding from a large range of partners;
- a **participatory management training workshop** for managers in the French Pacific territories, organised by SPREP (Tahiti, 2009);
- the **Pacific Regional Conference on Marine Managed Areas** (Moorea, French Polynesia, 2009), in association with the IUCN and the Marine Protected Area Agency (AAMP). CRISP held a special session on governance and MPA management (Govan et al., 2009).
- a **training session on MPA governance** in the South Pacific, organised by 'IRCP' (Pacific Coral Reef Institute, Moorea, 2010). The seminar, which had 20 participants, was designed to provide multidisciplinary training in MPA governance, propose tools for a comprehensive approach to MPAs, strengthen the administrative capacities of Pacific OTCs in terms of MPA governance and community management and strengthen the ties and networks between scientists and environmental, fisheries and planning agencies.

Besides capacity building, all these workshops helped foster ties between managers, particularly between English-speaking and French-speaking managers.

In the area of integrated management and watersheds, three workshops were held:

- a training workshop (satellite imagery, hydrological charts, GIS) in Noumea (June 2008) for six participants from Vanuatu and Fiji;
- a participatory integrated watershed management workshop (Fiji, 2009);
- a symposium on good practice in participatory management and community restoration of watersheds (Fiji, December 2009).

In addition, more than 40 communities in Fiji and on Efate in Vanuatu received training in watershed management.

4.7 MPA and watershed knowledge, management and monitoring tools

CRISP led to the production and/or sharing of a certain number of MPA tools:

- **An overall summary of and capitalisation on all the experiences of all the region's LMMAs** (Govan et al., 2009)

This major work titled "Status and potential of locally-managed marine areas in the South Pacific: Meeting nature conservation and sustainable livelihood targets through wide-spread implementation of LMMAs" was coordinated by H. Govan (2009). It presents the region's social and cultural background, which LMMAs are based on, and provides an updated inventory of all the marine protected/managed sites, according to their different statuses.

This inventory covered 30,000 sq km of marine areas, including 12,180 sq km of LMMAs and 1107 sq km of no-take zones (NTZ). It brought obsolete international data up to date. The document covers several points such as the benefits LMMAs provide and community management (see inset). An approach to the costs of and ways to fund MPAs is also proposed as are guidelines for developing the potential of LMMAs.

LMMA impacts (Govan et al., 2009)

While communities generally feel that their LMMAs are beneficial, scientific studies, particularly in terms of landings and catches per unit effort, are less conclusive. An increase in the abundance of target species in no-take zones has been proven scientifically but proof is less conclusive in terms of the social and environmental benefits. While the impact on the living standard of the population is difficult to demonstrate at this point in time, it is still true that this participatory community approach is, at this time, one of the few approaches to integrated ecosystem-based management of these islands.

- **Translation of a practical guide for users,** local communities and their partners, on creating and managing LMMAs:[15] "Locally-Managed Marine Areas: A guide to supporting Community-Based Adaptive Management " (Govan et al., 2008);
- A **bibliographic review** of all the documents in the region related to the socio-economic and environmental impacts of MPAs was produced by ReefBase Pacific; it contains about 80 references (Cohen et al., 2008).
- French Polynesia produced its own **bibliographic review** of MPAs in French Polynesia (Petit, 2010).

A **summary of MPA experiences** in the region ("Lessons learnt"), is due to be produced shortly by FSPI and this will lead to a technical guide.

There have also been a wide range of monitoring tools (like SEM-Pasifika; see section on "Expanding knowledge" [p.83]),

As part of watershed management and the COWRIE project, a good practice guide on community-based watershed management and educational posters were produced in English, Fijian, Hindi and Bislama.

15 Funded by the John D. and Catherine T. MacArthur Foundation, the David and Lucile Packard Foundation, the UK Darwin Initiative, the European Commission and the Global Coral Reef Monitoring Network (GCRMN).

Key points

The field of marine protected or managed areas was one of CRISP's major areas and support for the development or creation of MPAs has been particularly extensive.

This allowed the creation of or support to 50 MPAs - from the smallest to the largest in the world - in seven countries and three French territories. Nearly 1,000 sq km were involved (638 sq km created and 334 sq km strengthened); with the MPA of Phoenix, in Kiribati, the total protected surface area developed under the auspices of CRISP is 411,138 sq km. Of those MPAs, all but five were community managed areas, including 37 LMMAs. Their surface areas vary but are generally small: less than one sq km for LMMAs, 80 to 100 sq km for MPAs in New Caledonia, to the largest in the world, 410,500 sq km (Phoenix). These surface areas are obviously limited (1%) in comparison to the total surface area of reefs in those Pacific territories included in CRISP (136,422 sq km) and in comparison to the number of MPAs that already existed, but they are still very significant. The cost of establishing them varied but was often low (around a few thousand Euros for the small LMMAs).

The diverse nature of these MPAs provides a rich range of experiences in terms of governance, creation methods, size and maturity, linkages between participatory approaches and the involvement of national technical services. LMMAs provide an excellent model in terms of mobilising local communities to manage their own resources, limiting the resources used, and simplicity and flexibility in the implementation and management of protected areas.

The work to raise awareness, mobilise forces and build capacities - directly in the field and during a large number of workshops - has been remarkable. It concerned more than 40 local communities and about 100 managers and members of the administrative services of seven countries, who were trained, in particular, in the areas of participatory development of the management plans and resource and environment monitoring.

Some three-quarters of these MPAs have formulated management plans and most are now engaged in resource monitoring. In general, the communities have experienced improvements in their resources thanks to the MPAs, even if these improvements have not always been proven scientifically. The development of alternative activities has been more modest.

In terms of networking, the network of LMMAs and other community-based managed areas was significantly strengthened; numerous exchanges took place either via visits by managers to other countries or during workshops. In particular, CRISP helped organise some of these meetings, notably the regional workshop for LMMAs from the Indo-Pacific networks to exchange experiences in 2008 (nearly 100 participants from 16 countries), and CRISP made a special effort to ensure that a large number of managers could attend these meetings. The meetings and exchanges proved to be particularly fruitful, especially between the French Pacific territories and the other countries of the region. In the same way as numerous other partners from the region, CRISP clearly made it possible to strengthen overall mobilisation around community protected/managed marine areas.

In the French Pacific territories, the issue is also to implement governance methods that allow a balanced combination of management tools from custom law and provisions based in modern law. This was done, with the support of the Northern Province of New Caledonia and WWF–France, in the northeastern part of the Northern Province in order to create three MPAs, the first in that Province.

Support was given to the work of the SCRFA (Society for Conservation of Reef Fish Aggregations) to protect spawning aggregations.

Summaries and tools were developed or improved concerning participatory approaches for plans to manage and monitor MPAs and watersheds. A major review of LMMAs was carried out (Govan, 2009) and provided a full update on the creation and management of these community-based areas in the region. It will be possible to update obsolete data about MPAs in international and regional databases, which up to now have underestimated the part played by community-managed areas.

Many partners, mainly NGOs, were involved: FSPI and its local NGOs, e.g. Solomon Islands, Vanuatu, Fiji; WWF in New Caledonia and Cook Islands; French Polynesian NGOs and consultants for PGEM, frequently with the support of the governments (Samoa, Northern Province in New Caledonia) and technical departments, mainly fisheries, of the countries involved.

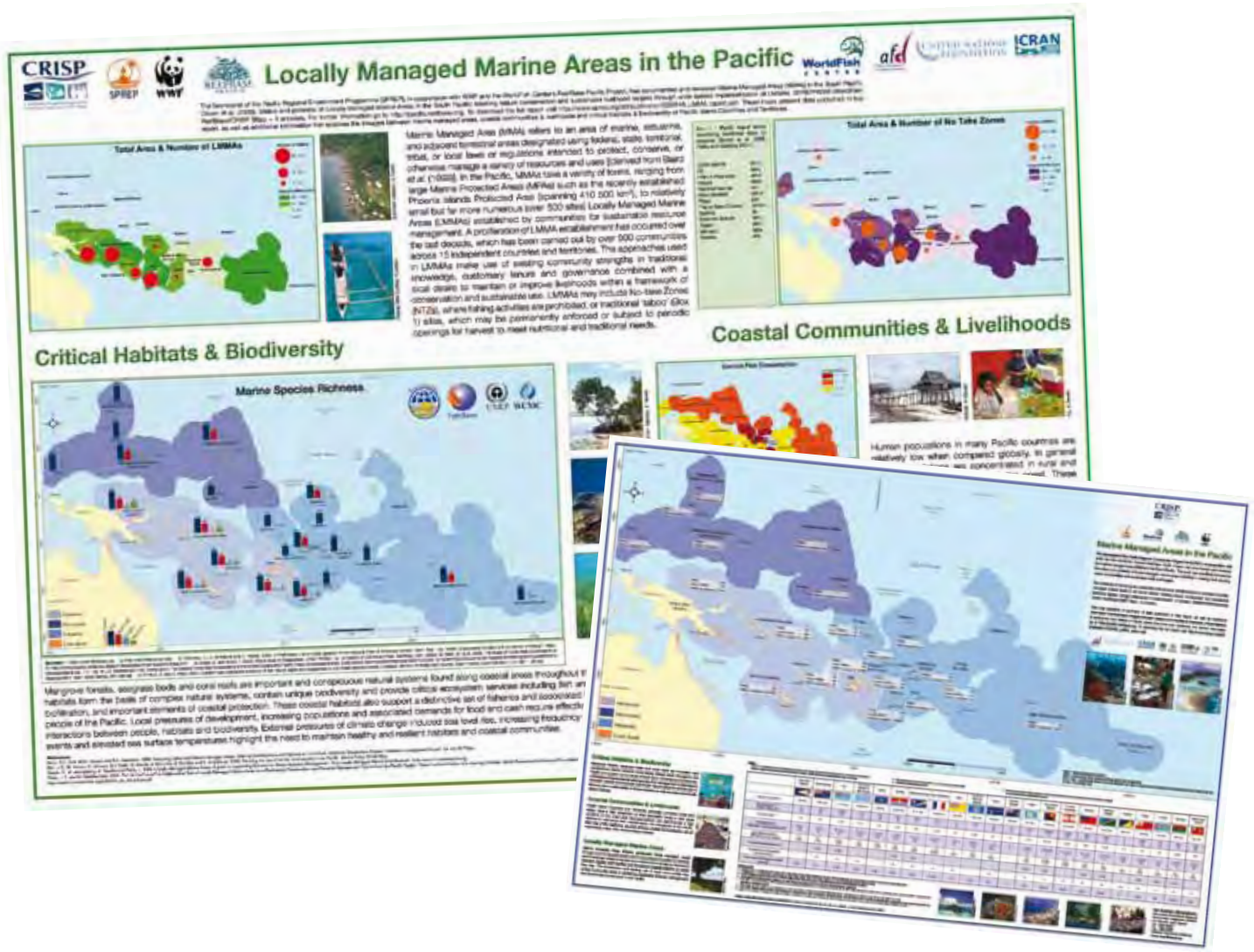
Several instances of basic and applied research conducted under the CRISP umbrella directly concerned the creation and management of MPAs: work on larval connectivity and dispersal, on methods for monitoring resources in MPAs (community monitoring), and on assessing the social and economic benefits provided by MPAs and the MPAs' spill-over effect. The socio-economic monitoring system "SEM-Pasifika" was developed.

The research carried out on MPA governance and integrated management as part of the IRD's GERSA programme provided some fresh insights:

- The most economically and socially vulnerable families are those most affected by the creation of MPAs; when MPAs are too small, their creation can result in the strengthening of the hegemonic positions of dominant groups and institutionally recognised local authorities and create conflicts that hinder implementation of approaches at environmentally relevant scales.
- Local populations and stakeholders have a good idea of the interactions between land and marine environments and easily adopt integrated management concepts. In contrast, on the institutional, legal and administrative levels, sectoral approaches dominate and there is no coordination between them.
- Rather than dealing with management from the conventional angle of "environmental issues", the GERSA programme explored different methodologies that give priority to the issues of local societies (cultural, social, economic, etc.) and to understanding what environmental changes are likely to be a threat to them; then to consider, in a participatory manner, ways to control them. These participatory and integrated management processes should be supported over the long term by public authorities and such projects should assist with this process.
- A balance must be found between the "top-down" approach of the French territories and the "bottom-up" approach of the independent countries.
- In addition, the GERSA programme supported governance in Vanuatu by setting up multi-stakeholder steering committees and developing an interoperable GIS for the Government of Vanuatu, designed to share information between administrative departments.

The good example provided by Vanuatu as a site where CRISP activities were integrated (MPAs, watersheds, governance, monitoring, economic valuation) should be emphasised.

In those zones where the MPAs received sizeable support from CRISP and community dynamics were created, several projects are going to continue through other funding, e.g. the MacArthur and Packard Foundations in Solomon Islands and Vanuatu or the trust fund in Samoa. As for AFD, it is continuing to invest in evaluating the benefits provided by MPAs in reducing poverty, promoting economic growth and preserving global biodiversity. Work on integrated management will continue as part of the 10th EDF regional programme for Pacific OCTs and as part of FFEM's PICMAC project.



Bibliography

MARINE PROTECTED AREAS (MPAs)

Annelcauhat Council of Chiefs (2007). Declaration blong Mystery Island adaptive management plan. Management plan, FSP Vanuatu/Vanuatu Fisheries Department, 11 pp.

David G., Dumas P., Mangeas M., Herrenschmidt J.-B., Some hints about the impacts of watershed management on MPAs in the South Pacific Islands, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, PowerPoint presentation, 12 pp.

Government of Samoa, Safata MPA District Committee (2008). Safata Marine Protected Area management plan 2008–2010. 28 pp.

Government of Samoa, Aleipata MPA District Committee (2008). Aleipata Marine Protected Area management plan 2008–2010. 29 pp.

Faninoz S. (2009). Aires Marines Protégées Nord-Est de Nouvelle-Calédonie. WWF/Province Nord/Adecal, 18 p.

Kiribati Ministry of Environment, Lands, Agricultural and Development, Conservation International, New England Aquarium (2008). Phoenix Islands Protected Area. Flyer, 2 pp.

Kiribati Ministry of Environment, Lands, Agricultural and Development, Conservation International, New England Aquarium (2010). The little nation that could, and did – Kiribati's Phoenix Islands Protected Area earns global spotlight as largest World Heritage site on Earth. Press release, 3 pp.

Marou Council of Chiefs (2007). Declaration blong Marou komunity adaptive management plan. Management plan, FSP Vanuatu/Vanuatu Fisheries Department, 11 pp. Takara Kaonsel of Chiefs (2008). Declaration blong Takara komunity adaptive management plan. Management plan, Wan Smolbag Theater/FSP Vanuatu/Vanuatu Fisheries Department, 18 pp.

The LMMA Network (2010). The Locally-Managed Marine Area Network: Improving the practice of marine conservation – 2009 Annual Report: A new age of community-based adaptive management.

PGEM (Management Plan of the Maritime Space)

Charles M., De Villers P. (2010). Etude du financement pérenne de l'association du Plan de Gestion de l'Espace Maritime (PGEM) de l'île de Moorea, Polynésie française. Rapport d'étude, PROE, 109 p. + 8 annexes

Egretaud C. (2010). Diagnostic environnemental – PGEM du lagon de Aitutaki, Iles Cook. Rapport CRISP, 28 p.

Egretaud C., Jouvin B., Fare H., Quinquis B. (2007a). Diagnostic environnemental – PGEM de Wallis. Rapport CRISP, 62 p.

Egretaud C., Jouvin B., Fare H., Quinquis B. (2007b). Diagnostic environnemental – PGEM des îles de Futuna et Alofi. Rapport CRISP, 49 p.

Verducci M., Juncker M. (2007). Faisabilité de la mise en place d'un Plan de Gestion des Espaces Maritimes (PGEM) à Alofi, Futuna et Wallis. Rapport de mission, CRISP, 91 p.

GUIDES

Govan H., Aalbersberg W., Tawake A., and Parks J. (2008). Aires Marines Localement Gérées : Guide de soutien pour une gestion adaptative reposant sur la communauté. The Locally-Managed Marine Area Network, 114 pp.

Govan, H. et al. (2009). Status and potential of locally-managed marine areas in the South Pacific: meeting nature conservation and sustainable livelihood targets through wide-spread implementation of LMMAs. PROE/WWF/WorldFish–ReefBase/CRISP. 95 pp. + 5 annexes

Cohen, P., Valemei A.D., Govan H. (2008). Annotated bibliography on socio-economic and ecological impacts of marine protected areas in Pacific Island Countries. WorldFish Bibliography No. 1870. The WorldFish Center, Penang, Malaysia. 36 pp.

GOVERNANCE

Clua E. (2007). Building capacity and cooperation for sustainable development of Pacific coastal resources Forum, Townsville, Australia, 03–07 Sep. 2007. Proceedings, 29 pp.

Govan H., Contribution of communities to marine conservation in the Pacific, 2nd International Marine Protected Areas Conference, Washington D.C., USA, 19–24 May 2009, PowerPoint presentation, 15 pp.

Govan H., Rupeni E., Chenet A., Troeng F., Heaps L., Cohen P., Dupré C., Bambridge T., Herrenschmidt J.-B. (2010). Governance & Management issues of Marine Managed Areas – Pacific regional Conference on Marine Managed Areas, Moorea, French Polynesia, 15–19 Nov. 2009. Agence des Aires marines protégées, 14 pp.

Herrenschmidt J.-B., Technology and community-based management: Dilemna or challenge? – Vanuatu, Fiji, French Polynesia, New Caledonia, Building Capacity and Cooperation for Sustainable Development of Pacific Coastal Resources Forum, Townsville, Australia, 01–07 Sep. 2007, PowerPoint presentation, 49 pp.

Herrenschmidt J.-B., Heritage: the new cultural and institutional challenge of environmental governance in the Pacific Islands, 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, PowerPoint presentation, 16 pp.

Herrenschmidt J.-B., Clua E., Vers une gestion «culturelle» des milieux naturels en Océanie ?, GECOREV Symposium, Saint-Quentin-en-Yvelines, 26–28 juin 2006, Presentation PowerPoint, 17 pp.

Herrenschmidt J.-B., Clua E., Culture and Locally-Managed Marine Areas in the South Pacific: Supporting cultural revival for good reasons, 2nd International Marine Protected Areas Conference, Washington D.C., USA, 19–24 May 2009, PowerPoint presentation, 18 pp.

Herrenschmidt J.-B., Dumas P., Coral reef management in the Pacific Islands: Governance at risk, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, PowerPoint presentation, 25 pp.

Léopold M., Herrenschmidt J.-B., Building the co-management of fisheries in customary marine areas, Ouvea, New Caledonia, BIODEC Symposium, Nouméa, Nouvelle-Calédonie, 30 oct. – 04 nov. 2006, Poster.

Léopold M., Herrenschmidt J.-B., Thaman R., The relevance of traditional ecological knowledge for modern management of coral reef fisheries in the South Pacific, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, PowerPoint presentation, 8 pp.

Léopold M, Sourisseau J.-M., Cornuet N., Lasseigne L., Guillemot N., Herrenschmidt J.-B., Le Meur P.-Y., Participation, usages, appropriation : la gestion des ressources marines côtières dans la région de Koné (Province Nord, Nouvelle-Calédonie), 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, Poster.

Vacelet V. (2008). Governance towards integrated coastal management in Vanuatu – GERSA project. Internship report, IRD/Université de La Rochelle, 62 pp.

Vieux C. (2009). Gestion participative pour les pays et territoires français du Pacifique – Atelier de formation, Vairao, Tahiti, Polynésie française, 23–26 nov. 2009. Rapport d'atelier, PROE, 54 p.

5. Ecosystem restoration

"Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." (Society for Ecological Restoration International)

5.1 Restoring watersheds

Within the "Watersheds and integrated management" component, efforts addressed methodological approaches to studying erosion (see section on "Expanding knowledge" [p.83]) and governance (see Chapter 4) as part of the GERSA project. As for the COWRIE (Coastal and Watershed Restoration for the Integrity of Island Environments), project, its goals were field activities on management and participatory restoration of watersheds (see Fig. 8 below):

The goals of the COWRIE project (USP, Landcare Research, FSPI)

1. Conduct a scientific and technical review of coastal watershed restoration projects, knowledge and best practice in terms of ICZM and watershed management;
2. Design and implement coastal watershed restoration projects at demonstration sites to control erosion, improve water catchment and conduct ecological restoration;
   - raise awareness about the concepts and advantages (environmental, economic and social) of ICZM;
   - conduct participatory planning at demonstration sites;
   - design demonstration protocols for pilot sites;
   - prepare reforestation activities, set up nurseries;
   - develop demonstration plots and monitor the process;
3. Based on experience at demonstration sites, document the lessons learnt on best practice and develop training manuals and toolboxes on ICZM and community restoration.

These activities took place at two sites in Vanuatu, i.e. one on Efate and one in the northern part of the island of Aneityum, as well as at two sites in Fiji, i.e. in the northern part of Viti Levu (Rakiraki; Nakorotubu in Ra Province). Most of the restoration activities were follow-up work on projects that had already begun: in Vanuatu, the ELMA (Efate Land Management Area) project and in Fiji the reforestation activities were based on methodology used as part of Conservation International's voluntary carbon emission compensation programme.

The COWRIE project was carried out by USP's Institute of Applied Sciences and the Landcare Research Institute of New Zealand, together with the NGO FSPI of Fiji, the NGO Farm Support Association of Vanuatu and with the support of the governments and regions of Fiji and Vanuatu.

To introduce the project, a symposium was held in Fiji (2009) to present the good practices already developed in the region in terms of reforestation and community-based watershed management. The activities already developed or to be developed at the four sites, which are at different stages of advancement, are as follows:

- Increasing awareness in the community;
- Participatory diagnostics based, where appropriate, on information provided by the GERSA programme, and development of a community watershed action plan;
- Setting up a management committee;
- Creating or strengthening nurseries;
- Activities to restore watersheds.

Figure 8: Restoration method for eroded zones in Vanuatu (Landcare Research; in Calas, 2009)

The method consists of beginning by planting rows of vetiver grass (whose root system can reach depths of five metres for an aerial portion that is about one metre tall) perpendicular to the erosion rills so as to hold the soil and retain both sediment and water. Then work to plant Acacia spirorbis, a rapid-growth endemic species that fixes nitrogen in the soil (legume), allows growth of stable plant cover, which, in turn, facilitates the reintroduction of local species. Where necessary, a mixture of coral sand with P and N supplements is used at the bottom of the trenches.

At Epau in Vanuatu, the participatory diagnostic workshop was done in 2010 and produced participatory maps of resources, of various watershed zones and of the watershed's evolution over time. A watershed committee was created and the action plan has been formulated. Action will involve restoring the riparian forest of the Eluk River, over a 20-m buffer zone, in order to protect the village's water source better. The community also set up a nursery for whitewood, sandalwood, *Santalum australcaledonicium*, and mahogany, *Canarium indicum*.

On Aneityum, reforestation activities were based on a methodology that had already been successfully tested by Landcare Research between 1997 and 2001 (see box). Two nurseries of about 1,000 sq m each, with more than 6,000 parent plants were set up and over time they are supposed to be able to provide 60,000 plants, which should be enough to restore 6 sq km of terraces, before Acacia is planted, followed by sandalwood.

In Fiji (Vanua Rakiraki Yaubula Project), in the province of **Rakiraki** in the northern part of the island of Viti Levu, the programme is scheduled to begin planting four species that have already been tested and validated for their qualities and growth capacities, i.e. mahogany (*Swietenia sp*), teak (*Tectona grandis*), and two other local species. The trees will be planted on the land of the village of Narara, which wants to develop ecotourism activities. To date, an awareness training session and a participatory diagnostic have been completed (March 2010) that brought together representatives from four districts, i.e. Rakiraki, Navolau, Raviravi and Naiyalayala.

In Fiji, in the district of **Nakorotubu**, province of Ra, which has some 27 villages, the first awareness training on watershed management was held in March 2010, followed by a participatory diagnostic workshop in April 2010; construction of a community nursery has begun by maximising use of existing resources, by collecting and planting seeds from indigenous species and fruit trees.

Key points

The COWRIE (Coastal and Watershed Restoration for the Integrity of Island Environments) project is designed to develop integrated management and community activities to restore watersheds. The project partners are USP-Fiji, and the Landcare Research Institute of New Zealand, together with the NGO FSPI from Fiji, and the NGO" Farm Support Association " from Vanuatu, with the support of the governments and regions of Fiji and Vanuatu.

More than 40 communities, at four sites in Vanuatu and Fiji, were involved and educated on the importance of watershed management and trained in restoration. The project has had a wide range of successes:

- Mobilising local communities around integrated watershed management projects;
- Strengthening their capacities and ability to manage their own territories;
- Restoring several hectares of watershed (30 ha in Fiji);
- Setting up three nurseries;
- Transferring experience and developing know-how in the creation of nurseries, restoration and reforestation; in Fiji, seven villages have now set up their own nurseries;
- A series of four illustrated manuals were developed for communities on the need and techniques for watershed restoration.

In Fiji, the Forestry Department is going to continue the activities, ensuring the viability and continuity of actions after the project ends.

5.2 Coral reef restoration

Reef restoration can include physical restoration (reprofiling the seabed, consolidating reef structures, putting in artificial structures) and/or biological restoration (transplanting coral and other organisms, repopulating with larvae). These reef restoration operations have been developed around the world.

The original CRISP objective was to develop low-cost and low-technology methods and to make them accessible to Pacific Island communities. Reef restoration activities took place at two sites, in two countries. In both cases, similar activities were carried out, with technical training for local partners: information meetings for nearby communities and other stakeholders, selection of a suitable site for restoration, restoration of the site (collection at a donor site, transport and then transplantation of coral colonies to the recipient site), and then upkeep, e.g. removing algae, and monitoring at the restored site.

- An initial project was carried out in a fishing reserve (no-take zone) on the island of Moturiki, in Fiji, in 2005, and was completed in late 2006, after one year of observation (Job et al., 2005; Fisk et al., 2006a). As part of an ongoing approach involving the participatory management of marine resources around the island of Moturiki, the project's ultimate objective was to restore a part of the reef damaged by coral bleaching in 2000 and 2002 so as to increase fisheries resources. Three sections of reef, covering a total surface area of some 2,150 sq m, were restored with 265 sq m of live coral colonies, i.e. nearly 2,000 colonies and fragments transplanted.
- The second pilot site is located in Lofeagai on the atoll of Funafuti (Tuvalu). After a phase to locate a transplantation site corresponding to CRISP's objectives (Fisk et al., 2006 b), restoration and transplantation work was carried out in 2007 and monitored for 18 months (Fisk and Job 2009). The end goal was also to improve fishery production by creating coral habitats favourable to fish repopulation, in a setting that is poor in fish and threatened by predation by *Drupella cornus* (coral-predator mollusc), as well as by excessive algae growth, (water pollution from sewage and low numbers of herbivores). The restoration extension zone was some 200 sq m and nearly 200 colonies of *Acropora branchus* were transplanted.
- These restoration activities were carried out through a partnership between the consultants CAREX Environnement – SPI Infra (GINGER group) and the NGO FSPI (Foundation of the Peoples of the South Pacific International), via local partners, i.e. PCDF (Partners in Community Development - Fiji) in Fiji and TANGO (Tuvalu Association of Non Governmental Organizations), in Tuvalu.

Outcomes

Monitoring was designed to assess the methods' effectiveness and relevance, transplanted coral's ability to adapt and changes to coral cover as well as to note trends in fish and invertebrate recruitment.

In Fiji, an approximate total volume of eight cubic metres of coral colonies was taken from nearby reefs and transported by boat, while about 100 colonies came from a coral farm that the local community had been developing over the past few months. Six zones were monitored at 1, 3, 6 and 9 months after transplantation.

In Tuvalu, the branching *Acropora* colonies taken from a nearby fringing reef were transported and replanted in a sandy zone at a depth of five metres in four large circular areas three to four metres in diameter (see photo). Monitoring began with a baseline study at the time of implantation then continued at 2, 4, 8, 9, 12 and 15 months after transplantation. Monitoring was carried out by Fisheries Department staff or the NGO TANGO (local partner), with the idea being that over the long term, volunteers from the villages and school would take over.

In both cases, the results showed a good initial survival rate for the colonies, demonstrating the operation's high success during the first months after transplantation, e.g. more than 50% of the colonies were alive after nine months in Tuvalu. But by nine months in Fiji, and 15 months in Tuvalu, nearly 75% of the transplanted colonies had died; in Fiji, due to bleaching, and in Tuvalu, probably due to eutrophication following heavy rain.

The local communities' participation was an important asset at both pilot sites. The work teams spent many long hours discussing coral ecosystem protection and management issues with the communities. In Tuvalu, a large-scale information and education campaign was held. The communities and government staff (from the Fisheries Department and the Ministry of the Environment) were trained and played an active role in restoration work (collection, transporting the colonies, transplantation, helping count the invertebrates) and, for some, in monitoring.

As the same time as the field activities, CRISP took part in preparing two documents in collaboration with the World Bank's "Coral Reef Targeted Research & Capacity Building for Management" research programme: a practical guide to restoration in 2007 (Reef Restoration Concepts and Guidelines) and then a manual in 2010 (" Reef Rehabilitation Manual "). These documents present the experience of case studies and the lessons learnt as part of these CRISP projects (see inset). These experiences were also shared at many different meetings (see Chapter 12).

Lessons learnt

Among the lessons learnt as part of these participatory reef restoration experiences, in shallow depths and with limited resources, we want to highlight the following:

- Reef restoration is not a panacea and must be considered as one option in a wider context of integrated coastal management and environmental protection;
- Reef restoration is a good communication and awareness tool for local communities and the general public;
- Restoration techniques (collection, transport, implanting) are well known and effective but the long-term success of such operations depends heavily on outside man-made or weather events that can, at any moment, reduce all the efforts to nothing;
- Reef restoration should not therefore be undertaken until all other possible management measures have been tried;
- Restoring a reef subject to regular natural or human pressures is almost certainly destined to fail. Identifying and managing threats should, then, be a priority before beginning such often-costly restoration operations.

Key points

"Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." (Society for Ecological Restoration International) Reef restoration can include physical restoration (reprofiling beds, consolidating reef structures, putting in artificial structures) and/or biological restoration (transplanting coral and other organisms, repopulating with larvae).

Over the past few years, reef restoration and coral transplant operations have been developed around the world. The originality of CRISP, as part of collaborative efforts between the consultants CAREX Environnement – SPI Infra (GINGER group) and the NGO FSPI, was to develop low-cost and low-technology methods and make them accessible to Pacific Island communities.

Community reef restoration activities were carried out in Fiji and Tuvalu:

- in Tuvalu, on the atoll of Funafuti, nearly 200 colonies of branching *Acropora* were transplanted over 200 sq m;
- in Fiji, on the island of Moturiki, three sections of the reef, covering a total surface area of 2,150 sq m, were restored with nearly 2,000 colonies and fragments transplanted.

In both cases, during the initial months after transplantation, the colonies' survival rate was very good, demonstrating the success of the operations; then the transplants experienced high mortality due to bleaching in Fiji and probably an invasion of *Drupella* (coral-predator mollusc) and eutrophication in Tuvalu. In spite of the low surface areas involved (less than 3,000 sq m in all), at a relatively high cost, and in spite of the relative failure of transplants following natural or man-made environmental damage, the added value of CRISP's reef restoration experiments is remarkable, i.e.:

- the development of simple, low-cost methods, suitable for local communities;
- sharing and passing on skills and knowledge to local communities and between members of the work teams;
- finally and most importantly, expanding knowledge on reef restoration techniques and the conditions influencing their success or failure.

A particularly fruitful partnership with the World Bank's Coral Reef Targeted Research & Capacity Building for Management programme led to the joint publication of two high-level methodology guides on reef restoration, the most recent and comprehensive in the world today. This partnership made it possible to promote CRISP's activities in this area and to go beyond what had been initially planned in terms of publications on this topic.

The causes of success and failure depend on a large number of factors and consequently are complex, e.g. the site's environmental conditions, similarity between the donor and recipient sites and handling conditions. The feasibility study and preliminary study of donor, and particularly, recipient sites are of primary importance for the restoration to be viable, and site monitoring is essential: the baseline state must be very precise and the sites must be monitored throughout the operations.

Bibliography

Watershed management and rehabilitation

Afro P., Despinoy M. (2010). Traitement d'images satellites SPOT déstiné à l'analyse de l'évolution de l'occupation des sols au nord de Viti Levu, Fidji. Rapport technique, IRD – Unité Espace, 23 p.

Aubert M., Despinoy M. (2008). Mise à jour de la cartographie de l'occupation des sols à Efate (Vanuatu) par l'utilisation d'images très haute résolution (THR) du satellite Formosat-2. Rapport technique, IRD – Unité Espace, 21 p.

Bailleul J. (2006). Apport des systèmes d'information géographique pour une gestion spatialisée des écosystèmes coralliens : Cas de la pêcherie au crabe de palétuvier dans la zone de Voh (Nouvelle-Calédonie). Mémoire de master, Université des Sciences et Technologies de Lille, 51 p.

Batti A., Deprataere C. (2007). Panorama des méthodes d'analyse de l'érosion dans un contexte insulaire. Analyse méthodologique, IRD – Unité Espace, 28 p.

Broucke S. (2010). Modélisation et simulation de l'impact des activités naturelles et anthropiques des bassins versants sur la vitalité du récif corallien – Presqu'île de Tahiti. Rapport technique, IRD – Unité Espace, 30 p.

Buliruarua L.A., Fenemor A. (2010). Best Practice Symposium on Community-based reforestation/Watershed Management, 02–04 Dec. 2009 – COWRIE Project. Workshop report, USP/ Landcare research, 45 pp.

Buliruarua L.A., Koroiwaqa I., Wendt H., Bogiva A. (2010). Report of the Two-Day watershed Management Planning Workshop for the Sub-District of Nakorotubu, Ra – COWRIE Project. Workshop report, 14 pp.

Cedat S. (2008). Approche prospective pour l'analyse des impacts naturels et anthropiques du bassin versant sur le milieu récifo-lagonaire. Rapport CRISP, 22 p.

Comley J. (2010). Coastal and Watershed Restoration for the integrity of Island environments, A reforestation project in Naroko, Ra Province. Project document, USP, 15 pp.

Comley J. (2010). Tikina Nakorortubu Nursery Training - Verevere village, Nakorotubu sub-district 31 May–04 Jun. 2010 – COWRIE Project. Training report, 10 pp.

Comley J., Wendt H.K., Bogiva A. (2010): Sediment inputs and status of nearshore reefs in Nakorotubu Tikina, Ra, Viti Levu, Fiji. Technical report, 8 pp.

David G., Dumas P., Mangeas M., Herrenschmidt J.-B., Some hints about the impacts of watershed management on MPAs in the South Pacific Islands, 21st Pacific Science Congress, Okinawa, Japan, 12–18 Jun. 2007. PowerPoint presentation, 12 pp.

David G., Dumas P., Mangeas M., Herrenschmidt J.-B., Some hints about the impacts of watershed management on MPAs in the South Pacific Islands, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008. PowerPoint presentation, 12 pp.

Diguer, A. (2009). SIE (Système d'information environnemental) Vanuatu, Version 1.2. – Programme GERSA – Document d'architecture, Rapport de stage, IRD – Unité Espace, 13 p.

Despinoy M. (2007). Cartographie de la couverture et de l'occupation des sols à Efate (Vanuatu); Point zéro de 1989. Rapport technique, IRD – Unité Espace, 9 p.

Dumas P., Fossey M., Mapping Potential Soil Erosion in the Pacific Islands A case study of Efate Island (Vanuatu), 11th Pacific Science Inter-congress, Papeete, Polynésie française, 2009, Proceedings, Extended abstract, 5 pp.

Dumas P., Printemps J., Spatialisation et évaluation de l'aléa érosion des sols dans les îles hautes du Pacifique, 11th Pacific Science Inter-congress, Papeete, Polynésie française, 2009, Proceedings, Abstract, p. 56.

Dumas P., Printemps J., Fossey M., The risk assessment of soil erosion for better management of coral reefs in the Pacific, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07-11 Jul. 2008. Poster.

Eckert D. (2010). Towards coastal and watershed restoration for the Integrity of Island Environments, Epau Village, Efate, Vanuatu, 23–24 Feb. 2010 – COWRIE Project. Workshop notes, Shefa Province ELMA Project/US Peace Corps Vanuatu 12 pp.

Eckert D. (2010). Towards coastal and watershed restoration for the Integrity of Island Environments, Epau Village, Efate, Vanuatu, 03–05 Mar. 2010 – COWRIE Project. Buffer Zone Restoration and GPS mapping notes, Shefa Province ELMA Project/US Peace Corps Vanuatu 23 pp.

FLMMA Network (2010). Tikina Rakiraki Workshop, Vitawa, Rakiraki, Ra, 29–31 Mar. 2010. Workshop report, 28 pp.

Fossey M. (2008b). Spatialisation et modélisation des données hydrologiques pour l'évaluation des processus d'érosion : Etudes de cas à Vanuatu, Fidji et Polynésie française. Rapport technique, IRD – Unité Espace, 44 p.

Fossey M. (2008a). Etudes hydrologiques dans le Pacifique : premières étapes d'une modélisation sous SIG. Rapport technique, IRD – Unité Espace, 18 p.

Fossey M. (2007). Développement méthodologique et spatialisation du risque d'érosion hydrique à Efate (Vanuatu). Rapport technique, IRD – Unité Espace, 55 p.

Gay D., Rouet I., Mangeas M., Dumas P., Selmaoui N., Assessment of classification methods for soil erosion risks, Modelling & Simulation International Conference, Christchurch, New Zealand, 01 Dec. 2007. Proceedings, Extended abstract, 7pp.

Gueyte R. (2008). Sedimentary contribution of catchments on Efate Island, Vanuatu: Instrumentation and modelling. Technical report, IRD – Unité Espace, 49 pp.

Laurent V., Despinoy M. (2007). Comparison of classification methods (SPOT Image) for land cover mapping in Efate (Vanuatu). Technical report, IRD – Unité Espace, 37 pp.

Printemps J. (2008). Mapping Potential Erosion Risks in North Viti Levu (Fiji) using the USLE Model and a GIS. Technical report, IRD – Unité Espace, 38 pp.

Printemps J., Ausseil A.-G., Dumas P., Mangeas M., Dymond J., Lille D., An erosion model for monitoring the impact of mining in New Caledonia, Modelling & Simulation International Conference, Christchurch, New Zealand, 01 Dec. 2007. Proceedings, Extended abstract, 6 pp.

Tuiwawa M., Koroiwaqa I., Buliruarua L.A., Bogiva A. (2010). Report of the One-Day Watershed Management Awareness Workshops for the District of Nakorotubu, Ra. Training report, USP, 9 pp.

Coral reef rehabilitation

Edwards A.J. (ed.) (2010). Reef Rehabilitation Manual. Coral Reef Targeted Research & Capacity Building for Management Program: St Lucia, Australia. ii + 166 pp.

Edwards A.J., Gomez E.D., Job S. (2007a). Reef Restoration Concepts and Guidelines: making sensible management choices in the face of uncertainty, Coral Reef Targeted Research & Capacity Building for Management Program: St Lucia, Australia. iv + 38 pp.

Edwards A.J., Gomez E.D. (2007b). Restauration récifale - Concepts et recommandations : faire des choix raisonnés dans un environnement indécis. Coral Reef Targeted Research & Capacity Building for Management Program: St Lucia, Australia. iv + 38 pp.

Fisk D., Job S. (2009). Funafuti Atoll (Republic of Tuvalu) - Coral reef restoration project, 1 to 18 months post-trial - Monitoring report. CRISP report, 42 pp.

Fisk D., Job S., Khan Z. (2006a). Monitoring Report on Restoration Work, Moturiki District, Fiji Islands: 1, 3, 6, and 9 months surveys. CRISP report, 33 pp.

Fisk D., Job S., Khan Z. (2006b). Baseline Report: Funafuti Atoll Tuvalu: Fieldwork report for Funafuti restoration work. CRISP report, 42 pp.

Job S. (2006). Samoa Coral Garden Project: a concept proposal to demonstrate coral rehabilitation and associated benefits for local communities, including tourism. CRISP report, 5 pp.

Job S., Participative reef Restoration Project, Moturiki Island, Fiji, 3rd International Tropical Marine Ecosystems Management Symposium, Cozumel, Mexico, 16-20 Oct. 2006, PowerPoint Presentation, 20 pp.

Job S., Lessons learnt from applied restoration projects, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07-11 Jul. 2008, PowerPoint presentation, 18 pp.

Job S., Bowden-Kerby A., Govan H., Fisk D., Khan Z. and Nainoca F. (2005). Fieldwork report on restoration work, Moturiki District, Fidji Island. CRISP report, 23 pp.

SPC
Secretariat of the Pacific Community

CRISP
Coral Reef InitiativeS for the Pacific
Initiatives Corail pour le Pacifique

The CRISP programme is implemented as part of the policy developed by the Secretariat of the Pacific Regional Environment Programme for a contribution to conservation and sustainable development of coral reefs in the Pacific

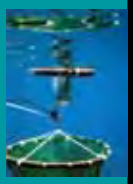
CRISP Coordinating Unit (CCU)
Programme Manager: Eric CLUA
SPC - PO Box D5 - 98848 Noumea Cedex
New Caledonia - Tel/Fax: (687) 26 54 71
E-mail : ericc@spc.int

CASE STUDY

Development of economically viable postlarval capture and culture (PCC) based activities in Bora Bora (French Polynesia)

What is PCC?

PCC stands for postlarval capture and culture (or "grow-out"). Postlarvae are a development stage in reef fish and crustaceans prior to both settlement in the lagoon and adulthood. The vast majority of animals start their development cycle with an ocean phase lasting one to three months, after which fish and crustaceans re-enter the lagoon in their hundreds of millions. Only approximately one in a million individuals will reach their adult stage, with most juveniles being eaten by predators. Using innovative techniques (such as crest nets or light traps - see photos below), postlarvae can be captured and bred for sale to four potential uses: **aquaculture** for food purposes; **restocking** into ecosystems to boost biodiversity and fish density for fishing purposes or simply for **ecotourism** such as snorkelling in coral gardens; and the lucrative **aquarium market**. Despite their impressive numbers, the captured animals only account for a very small portion of the larval flow, hence the very slight impact on the ecosystem compared to techniques involving the capture of adults with large quantities of breeding individuals. This makes PCC a potentially **ecofriendly industry**.



For more information on PCC ecological effects see:
BELL, J. D., CLUA, E., DOHERTY , P., GALZIN, R. and C. A. HAIR (2009). "The capture and culture of postlarval fish and invertebrates for the marine ornamental trade". Reviews in Fisheries Science, Vol. 17 (2): 223-228.

Photos courtesy of CRIOBE (Moorea), SPE in French Polynesia and Ecocean

PCC CASE STUDY

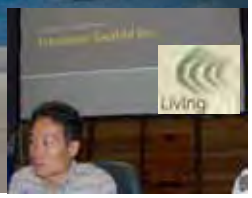
ACTIVITY 1:

EXPORTATION OF POSTLARVAE OF HIGH VALUE SPECIES FOR THE AQUARIUM TRADE MARKET

PARTNER #1:
BoraEcoFish (BEF) is a French company based in Bora Bora island (French Polynesia), owned by François Chevalier, that currently employs 3 people. BEF is currently developing a threefold strategy for selling postlarvae products based on contracts with international ornamental wholesalers, local high standard hotels and gourmet restaurants.

A joint venture between BoraEcoFish and Hawaiian SeaLife supported by the CRISP programme.

This project is a partnership between the biggest marine ornamental wholesaler in Hawaii and a French Polynesia company specialized in PCC, in order to demonstrate that sustainable PCC-reared fishes are a feasible alternative to wild-caught fishes to supply the American and Asian ornamental fish markets. The project will take place in Bora Bora and Marquesas, where partner #1 already has extensive experience of PCC and will receive new PCC technology and perform capacity building. Partner #2 already owns a fish farm in Hawaii that will undergo extensive modifications in order to be optimal to rear postlarvae on a large scale. After best site selection, various postlarval fishing gear will be tested to determine which is most efficient for the chosen site and, finally, estimates will be made of the profitability of PCC depending on species collection. The project will test export to Hawaii and then to the wider retail market.



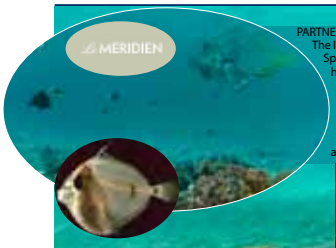
PARTNER #2:
Hawaiin Sealife is a US company based in Hawaii (US territories), owned by Richard Xié, one of the biggest marine ornamental wholesalers aiming to promote PCC products.

Photos courtesy of Françoise Buil (Reporter)

PCC CASE STUDY

ACTIVITY 2:

USE OF POSTLARVAE AND CORAL GARDENS FOR ECOTOURISM-BASED ACTIVITIES



PARTNERS #3 and 4:
The Intercontinental Bora Bora Resort & Thalasso Spa and the Méridien are two high standard hotels located on Bora Bora island. These hotels are promoting ecofriendly practices and coral reef knowledge to their customers, in particular by developing coral gardens that are maintained by BEF, which implements coral restoration, fish reseeding and on-farm visits for tourists.

The Intercontinental Bora Bora Resort & Thalasso Spa achieved Benchmarked status under Green Globe international sustainable tourism programme and is proceeding to certification. A process supported by the CRISP programme was launched in early 2009 by a local association, Te Mana O Te Moana, to develop marine-based standards for the Green Globe certification.

From left to right: Sylvio BION (Director of Thalasso), Mathieu PETIT (Te Mana O Te Moana association), Anne-Catherine IMHOFF (Intercontinental Papeete) and Eric CLUA (CRISP Manager).

Photos courtesy of Eric CLUA (CRISP)

PCC CASE STUDY

ACTIVITY 3:

RAISING AND GROWING MANTA SHRIMP POSTLARVAE FOR THE RESTAURANT MARKET

The manta shrimp (MS) is a luxury food in French Polynesia, where the demand is never met by the supply. MS are caught in the wild by fishers who sell the crustacean for up to USD 300 /kg. Postlarvae of MS are regularly trapped in small mesh nets and can be raised up to the commercial size (around 20 cm).

BoraEcoFish staff member Corentine FAVRE manipulating an adult MS for technical monitoring.

A pilot study is currently being conducted in the BoraEcoFish facility with funding from the fisheries department of French Polynesia. Two MS species are presently studied: *Lysiosquillina maculata* and *L. sulcata*, the former one being more appreciated by gourmets. These two species of MS are caught at 1.5 and 2 cm respectively and must be raised in PVC pipes which replace their natural burrows in soft lagoon substrates. The aquaculture of MS requires solid technical knowledge but is an interesting complementary income generating activity.

Photos courtesy of Eric CLUA (CRISP)

Developing economic potential

6. Developing PCC

Postlarval capture and culture (PCC, see inset) was one of CRISP's key areas; it received specific and repeated support from AFD and FFEM.

The concept, which originated in French Polynesia in the 1990s, is to catch post-larvae (stage between larvae and adults) when they enter the lagoon en masse and to raise them for the aquarium fish market, for food or to reseed overfished lagoons (see inset). This activity could be an alternate source of income for certain local communities.

The technique is more sustainable than the current one, i.e. taking adults from the wild with techniques that are often destructive (toxic products, destruction of the reefs).

Support for PCC first involved French Polynesia and was then extended to Fiji, Wallis and Futuna and Pohnpei, as well as to Kiribati, Hawaii, and other Pacific countries. The activities carried out as part of CRISP took several complementary directions:

- **research and development** in the areas of (1) recruitment and (2) capture and culture techniques;
- **sharing knowledge** through guides that are useful for operators (larvae identification guides or methodology guides);
- **technical and financial feasibility;**
- **skills transfer** from French Polynesia (training sessions on capture, culture, packaging and shipping products);
- Modifying legislation to facilitate the creation of export sectors;
- **financial support** to private partnerships to develop sectors to export post-larvae to several Pacific Island countries;
- promoting PCC products.

A related project now in progress, funded more recently by FFEM, covers downstream support for these sectors with:

- implementation of coherent marketing arrangements;
- design of an ecolabel;
- analysis of the legislative and regulatory conditions in the products' countries of origin and destination;
- monitoring the impact of catches;
- broad communication efforts.

What is PCC? (Moana Initiative 2007)

PCC stands for post-larval capture and culture, or "grow-out". Post-larvae are a developmental stage that reef fish (see Fig. 9) and crustaceans undergo prior to settlement in the lagoon and to their adult stage. Most animals begin their developmental cycle with a pelagic stage that lasts roughly one to three months, after which fish and crustaceans settle in the lagoon (in numbers that vary from a few hundred to many million). Approximately one in a million specimens will reach the adult stage, as most juveniles are eaten by predators.

Using innovative techniques, post-larvae can be captured and bred for trade on three potential markets: aquaculture (for food purposes); reseeding into ecosystems (to boost biodiversity and fish density for fishing purposes or tourism); and the (lucrative) aquarium fish trade.

Despite their impressive numbers, captured animals account for a very small proportion of the larval flow and, therefore, have only a modest impact on the ecosystem compared with techniques involving the capture of adults, which are potential brood stock. This makes PCC an eco-friendly tool for the conservation and maintenance of reef population biodiversity

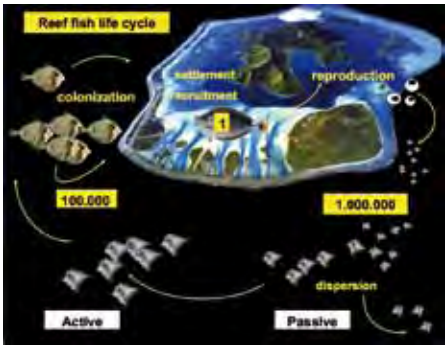
Situation in the Pacific (Teitelbaum et al., 2010)

The Pacific region first became a part of the luxury aquarium trade in the 1970s. Thirty years later, the total annual value of aquarium organism exports from the region is between 40 and 60 million US dollars (USD), accounting for about 10–15% of global trade. The aquarium fish market is becoming an important source of income and employment for local communities in the Pacific.

In Fiji alone for example, the aquarium trade provides employment for 600 people, and income from this trade is second only to tuna fisheries.

Today, the activity has spread to more than 13 Pacific Island countries and territories (PICTs), finding its source in unique coral reef habitats. It has even come to some of the most remote places, where there are a number of rare or endemic fish species not found in Southeast Asia, the Pacific's major competitor.

Figure 9: Reef fish development stages (Galzin, 2008).



6.1 Basic research on larval recruitment

The success of reef fish recruitment mainly depends on the survival of larvae and juveniles. In marine species with a pelagic larval phase, the larvae's choice of settlement habitat is a major determining factor in the success of juvenile settlement as well as in their later performances (growth and survival). Several studies were carried out in partnership with a research programme of the French national research agency (ANR), under the direction of CRIOBE and USP (University of the South Pacific in Fiji). They dealt with the factors that affect selection of the settlement habitat and then larval survival and growth (environmental factors, reef status, presence of fellow species members, predation and parasites, distribution of zooplankton) and finally the sensorial abilities of postlarvae, with a view to developing new catch techniques based on chemical, auditory and olfactory attraction.

While research has, for a long time, covered fish, CRISP also addressed invertebrates, crustaceans and molluscs (Mills et al., 2007; Santos, 2008; Burgy, 2008; Zvara's literature review; 2008a and Zvara, 2008b; Lecchini, 2009). More specific studies focused on high-added-value species such as mantis shrimp or *varo* (Société Tropical Fish Tahiti, 2007; Brié et al., 2008; Chevalier et al.; 2009a and b), French Polynesian eels (study on the population dynamics of *Anguilla marmorata*, *megastoma* and *obscura;* Grousseau, 2010), endemic fish in the Marquesas Islands (Clua et al., 2010) or the pearl oyster *Pinctada margaritifera* (Ubertini, 2009).

Influence of the reefs' health status

Coral reef degradation, characterised by a change from an ecosystem dominated by live coral to an ecosystem dominated by algae, has widely varying effects depending on the taxonomic group studied and consequently the conclusions of the various studies differed significantly. Zvara, in 2008, concluded that reef degradation did not have any clear effect on crustacean and mollusc recruitment, since large-scale habitat degradation did not systematically influence degradation at smaller scales; the impact varied from one taxon to the next, in time and space. On the other hand, Burgy's work (2008), also on crustaceans and molluscs, showed that recruitment success differed between degraded and non-degraded sites. Trials also covered the possible impact that auditory signals from reefs in various states of degradation might have on the choice of the status of the reef for fish and invertebrate larvae (Lecchini et al., 2009).

Habitat selection mechanisms and impact

Night-time recruitment observations, studied on Moorea with 534 coral fish larvae from 27 species, showed that there is a significant relationship between their vertical position in the water column and the distance covered from entry into the lagoon to the settlement habitat (Irisson et al., 2008). In his dissertation, Mellin (2007) also studied habitat settlement mechanisms and habitat use after settlement in reef fish in New Caledonia.

The influence of habitat characteristics and fellow members of the species on reef fish juvenile attraction was studied in the damselfish *Chromis viridis* on Moorea. The study showed that survival rate is higher in the preferred settlement habitat, a massive coral (*Porites rus*), and that juveniles are attracted by those *Porites* where other members of their species can be found. However, the mortality rate was independent of the presence of members of fellow or other species, suggesting that, at least over the short-term, site selection does not have an effect on the mortality rate (Lecchini et al., 2006).

In order to find the most appropriate sites during settlement in the reef, certain larval species use signals to orient themselves and to navigate on small spatial scales. Studies therefore covered the environmental determinants and sensorial mechanisms (visual or olfactory signals) that make it possible to identify preferred habitats or the presence of fellow members of the species (or, in contrast, other species), with signals varying between species and between habitats. For instance, in the wrasse species *Thalassoma Hardwicke,* larvae use a visual signal, whereas juveniles are attracted by visual and olfactory signals linked to the presence of members of the same species (Lecchini et al., 2007a). In *Pinctada margaritifera*, the fact that other adult members of the species are present or absent does not affect recruit abundance significantly (Ubertini, 2009). Initial studies on crustacean post-larvae revealed sensorial signals for a wide range of crustaceans (Lecchini et al., 2009 and 200). They demonstrated that habitat selection is an active behaviour but the presence or absence of members of the same species did not always seem to have an impact (Lecchini et al., 2009).

Studies were also conducted on sound production in damselfish (*Dascyllus flavicaudus*) (Kever, 2009; Parmentier et al., 2009, 2010). These studies showed that the sounds produced by these fish vary within the same species depending on behaviour, e.g. hunting, breeding, and between different species in geographically different regions. The idea was to develop new post-larval capture techniques based on smell and hearing, by creating a bank of the chemical and sound signals responsible for attracting larvae, in order to improve the fish settlement phase in coral reefs and then to increase the stock available to fishers (Lecchini et al., 2009).

In his dissertation, Grignon (2010) showed that sampling effort had a significant effect on detecting and estimating recruitment distribution and diversity in larvae, that environmental parameters only explained 27 to 35% of the total variation in fish recruitment and that certain species display marked seasonal tendencies in recruitment. He also highlighted the interactions between the age of fish, the presence of predators and habitation selection for colonisation.

A study was carried out on certain life characteristics (survival, condition and parasite load) of fish juveniles during settlement in coral reefs (Burgy, 2009; Peyrusse, 2010).

6.2 Improving capture and culture techniques

As part of CRISP's knowledge dissemination section, three identification guides were produced to facilitate the work of classifying the species caught by professionals.

In 2006, a **guide on identifying reef fish larvae in French Polynesia** was published (Maamaatuaiahutapu et al., 2006). It covered some 140 species of reef fish that can be caught using PCC techniques.

Then, in 2006 and 2007, the first inventory of common crustaceans in Wallis and Futuna (land, rivers and estuaries, mangroves, marine environments) was carried out. It led to an **illustrated inventory of crustaceans in Wallis and Futuna**, marketable species and larval forms (Poupin and Juncker 2008). Among the 127 taxa listed, 108 are shown in colour illustrations to make it easy to identify the most common species.

Finally, in 2007, Matthieu Juncker produced, for CRISP and in partnership with IFRECOR, a bilingual (French-English) **guide to identifying fish larvae for the Central Pacific** (Juncker, 2007), 300 copies of which were then printed. It includes 70 species illustrated by 117 photos.

Research on capture methods

There are two main methods for catching live post-larvae: passive techniques that collect post-larvae as they enter the lagoon over the reef crests or through the *hoa* (crest nets or hoa nets)[16] and active techniques based on their attraction to light ("light-traps"), e.g. the CARE (Collect by Artificial Reef Eco-friendly;) approach developed by Ecocean. Various methods were tested as part of CRISP.

The techniques are well known and while their use and effectiveness do depend on numerous factors, e.g. exposure, recruitment, in any event, thanks to the wide range of traps available, PCC can, in theory, be used in any country whatsoever. Experimentation with different collection systems was carried out in several countries.

In **French Polynesia,** testing took place on Bora Bora and on the atoll of Rangiroa (Santos, 2008; Chevalier, 2009), and in New Caledonia. On Moorea, Viliame Pita Waqalevu (2009) showed that crest nets depend heavily on the weather conditions (in contrast to light-traps), and on the sites where they are set up, as well as on tidal fall. But species diversity in the fish collected is lower with light traps.

On **Wallis**, Juncker's work (2005) proved the effectiveness of fixed nets attached to rubble ridges in catching fish and marine invertebrates at early life stages (Junker, 2006).

Number of larvae caught in the South Pacific during the 2005-2010 programme.

More than 1,000,000 larvae probably caught		
Live fish	0	0%
Aquariums	5,000	0.5%
Reseeding	15,000	1.5%
Research	980,000	98%

16 Natural channels that vary in size, which allow sea water to come into the lagoon

In **Fiji**, the CARE process was tested; it is appropriate and can be used on any Pacific Island but nets are better when it is possible to reach reef crests on foot to install them; experience has also shown that not all the zones are conducive to capture (depending on water quality, exposure to swell – see inset for results of the capture trials).

Capture results in Fiji

The experience in Fiji demonstrated that it is feasible to collect post-larvae in the islands. It is advisable to involve fisher communities in developing this technique along with the fisheries departments of the countries involved. The transfer of experience in larval collection techniques worked well, e.g. fishers, technicians, village chiefs, and the fishers took good ownership of these methods. However, the setting proved to be poor in terms of post-larval recruitment, due to the heavy overfishing of marine resources in the zone and pollution at the site. The diversity of species collected (20,000 post-larvae, about 125 species) was relatively low in comparison to Fiji's diversity and species coverage was skewed to the detriment of species used for export (food fish).

In **Vanuatu**, IRD developed simple traps made of low-cost materials that could be used by villagers to catch the mollusc species larvae that are a traditional resource (trochus, green snail, giant clams – DECOVAN project, Dumas, 2010; Dumas et al., 2010). Some experiments were carried out in New Caledonia and Vanuatu to ensure the traps would attract larvae and to test their potential as a tool for assessing natural recruitment of target species in various management contexts (MPA, reseeding zones). The results demonstrated that the traps' effectiveness depends directly on variations in local recruitment against a backdrop of a steep decline in the natural populations of these species at a regional scale. The prospects opened by this pilot project led the Fisheries Department to request an extension of testing in Vanuatu over the period 2011–2012.

Research on culture protocols

After collection, larvae are transported to a farm unit on land. Then come the sorting, weaning and grow-out phases. Several studies looked into the factors for successful farming. They showed that a wide range of factors are important, such as water quality, the water circulation system, feed for weaning larvae, species composition in the ponds, etc. They also led to the conclusion that the main problems with post-larval weaning and grow-out do not come from the sorting and nutrition phases (except for certain difficult species), but rather from the multi-species aspect of

sorting and grow-out as well as from the price of feed, which is imported.

The largest number of studies took place in **Fiji**. A postlarvae farm was set up by Ecocean, with the support of USP, at the university. The work was carried out by students from metropolitan France (T. Rauby, S. Vermond, A. Gruss) and one Fijian student (S. Bala), under the guidance of Ecocean. This work covered optimising conditions for grow-out, sorting and health monitoring (Vermond, 2007), in particular to improve the success of specimens released for repopulation (Bala, 2008 and Grignon, 2010).

Several experiments covered **feed** for post-larvae and larvae in the grow-out and weaning phases and on the impact feed has on the growth rate, by comparing live feed (*Artemia nauplii*) and inert feed, e.g. pellets, flaked or frozen *Artemia*. The price of feed is a problem and if this activity is to develop, reliable suppliers who offer reasonable prices must be found (Bala, 2008).

One of the main difficulties encountered in raising fish larvae in aquariums is **interspecies relations,** which can lead to predation or mortal fighting between animals. S. Vermond's study (2007) provided data on the behaviour and ecological preferences of various species of fish larvae by size category and made it possible to produce a hierarchical classification of those species that can and cannot coexist in aquariums. This tool led to an operational tool in the form of a species compatibility chart, which clustered almost all the species used for farming in the region into 11 different interconnected groups with compatibility pathways (Vermond, 2007); this tool was tested for validation in other PCC-related projects.

In **French Polynesia,** several experiments covered **crustacean larvae culture**. Besides research into larvae collection (see paragraph below), trials were carried out on *varo* (squillids) *Lysiosquillina maculata* and *Lysiosquillina sulcata* farming (Tropical Fish Tahiti, 2007; Santos, 2008; Chevalier, 2009). The results were not very conclusive.

6.3 Technical feasibility, economic effectiveness and technology transfer

Studies were mainly carried out in Fiji, Federated States of Micronesia (Pohnpei), Kiribati, Hawaii, Wallis and Futuna, Marshall Islands, Solomon Island and French Polynesia. It seems that the American market has the most potential for the region. Of the 1.5 to 2 million people around the world who have aquariums, more than 600,000 live in the US (Green, 2003) and according to Wabnitz et al. (2003, in Lecaillon, 2009) 50% of ornamental fish are exported to the American market. The Chinese market is also very promising.

The most comprehensive approach was in **Fiji**. For more than two years, the company Ecocean conducted technology transfer (capture, culture, repopulation, see above), but also analysis of the economic feasibility and possibilities of adding value on-site as well as the legal aspects. Studies showed the potential of developing PCC, as long as capture is optimised. A study on the costs and possible outlets in various types of markets (Gruss and Cavakigali in Lecaillon, 2008) revealed that the most promising markets would be the aquarium trade with, as a back-up, the coral garden market at luxury hotels. The food fish market proved not to be profitable.

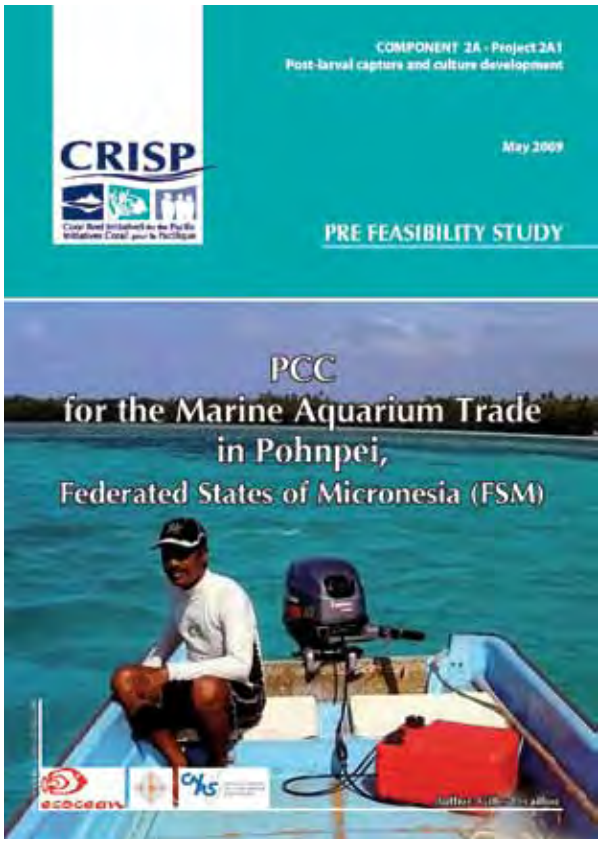
An economic survey that was carried out to calculate potential turnover using two scenarios (depending on assumptions on post-larvae capture percentages with very different values) showed that the outcomes would be positive in both cases. In one case, there was a balanced outcome with no real profit. With careful optimisation (increase in rare and expensive species), the net result was more than €50,000, which, for a developing country, can only be considered encouraging. The issue of exports (companies, costs) still needs to be looked into. At the current time, the private sector is not motivated but if air service between Nadi, Christmas Island and Honolulu was reopened, this could reverse the trend.

In his thesis, Grignon also included a study on PCC's economic effectiveness in Fiji in terms of the reseeding market, via a computer simulation (software). The study concluded that reseeding based on PCC is not economically viable in Fiji in its current form, mainly due to the local capture rates recorded. As part of this work, Grignon contributed, in collaboration with the Australians, to the development (now being completed) of bio-economic software designed to test other micro-sectors in the Pacific over the medium term.

In 2009, Ecocean carried out a pre-feasibility study on using PCC for the ornamental fish market in the state of **Pohnpei** (Federated States of **Micronesia;** Lecaillon, 2009); the study showed higher potential than in Fiji, with greater species diversity; farming could be supported by the Marine and Environmental Research Institute of Pohnpei (MERIP), which already farms coral in collaboration with local communities. In 2010, CRISP, MERIP and Hawaiian SeaLife Inc signed an agreement on developing PCC to supply the aquarium trade market in Hawaii. Equipment was provided along with technical assistance. Collecting began with local fishers trained in this technique and farming also began. Exports to Hawaii began with two successful shipments of a few thousand post-larvae (Teitelbaum, 2010). But capture volume is too low and the sector will only be viable if more effective fishing gear is used.

In **Marshall Islands**, there was skills transfer (capture and culture) to local communities in collaboration with a large ornamental fish producer (Ora), and a private local structure (Lecaillon, 2009).

In **Hawaii**, CRISP was involved in a joint project between Ecocean and one of the biggest aquarium fish exporters, the American company Hawaiian SeaLife Inc (HSL), to purchase and market post-larval products from Pacific Island countries such as Kiribati and Federated States of Micronesia. HSL used its own funds to develop new, very promising capture equipment, i.e. giant light traps, which, just like with CARE, are based on larvae's attraction to light. Testing covered the effectiveness of these traps and the resilience of post-larvae during transport. Finally, a strategy to sell post-larvae as a fully-fledged product, as substitutes for adult aquarium fish, was developed as the traceability and certification of PCC-produced aquarium fish have been difficult to implement.



In **Kiribati**, particularly on Christmas Island, marine product trade for the aquarium market is already a well-developed activity, which provides relatively high income for local communities. The industry's value is currently estimated at USD 1.5 million annually, at the very least. But this activity has not always been developed in a sustainable way. As part of its Live Reef Fish Initiative, SPC, in collaboration with CRISP and Kiribati's Ministry of Fisheries, has provided technical support for developing this activity. A training workshop was held and four fisheries officers were trained in fisheries resource surveys, zones that are important for quality or fish survival were identified and the current status of aquarium fish resources was assessed in order to set annual catch quotas. A management plan was developed addressing the legal basis for good practice, diving safety measures, framework for an increased role by industry in responsible management and monitoring, creation of a consultative committee, etc. A 26-minute-long television documentary was filmed by RFO with CRISP's support.

Also on Christmas Island (Kiribati), a mission carried out by HSL (Richard Xié) confirmed the existing high local potential for PCC and led to a partnership

between that company and a local operator, Otee Marine, to export post-larvae over the long-term (an application for a permit to carry out PCC has been submitted to national authorities).

Several other approaches were used: in **Solomon Islands** work was done on juvenile fish capture and grow-out (rabbitfish and Mullidae) with the development of low-cost feed that local fishers can make themselves; **Wallis and Futuna** has potential in the area of ornamental crustaceans (like the shrimp *Stenopus hispidus*, which accounts for up to 6% of the larvae caught). In **French Polynesia**, in the Marquesas Islands, the potential for high-value commercial fish species (rare or endemic species) was assessed along with the possibility of setting up pilot capture and export operations (Clua et al., 2010). Studies on French Polynesian eels, squillids (varo) in French Polynesia, or rock lobsters on the island of Maré in New Caledonia showed that such operations were not profitable.

Coral farming in Solomon Islands

Sponsored by the Ministry of Fisheries, exporters and the WordFish Center in Solomon Islands, an original project for sustainably farming ornamental marine products, e.g. coral, molluscs, was developed with CRISP's support. The goal was to ensure sustainable development of this commercial activity and to promote demand by diversifying the range of products available and selling them on the Internet. A website (www.solomonseasustainables.com) and an eco-friendly label were developed to promote the activity and a specific logo was created for products from Solomon Islands. This site provides an information portal for international customers interested in purchasing products and a practical guide for local communities interested in this type of aquaculture, which respects the reefs' integrity. The first trials were carried out to identify new coral species to be farmed and attachment techniques that would make it possible to increase production rates by concentrating on high-demand products. The information gained during these initial trials will allow a guide to be produced for local people on identifying coral and on culture techniques. About 20 farmers were trained in PCC techniques (and other coral-grafting-type products), and have now joined forces in an export cooperative. The volume of the Gizo cooperative's ornamental product exports climbed 50% between 2009 and 2010.

6.4 Adapting trade laws

Two reports were produced: one in French Polynesia on an overall strategy for the territory (Lipchitz, 2007) and the other in Fiji, focusing on legislation and restrictions that currently prohibit post-larval exports (Manoa, 2007a, b), as the main possible PCC market in Fiji is aquarium trade exports. A technical assessment of Fiji's legislative framework for aquarium fish trade was carried out, together with proposed adaptations (Manoa, 2008a and b). In addition, CRISP supported Pacific countries' preparations to take into account OIE requirements covering the export of animal products (including PCC).

6.5 Promoting the sector and disseminating knowledge

PCC has been widely promoted in the region and information about it has been shared on a broad basis. The various stakeholders, i.e. CRIOBE, Ecocean, donors, the CRISP Coordination Unit, contacted a wide range of potentially interested participants in the region.

Besides general information documents on PCC (Lecchini et al., 2006; Bell et al., 2009), about 20 reports, four guides available on the website, and many seminars and other meetings made it possible to present the technique and the most recent progress achieved by the programme.[17] About a dozen papers were published in well-know scientific journals.

A few events, in particular, were held with CRISP's support:

- **Pacific Sub-Regional Marine Ornamentals Trade Workshop** by SPC (Noumea 2008; Kinch et al., 2008).
- **Porte Dorée seminar on developing post-larval sectors for the aquarium trade market (Paris 2008)**. This workshop brought together about 40 people, including professionals, scientists, users and French agencies involved in this area. The goals were to present PCC and evaluate the interest the various professionals attending had in such products. Contacts were made with French aquariums.

17 BIODEC (Noumea, 2006, Junker), Regional Cooperation Forum on the Sustainable Development of Coastal Resources in the Pacific (Townsville, 2007, Galzin et al.), Pacific Science Inter-Congress (Okinawa, 2007, Lecaillon), Pacific Science Inter-Congress, (Papeete, 2009, Lecchini), CLAM Congress (Montpellier, 2009, Galzin), International Aquarium Congress (IAC) (Shanghai, 2008; Rojat et al., Lecaillon et Galzin), Porte Dorée PCC Seminar (Paris, 2008, Lecaillon, Galzin), ICRI General Assembly (Phuket, 2009, Clua).

- **International conference on aquaculture** (Tahiti Aquaculture 2010), which made it possible to promote PCC to 180 professionals from 80 different countries.

At the same time, Moana Initiative produced an **information guide**, funded by the Total Foundation for Biodiversity, and a **flyer** was published. A 26-minute **film** was produced in collaboration with France Télévision, "Grow, grow, little fish", which promotes PCC as an alternative to catching adult fish for the aquarium trade market and as a support for ecotourism.

HSL created a website for children on post-larvae culture (www.livingarteducation.com), and funded free sessions in schools to raise awareness among children.

In addition, CRISP supported a partnership between a French Polynesian environmental association (Te Mana O Te Moana) and the company BoraEcoFish, which developed the concept of "**Postlarvae-seeded coral gardens**". The idea was to develop a type of PCC to help hotels obtain their eco-friendly certification.

6.6 Training and developing partnerships

Most of the work on PCC, whether in French Polynesia under the supervision of CRIOBE and USP or in Fiji under the supervision of Ecocean and CRIOBE, was carried out by masters or doctoral students. A total of 21 students took part in the research (including two doctorals students and 14 masters students), from France (16) and Fiji (5) (see appendix).

In addition, one of PCC's objectives is, through alternative sectors, to provide income to the local communities that catch post-larvae. In Fiji, in Micronesia, Kiribati and Marshall Islands, fishers (several dozen in all) were trained in collection and technicians from the Fisheries Department were trained in culture.

This component made it possible to develop a large number of partnerships: between scientists, (University of Perpignan and USP, which signed a framework agreement that ensures continued scientific collaboration between these two institutions), between scientists and private firms, between consultants (see Ecocean) and scientists and/or private firms (e.g. MERIP, HSL, ORA), or even between NGOs (Te Mana O Te Moana) and private firms (BoraEcoFish).

6.7 Prospects and development strategy

CRISP has obtained some promising results from this rather innovative technique. These results have shown that capture and culture techniques have been mastered and that it is possible to transfer the technology to local communities and fisheries department technicians. The technique's limits are linked partly to variability of recruitment over time and partly to the cost of the technique, whose products are probably 20 to 30% more expensive than those from "conventional" sectors that harvest adults directly from the reefs. There are a number of issues:

- Developing more efficient traps, while ensuring they do not have an impact on the environment;
- Targeting high-added-value species*[18], decreasing costs, particularly those for feed and export;
- Working on eco-certification for the sector to make it more attractive or, at least, to ensure that the products have "eco-labels".

The long-term success of these sectors is closely linked to a regional approach, which can stabilise supply. It also depends on professionals, who still have to be convinced, as most of them are still very cautious about the reality of the market due to the difference in prices as compared to catching wild adults; it depends on the interest such professionals show in promoting these products with the general public, modifying demand. Over the long run, PCC development could benefit from the unsustainable nature of many of the current sectors based on catching adult fish. This trend, combined with the growing demand from buyers in developed countries for products guaranteed to be "sustainable" will surely guarantee PCC a certain amount of success over the long run.

There are already several positive points:

- HSL has developed new PLACE 1 and 2 traps that can significantly increase the cost-effectiveness of fishing; the lack of environmental impact by this new gear still has to be proven;
- Several large-scale private operators, e.g. HSL, ORA, Wan, have already invested or are about to invest in PCC, with an access to the world market, capable of supplying the Chinese, American and European markets;
- One operator (HSL) has already developed effective materials to promote PCC (Living Art Marine Center in Honolulu and the website), and a coherent post-larvae sales strategy;
- Pacific Island governments are motivated to promote the development of PCC.

FFEM provided a budget of an additional € 500,000 to support the development of catch techniques targeting high-market-value species, to better study the markets and the expectations of aquarium-fish export professionals and to work on certifying and promoting this sector, which is more sustainable then harvesting adults from the wild. Certain commercial outfits such as HSL or ORA are ready to invest, as are certain governments (French Polynesia).

> "The various methods for capturing post-larval fish and invertebrates alive as they settle on coral reefs have now been developed to the point where there is little doubt that they can supply a range of species for the ornamental trade in ways that remove the risk of damage to the physical structure of coral reefs and add substantial productivity to the target species by translating high mortalities at settlement into high rates of survival."
>
> The authors noted that special care is needed for PCC operations on small, isolated islands where recruitment comes from local populations of post-larvae. But PCC's contribution to the ornamental trade is expected to be limited due to large variations in post-larvae species abundance and composition from one year to the next and the logistics and costs of operations and export in remote locations (Bell et al., 2009).

18 *While larvae are caught in extremely large numbers, particularly with hoa nets as compared to light traps (which, in addition, have the advantage of being less vulnerable), less than 20% of the fish caught have any real commercial value, and less than 5% have a very high added value for the aquarium trade market, e.g. butterfly fish, angel fish. In addition, postlarvae, except for a few rare exceptions, have relatively drab, less attractive coats than older fish, which makes selling them early difficult.

Key points

Post-larval capture and culture (PCC) was one of CRISP's key areas and received specific support. The activities carried out as part of CRISP took several mutually complementary directions:

- research and development in the areas of (1) recruitment and (2) capture and culture techniques;
- sharing knowledge through guides that can be used by operators (larvae identification guides or methodology guides);
- skills transfer from French Polynesia (training sessions on capture, culture, packaging and shipping products);
- modifying legislation to facilitate the creation of export sectors;
- promoting PCC products;
- financial support to private partnerships to develop post-larvae export sectors in several Pacific Island countries.

Main CRISP outputs

- Significantly expanding knowledge about larvae recruitment in fish, molluscs and crustaceans;
- Tools that are useful for developing this activity:
  - larvae identification guides that can be used by operators;
  - a large post-larvae image base than can be used with many online digital tools (website and LearnFishID software), for both professionals and the general public (particularly children);
  - bio-economic software designed to simulate the profitability of micro-sectors in small Pacific Island countries;
  - a species compatibility chart for farming.
- Improved capture and culture techniques, which have now been mastered (crest nets, hoa nets, light traps – CARE or PLACE), although research must continue, particularly to target high-added-value species.
- Large-scale technology transfer in Fiji (see Lecaillon 2009):
  - An equipped and functional aquaculture unit, e.g. aquariums, ponds, distribution system, pumps;
  - Capture gear (CARE x10 and crest nets x2);
  - Tools: identification guides and plates, protocol on managing the health aspects at farms;
  - Skills shared with fishers (3) and technicians (2) on the various stages of PCC from capture to culture;
  - A socio-economic survey that indicated that the technology is feasible in Fiji;
  - An image as a pioneer in the development of sustainable techniques in the South Pacific.
- Though initially positive, PCC's overall results for the aquarium trade market in Fiji remain mixed, however, since the activity seems not to have lasted; experimentation should continue right through to offering to work with the country's wholesalers so as, in the end, to send shipments of PCC fish to sellers' markets (USA and EU).
- Feasibility studies and technology transfer also took place on other Pacific Islands (Federated States of Micronesia, Marshall Islands, Kiribati, Vanuatu, Wallis); local partners were identified, raising hope for the development of this activity.
- Support to the sustainably produced ornamental marine products sector, e.g. coral, molluscs, in Solomon Islands. A website (www.solomonseasustainables.com) and an eco-label were developed to promote the activity, about 20 farmers were trained in PCC techniques (and other coral-grafting-type products), and have now joined forces to create an export-oriented cooperative. That cooperative's volume of ornamental product exports climbed 50% between 2009 and 2010.
- Significant **capacity building** in capture and culture techniques: training provided to fishers and technicians (Fiji, Federated States of Micronesia, Vanuatu, Solomon Islands) and 21 students trained (Fiji, French Polynesia).
- Excellent **scientific enhancement** of the research, with 73 documents produced, publications, grey literature, guides and public presentations, including 10 top-ranked publications.
- **Promotion of this sector,** with the countries in the region better informed about why this activity is worthwhile.
- **Rich exchanges and partnerships** between the various interested parties in the region and beyond: scientists, fishers, private aquaculture firms, export companies, donors, political authorities.
- **Bilateral cooperation**, between IRD and Vanuatu, begun as part of CRISP and continuing so as to make further progress in collecting the larvae of marketable species.
- **Prospects** that are opening up with new equipment developed, new strategies identified (post-larvae sales) and a commitment by several private firms who want to get involved in the sector.
- **In Hawaii, a private partner was identified who is motivated and has a significant investment capacity,** resulting recently in the development of high-performance capture tools, a large PCC promotion centre and, most importantly, a strategy to make it possible to sell post-larvae as a fully-fledged product by targeting young customers. This operator's knowledge of and special access to the Chinese, American, and to a lesser degree European markets bode well for PCC's success over the long-term, which it will undeniably owe to CRISP.

Bibliography

Bala S. (2008). Postlarval fish capture, culture and release in Fiji: effects of culture conditions on survival in the wild. Master technical report, University of the South Pacific, 121 pp.

Bell J., Clua E., Hair C., Galzin R., Doherty P., The capture and culture of postlarval fish and invertebrates for the marine ornamental trade, Reviews in Fisheries Science, 2009, 17 (2): 223–240.

Bonhomme B. (2010). Etudes des capacités auditives des poissons au stade larvaire lors des phases de colonisation et d'installation dans les récifs coralliens. Mémoire de master, Université de Pau et des Pays de l'Adour, 47 p.

Brié C., Santos R. (2008). Étude de la colonisation larvaire de six espèces de crustacés et études préliminaires d'élevage du varo. Rapport technique, Service de la Pêche de Polynésie française, 99 p.

Brié C., Santos R. (2007). Étude de la colonisation larvaire de six espèces de crustacés et de l'élevage du Varo (Lysiosquillina sp.). Rapport technique intermédiaire, 18 p.

Burgy L. (2008). Effet de la dégradation des récifs coralliens sur le succès de recrutement des larves de crustacés et de mollusques (Rangiroa, Polynésie française). Rapport technique – Mémoire de Licence, Université de Pau et des Pays de l'Adour, 34 p.

Burgy L. (2009). Étude des traits de vie des juvéniles de poissons lors de leur phase d'installation dans les récifs coralliens (Rangiroa,

Polynésie française). Rapport de stage de master, Université de Pau et des Pays de l'Adour, 46 p.

Chevalier F., Favre C. (2009). Étude de la colonisation larvaire et du grossissement de deux espèces de Stomatopodes : les squilles (varo) Lysiosquillina maculata et Lysiosquillina sulcata, Bora Bora (Polynésie française). Rapport technique intermédiaire, 32 p.

Clua E. (2008). Séminaire sur le développement de filières postlarves pour le marché de l'aquariophilie, Aquarium de la Porte Dorée, Paris. Rapport de synthèse, 24 p.

Clua E., Le CRISP et la PCC (Capture et Culture de Postlarves), Séminaire sur le développement de filières postlarves pour le marché de l'aquariophilie, Aquarium tropical du Palais de la Porte Dorée, Paris, France, 02 juill. 2008, Présentation PowerPoint, 39 p.

Clua E., (2010). Le CRISP et l'aquaculture, Tahiti Aquaculture, Papeete, French Polynesia, 06–11 Dec. 2010, Presentation PowerPoint, 24 p.

Clua E. (2008). The development of PCC in the Pacific, Sub-regional Workshop on the Marine Ornamental Trade in the Pacific, Noumea, New Caledonia, 02–05 Dec. 2008, PowerPoint presentation, 25 pp.

Clua E. (2009). Development of economically viable postlarval capture and culture (PCC) based activities in Bora Bora (French Polynesia). Brochure, 4 pp.

Clua E. (2010). Evaluation rapide du potentiel d'exportation de postlarves de poissons ornementaux des Marquises (Polynésie française). Rapport technique, 15 p.

Clua E., Lecchini D., Galzin R. (2010). Developing efficiency of capture methods of coral reef fish larvae in the South Pacific, Tahiti Aquaculture, Papeete, French Polynesia, 06–11 Dec. 2010, PowerPoint presentation, 18 pp.

Clua E., Planes S., Xie R. (2010). Evaluation rapide du potentiel d'exportation de postlarves de poissons ornementaux des Iles Marquises (Polynésie française). Rapport technique, 15 p.

Dumas P. (2010). Développement de collecteurs de larves d'invertébrés commerciaux au Vanuatu. Rapport technique, IRD, 20 p.

Dumas P., Boudier A., Senia J. (2010). Développement de dispositifs expérimentaux de captage de larves de bénitiers (Tridacna maxima). Rapport technique, 15 p.

Ellis S. (2010). Development of Post-larval Capture and Culture (PCC) in Pohnpei for the ornamental fish market. MERIP Activity report, 12 pp.

Frédérich B., Lecchini D., Vandewalle P., Evidence of an original scale development during the settlement phase of a coral reef fish (Acanthurus triostegus), Journal of Applied Ichthyology, 2010, 26: 176–178.

Galzin R., Recherches sur les larves de poissons dans le Pacifique Sud, Séminaire sur le développement de filières postlarves pour le marché de l'aquariophilie, Aquarium tropical du Palais de la Porte Dorée, Paris, France, 02 juill. 2008, Présentation PowerPoint, 40 p.

Galzin R., Scientific knowledge on postlarvae capture and culture, Tahiti Aquaculture, Papeete, French Polynesia, 06–11 Dec. 2010, Poster.

Galzin R, Grignon J., Remoissenet G., More than one decade of fish larvae fishing in French Polynesia, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presentation, 24 pp.

Galzin R., Lecaillon G., Comment la PCC peut répondre à la problématique de durabilité de l'aquariologie marine ?, Congrès Bourse Clam 2009, Montpellier, France, 28–29 mars 2009, Présentation PowerPoint, 37 p.

Galzin R., Lecaillon G., Lipchitz A., Malpot E., De Villers P., Three experiences of post larval capture and culture (PCC) in the Indo-Pacific: Technical, ecological and socio-economical observations, Building Capacity and Cooperation for Sustainable Development of Pacific Coastal Resources Forum, Townsville, Australia, 01–07 Sep. 2007, PowerPoint presentation, 20 pp.

Grignon J. (2010). Post-larval Capture and Culture for coral reef fish stock enhancement in Fiji. PhD thesis, University of the South Pacific, 197 pp. + 4 annexes.

Grousseau J. (2010). Etude du recrutement et des populations en place d'anguilles polynésiennes. Mémoire de master, Université de Perpignan Via Domitia, 35 p.

Havimana L. (2010). Capture and identification of coral reef fish larvae (French Polynesia). Training course report, University of the South Pacific, 27 pp.

Hawes I. (2009). Développement de filières économiques écocertifiées pour l'approvisionnement du marché de l'aquariophilie à partir de postlarves de poissons et crustacés récifaux du Pacifique Sud. Rapport de présentation, 74 p.

Irisson J.-O., Lecchini D., In-situ observation of settlement behaviour in larvae of coral reef fishes at night, Journal of Fish Biology, 2008, 72: 2707–2713.

Juncker M. (2006). Projet de capture des jeunes stades de crustacés sur Wallis. Rapport de mission, 7 p.

Juncker M. (2007). Jeunes poissons coralliens de Wallis et du Pacifique central. Guide d'identification (Bilingue). Ed. SENV/ Programme CRISP, 170 p.

Kever L. (2009). Variation dans la production de sons chez Dascyllus flavicaudus (Pomacentridae). Mémoire de master, Université de Liège, 199 p.

Kinch J., Teitelbaum A. (2008). Proceedings of the Sub-regional Workshop on the Marine Ornamental Trade in the Pacific; 02–05 Dec. 2008, Noumea, New Caledonia. Workshop proceedings, 70 pp.

Lanyon R. (2010). Sensory abilities and brain anatomy of coral reef fish at larval stage (French Polynesia). Training course report, University of the South Pacific, 21 pp.

Lecaillon G., Socioéconomie de la PCC au travers de l'expérience acquise par Ecocean (Polynésie, Mayotte, Floride, Vietnam, Hawaï, Philippines, Hérault, Fidji, Réunion…), Séminaire sur le développement de filières postlarves pour le marché de l'aquariophilie, Aquarium tropical du Palais de la Porte Dorée, Paris, France, 02 juill. 2008, Présentation PowerPoint, 8 p.

Lecaillon G. (2008). Étude pilote sur la faisabilité technique et économique de la PCC aux Iles Fidji. Rapport technique, 69 p.

Lecaillon G. (2009). PCC for the marine aquarium trade in Pohnpei, Federated States of Micronesia (FSM). Rapport technique, Ecocean, 15 p.

Lecaillon G., Galzin R., Positive effects on the aquatic environment of using PCC as a source of tank-raised MAT products, 7th International Aquarium Congress, Shanghai, China, 19–24 Oct. 2008, Présentation PowerPoint, 9 pp.

Lecaillon G., Lourié S.M. (2007). La PCC, un outil pour la conservation et la valorisation de la biodiversité. Manuel, 76 p.

Lecaillon G., Lourié S.-M., Grüss A., Vermont S., Galzin R., PCC (Postlarval Capture and Culture) potential after 14 months of collection in Fiji, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, Poster.

Lecchini D., Dumas P., Mills S., Banaigs B., Ponton D., Sensories abilities and habitat selection in coral reef fish larvae, Effects of alternate coral reef states on the attraction, settlement and subsequent survival of marine invertebrates and fish larvae, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presentation, 22 pp.

Lecchini D., Mills S.C., Brié C., Maurin R., Banaigs B., Ecological determinants and sensory mechanisms in habitat selection of crustacean postlarvae, Behavioral Ecology, 2010, 21 (3): 599–607.

Lecchini D., Osenberg C., Shima J., St Mary C., Galzin R., Ontogenetic changes in habitat selection during settlement in a coral reef fish: ecological determinants and sensory mechanisms, Coral Reefs, 2007, 26: 423–432.

Lecchini D., Planes S., Galzin R., The influence of habitat characteristics and conspecifics on attraction and survival of coral reef fish juveniles, Journal of Experimental Marine Biology and Ecology, 2007, 341: 85–90.

Lecchini D., Polti S., Nakamura Y., Mosconi P., Tsuchiya M., Remoissenet G., Planes S., New perspectives on aquarium fish trade, Fisheries Science, 2006, 72: 40–47.

Le Rohellec M. (2010). Etude des patrons de colonisation larvaire des poissons de récifs coralliens. Mémoire de master, Université de Perpignan Via Domitia, 25 p.

Lipschitz A. (2007). Stratégie des filières poissons récifaux dans le Pacifique Sud à partir de la capture de larves en milieu naturel. Rapport d'étude AFD, 12 p.

Lo-Yat A., Simpson S.D., Meekans M., Lecchini D., Martinez E. and Galzin R. (In press). Extreme climatic events reduce ocean productivity and larval supply in a tropical reef ecosystem, Global Change Biology.

Maamaatualahutapu M., Remoissenet G., Galzin R. (2006). Guide d'identification des larves de poissons récifaux de Polynésie française. Éditions Thethys, 104 p.

Manoa P. (2007a). Adaptation of Fiji's legislative framework for the trade in aquarium fish, PART 1: Assessment of the framework, CRISP report, 75 pp.

Manoa P. (2007b). Adaptation of Fiji's legislative framework for the trade in aquarium fish, PART 2: Proposals for improvement. CRISP report, 61 pp.

Mellin C. (2007). Sélection de l'habitat à l'installation et utilisation de l'habitat post-installation chez les poissons récifaux-lagonaires de Nouvelle-Calédonie. Thèse de doctorat, Université Pierre et Marie Curie/Paris VI et Ecole Pratique des Hautes Etudes, 220 p.

Mills S., Lecchini D., Parmentier E. Dumas P., Larval recruitment as a function of habitat degradation, lunar month and conspecifics, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, Poster.

Parmentier E., Kéver L., Casadevall M., Lecchini D., Diversity and complexity in the acoustic behaviour of Dascyllus flavicaudus (Pomacentridae), Marine Biology, 2010, 157 (10): 2317–2327.

Parmentier E., Lecchini D., Frederich B., Brie C., Mann D., Sound production in four damselfish (Dascyllus) species: phyletic relationships?, Biological Journal of the Linnean Society, 2009, 97: 928–940.

Petit M. (2010). Promotion de la filière postlarves en Polynésie française, Stratégies appliquées à l'entreprise BoraEcoFish. Rapport de synthèse, 49 p.

Peyrusse K. (2010). Phase de colonisation larvaire et prévalence parasitaire des poissons de récifs coralliens. Mémoire de Master, Institut Européen de la Mer, Université de Bretagne Occidentale, 25 p.

Poupin J., Juncker M. (2008). Crustacés des îles Wallis et Futuna : inventaire illustré, espèces commercialisables et capture des formes larvaires. Rapport technique, 48 p.

Rauby T. (2006). Premiers éléments d'étude de la colonisation larvaire des poissons de récif corallien à Suva, Fidji. Mémoire de master, EPHE-CNRS/Université de Perpignan Via Domitia, 48 p.

Rojat D., Vallette P., Henard S., Hirel N., Creation of an economic sector based on the capture and culture of post-larval reef fish and crustaceans for aquarium trade, 7th International Aquarium Congress, Shanghai, China, 19–24 Oct. 2008, PowerPoint presentation.

Santos R. (2008). Étude de la colonisation larvaire des crustacés et stomatopodes à Rangiroa (Polynésie française). Rapport technique – Mémoire de master, Institut Européen de la Mer, Université de Bretagne Occidentale, 42 p.

Santos R., Brié C., Chevalier F., Remoissenet G., Lecchini D., Development of mantis shrimps (Lysiosquillina maculate and L. Sulcata): sustainable exploitation from capture and culture of post-larvae, Tahiti Aquaculture, Papeete, French Polynesia, 06–11 Dec. 2010, Poster.

Sasal P., Preliminary results on the potential use of eels for aquaculture in French Polynesia, Tahiti Aquaculture, Papeete, French Polynesia, 06–11 Dec. 2010, Poster.

Secretariat of the Pacific Community (2010). SPC Regional terrestrial and aquatic animal disease reporting workshop - 21–25 June 2010, Suva, Fiji. Workshop proceedings, 26 pp.

TahitiEcoClams. (2009). Rapport intermédiaire de la convention N° 8.0030 relative à des actions techniques et économiques sur la mise en place de la filière aquacole de bénitiers. Rapport intermédiaire, 14 p.

Thiault Y. (2009). Distribution spatiale des holothuries et étoiles de mer – Détermination de l'infestation des holothuries et des huîtres perlières par les poissons Carapidae. Rapport de stage de Licence, Université de Liège, 55 p.

Ubertini M. (2009). Recrutement larvaire de l'huître perlière d'intérêt économique Pinctada margaritifera (TakapotoTakapoto, French Polynesia) : effets des conspécifiques, de la prédation et des facteurs environnementaux. Mémoire de master, Université Pierre et Marie Curie, 41 pp.

Vermond S. (2007). Development of multispecific approach for rearing in aquarium. Internship report, ENSAT –AgroCampus Rennes, 39 pp.

Waqalevu V. (2009). Capture, identification and culture techniques of coral reef fish larvae (French Polynesia). Training course report, University of the South Pacific, 58 pp.

Xie R., Marine ornamental trends, wild captured and PCC, Tahiti Aquaculture, Papeete, French Polynesia, 06–11 Dec. 2010, Poster.

Zvara A. (2008a). Influence des facteurs benthiques sur le processus d'installation et post-installation des poissons et invertébrés marins des récifs coralliens. Rapport bibliographique, Université Claude Bernard, 19 p.

Zvara A. (2008b). Effet de la dégradation des récifs coralliens sur le succès de recrutement des larves de crustacés et de mollusques (Rangiroa, Polynésie française). Rapport technique, Mémoire de master, Université Claude Bernard, 39 p.

7. Active marine substances

The natural environment is an important source of prospection for therapeutic substances. Most of the drugs reaching the market come from substances of natural origin. Active marine substances (AMS) are active ingredients that can be isolated in various marine organisms and used for therapeutic purposes, e.g. for their anti-inflammatory, anti-malarial or cancer-fighting properties. Since their use on an industrial scale requires 12 to 15 years of work after the organisms have been collected, isolating AMSs is a slow, complex process involving 1) harvesting organisms in situ (bio-prospecting); 2) sorting and identifying them; 3) extracting and screening the substances in order to identify their active components.

As part of CRISP, besides harvesting, selecting and isolating active substances, this component emphasised improving the legal framework in those countries that have resources, in terms of protection and rules on access to biodiversity and on intellectual property so as to ensure the equitable sharing of potential financial gains.

7.1 Bioprospecting and species identification

Active marine substances were analysed using organisms collected during two IRD prospecting trips, one to Solomon Islands (2004) and the other, with funding from CRISP, to Fiji (2007) (see section on "Expanding knowledge" [p.83]).

In Solomon Islands, 41 sites were prospected at depths of 20 to 60 metres in the New Georgia group; collection mainly involved algae (900 specimens, 216 species) along with sponges, a group that is very abundant and diversified in Solomon Islands (194 species), and certain tunicates.

In Fiji, prospecting involved 31 stations in reef areas from 0 to 60 m spread out in the northern part of the island of Vanua Levu (Bua and Macuata Provinces in particular), the Ringgold atolls, and the islands of N'Gau and Kaduvu.

Collecting specimens from Fijian waters and exporting/importing them required prior authorisation from local authorities. Five memoranda of understanding (MOUs) were co-signed by IRD, the Fisheries Department and a representative of each province. More than 15 months of paperwork were needed for this approach, with USP's support. In addition, before each site survey, prior approval had to be secured from the chiefs of the villages near the study zone on the basis of the MOUs.

In terms of collection, 910 marine plant specimens were taken (not counting specimens from other campaigns – see section on "Expanding knowledge" [p.83]), i.e. 250 species of seaweed, along with 139 sponge references.

These prospecting trips therefore allowed a large number of specimens to be collected, mainly seaweed, marine phanerogams, sponges and ascidians. On that basis, after the species were identified, large-scale taxonomic work was carried out and promoted (see section on "Expanding knowledge" [p.83]).

7.2 Active substance research

Pharma-chemical studies made it possible to look for new sources of active substances, mainly in sponges, but also in ascidians and algae. The extracts from several dozen organisms collected during the various campaigns were subjected to a large range of

laboratory tests developed by all six of the project's partners. Biological activity was sought mainly on intermediate-host diseases such as malaria, but also on so-called "Northern" diseases, e.g. cancer, inflammation, as well as diseases of the central nervous system and cardiovascular system.

In Solomon Islands, in-depth research covered several sponges[19] and algae from genus *Turbinaria* or *Sargasso*, and certain ascidians.

This collection work led to the discovery of a large number of active substances, many of which were new:

- In Fiji, a total of 69 extracts were selected; 81 substances were extracted, including 5 (6.17%) that were new.
- In the Solomon Islands, a total of 106 extracts were studied; 177 substances were extracted, including 32 (18%) which were new.

19 *(Agelas see mauritiana, Phakellia sp, Theonella swinhoei, Ptilocaulis spiculifer, Petrosia crassa, Amorphinopsis excavans, Stylissa carteri, Coscinoderma mathewsi, Xestospongia testudinaria, Coscinoderma mathewsi Lamellodysidea herbacea, Dysidea arenaria, Dysidea avara, Aplysina ianthelliformis, Haliclona sp.).*

Some published results

- Sponges such as those from families Agelasidae and Axinellidae are a very rich source of alkaloids. Several new metabolites were isolated from the marine sponges *Agelas (*see *mauritiana* and *Phakellia sp* collected in Solomon Islands) (**Vergne et al., 2007; Appenzeller et al., 2008, 2009**). In the lab, these compounds have displayed anti-malarial activity against *Plasmodium falciparum*, one of the agents responsible for malaria.
- Two new metabolites, Perthamides C and D, were isolated from the marine sponge *Theonella swinhoei* (**Festa et al., 2009 and 2011**); in the laboratory, all the compounds have shown strong anti-inflammatory activity.
- Five new pregnanes were identified in a marine sponge from Solomon Islands, *Ptilocaulis spiculifer* (**Gabant et al., 2009**). Laboratory testing of these compounds showed that they are not cytotoxic for KB cells.
- In all, 65 substances were isolated in marine sponges from Solomon Islands *Agelas, Petrosia (Petrosia) crassa, Amorphinopsis excavans* and *Stylissa carteri* (**Kirti Patel, 2010**), 10 of which were new compounds. In particular, this research work broadened knowledge about pyrrole-2-aminoimidazoles, updated a new biogenesis theory for pyrrole-2- aminoimidazoles, and revealed a new class of these compounds.
- Work on the marine sponge *Coscinoderma mathewsi* led to isolating two new compounds from the Terpenoids class which displayed moderate anti-inflammatory activity (**De Marino et al., 2009)**.
- Tests on a sponge from the genus *Xestospongia* led to isolating a certain number of halenaquinone-type polyketides, including two new derivatives (xestosaprol C methylacetal 7 and orhalquinone 8). The latter has a significant effect on inhibiting the protein farnesyltransferase and a more moderate effect on the growth of *Plasmodium falciparum*, responsible for malaria (Longeon et al., 2010).

7.3 Legal framework for developing active marine substances

This component included a legal facet involving those island countries where living organisms are collected (Solomon Islands and Fiji but also Vanuatu) designed to improve legislation on profit-sharing from the use of active marine substances.

Visits were made to Solomon Islands and Fiji in 2006, and then to Vanuatu in 2007 (Beurier et al., 2008). They resulted in work on compiling and analysing existing national legislation in the area of protecting marine biodiversity, and led to three reports as well as two discussion papers on legal protection for marine biodiversity (Beurier et al., 2008a and b, 2009). For each of the three countries, studies were done on the status of existing international law (on natural resource management and protecting the marine environment); on legal, administrative, social and customary measures; and on the current legal status of those countries in several areas, i.e. custom and customary law, coastal and marine areas, resource

use, environmental protection, scientific research, intellectual property and trade.

Analysis of the results showed that the three test countries had fairly elaborate sets of legal rules covering the protection and sustainable use of marine biodiversity, which provide a satisfactory framework. However, they also showed that greater legal clarity about "maritime property" (customary tenure of marine areas adjacent to the land areas of villages and tribes) would be advisable.

A precise description of the rights and obligations of indigenous communities would not only be useful for the legal certainty of outsiders who want to access the resources of coastal areas, but also to ensure these resources are protected along with the rights of the communities themselves. Proposals to improve the legal framework were provided in a large range of areas, e.g. natural heritage inventories, protecting spaces and certain species, strengthening fishing laws, protecting deep coral and fishing for ornamental species.

As far as regulations on marine bio-prospecting are concerned (for which only Vanuatu has a specific legal framework), and those on intellectual property, proposals dealt with implementing regional good practice codes and setting up regional or national agencies (interface with the CDB, intellectual property). New legal nomenclature was proposed to make it possible to avoid the main sources of litigation between research agencies or companies to promote research and the governments of the countries where the resource is located (see inset).

7.4 Institutional strengthening

This work led to a large number of training sessions, dissertations, internships and exchanges between institutions:

- 15 internships took place in France or in the Pacific as part of credit-earning studies prior to a dissertation;
- 9 theses were presented or are in progress in France;
- 7 students from the Pacific benefitted from these training sessions, in France or at USP: 5 came from Fiji from Solomon Islands, including 2 masters (students from Fiji). Two doctoral theses (Fiji and Solomon Islands) are planned, one for 2010 and the other for 2013.

There a large number of scientific partners in the areas of research and training (see inset).

Partners

For research: French Institute for Research and Development (IRD), Paul Sabatier University (Toulouse III, UMR 152 IRD-USP, Pharmaco-chemistry of natural substances and redox pharmacophores), CNRS (Natural Substances Chemistry Institute), Queensland Museum (Brisbane) and the Universities of Nantes, Perpignan, Brest and Naples.

For training: IRD, Universities of Nantes, Toulouse, Bretagne occidentale (Western Brittany), Montpellier, Aix–Marseille, Paris VI, French National Higher School of Chemistry in Lille, French National Museum of Natural History (MNHN), CNRS, as well as USP, which was widely involved, and the Queensland Museum.

Legal research partners: University of Nantes [Oceanic and Maritime Law Centre (EA 1165)] and the government services in the test countries (Solomon Islands, Fiji, Vanuatu).

A possible *de lege feranda* solution (Beurier, 2009)

"Let us relate this type of contract to the economic development of research results from bio-prospecting: the status of the research and the status of the resource (as per the CDB) can be co-contracted to facilitate sample collection. The two-party agreements set out the partners who commit to creating a joint venture whose headquarters are located in the country where the resource is found. This company is dormant (no calls for capital, no staff, no taxes) while research is being conducted; this research is subject to a biological prospecting permit from the country where the resource is located and within those zones under its jurisdiction for a precise mission over a determined period of time. If research leads to a marketable product, the joint venture is then activated and applies for the patent(s). The joint venture will put the product on the market and the profits will be divided according to the terms of the agreement. The dormant firm is created as either a limited liability company or a venture capital company.

Under these arrangements, collection will be described in the agreement as a stochastic activity with economic potential. Its legal nature is not fisheries so it is not subject to a fishing permit nor to unloading the products so they can be taxed or to customs duties if samples are exported. On the other hand, two reference samples are identified, one for analysis and deposit in the country where the research is conducted and the other for deposit in a specialised agency in the country where the resource is located or in a gene bank of its choice. The raw collection products are goods that are not subject to legal transactions, which, like museum items, are part of the heritage of the countries that hold them or have them held on their behalf. It is their possible applications intended for sale that will be considered as commercial goods."

7.5 Knowledge dissemination

To date, eight top-ranked publications on algae taxonomy and 11 publications on active substance research, several duty travel reports, 10 internship reports and five theses have been or are being written (see bibliography).

Besides these reports and publications, four events were held:

- 2007 (Paris) – Workshop on the "Role of the Research Sector in Governance of Exchanges and Uses of Genetic Resources and Related Traditional Knowledge";
- 2007 (Vanuatu) – Conference on legal literacy: "Law of the Sea";
- 2009 and 2010 (Nantes) – Photo exhibit entitled "Vision insulaire" (Island Vision) to raise awareness about protecting marine biodiversity and CRISP's activities;
- 2009 (ICRS, Tahiti) – Workshop on "Access and Benefit Sharing with regards to the use of Genetic Resources in the Pacific". Held as part of the Pacific Science Inter-Congress, this workshop was jointly organised by IRD, the Gump Station (University of California, Berkeley) on Moorea, and the Smithsonian Institution's Consortium for the Barcode of Life. It allowed the many different experiences and legal backgrounds of Pacific countries to be shared in the areas of intellectual property and prospecting laws. The Moorea Biocode Project was also presented.

A meeting to report on the results of bio-prospecting was held in Solomon Islands (2008) and another will be held in Fiji in 2011, with handover of the seaweed collection to USP.

Key points

The natural environment is an important source of prospection for therapeutic substances. Most of the drugs placed on the market come from substances of natural origin. Active marine substances (AMS) are active ingredients that can be isolated from various marine organisms and used for therapeutic purposes (anti-inflammatory, anti-malarial, cancer-fighting properties). Before any industrial use, which requires 12 to 15 years of work after initial harvesting of the organisms, isolating AMS is a slow and complex process that involves collecting marine organisms from the wild (bio-prospecting), sorting and identifying them, extracting and sifting substances and finally, isolating and identifying the active components.

CRISP was very active in this area, where the activities were carried out by IRD, along with a large number of scientific partners. IRD engaged in bio-prospecting in Solomon Islands (2004; without support from CRISP) and in Fiji (2007, with CRISP's support) with 72 sites prospected at depths of between 20 and 60 metres, leading to the collection of some 3,000 samples. Besides the AMS identification work funded by CRISP, collection led to a significant taxonomic efforts with several species inventories and lists, thereby expanding knowledge about biodiversity in this part of the Pacific (see section on "Expanding knowledge" [p.83]) :

- Algae: 2,283 samples collected and 419 species identified (including study material collected by IRD as part of other campaigns: Vanuatu, 2004 and 2006, and New Caledonia – see paragraph on "Knowledge… ").
- Invertebrates: 212 samples collected and 169 species identified.

Collection uncovered more than 30 species that were new to science. It also made it possible to identify and describe for the first time (geomorphologic feature and bionomic description) various zones, most of which had never been prospected (deep zones at depths of more than 25 m and zones located far from urban centres); work on zones that are representative of the Pacific's organism dispersal gradient led to a better understanding of the region's bio-geographic features.

Collaboration was established with various museums in the region (Australia, Fiji) and reference collections were sent to them as well as to the French National Museum of Natural History in Paris.

Extracting and screening substances and isolating and identifying active components led to the discovery of 30 new active substances that have anti-malaria, anti-inflammatory, neuro-active and other properties, which raises hopes that, on this basis, new drugs will be developed over the long term. This is, then, an important outcome to CRISP and IRD's credit.

This component also focused on improvements to the legal framework in the countries that hold such resources, in terms of protection of and rules for accessing biodiversity and intellectual property so as to ensure equitable sharing of any potential financial benefits.

Among the accomplishments under this component, we also note:

- Particularly high levels of capacity building through training, at varying degrees, for 25 students, eight of whom were from the region;
- A high level of promotion of the results from the work in 19 top scientific publications;
- Reporting on the results in the countries where the work took place (Fiji and Solomon Islands);
- A large network of partners and closer collaboration in the region, particularly with USP.

Bibliography

Taxonomy ("Knowledge and monitoring" chapter)

Active marine substances

Appenzeller J. (2008). Extraction d'éponges marines du genre Agelas et synthèse biomimétique d'alcaloïdes pyrooles-2-aminoimidazoles : vers la synthèse totale de la palau'amine et de ses congénères, Thèse de doctorat, Université de Paris XI, 150 p.

Appenzeller J., Mihci G., Martin M.-T., Gallard J.F., Menou J.L., Boury-Esnault N., Hooper J., Petek S., Chevalley S., Valentin A., Zaparucha A., Al-Mourabit A., Debitus C., Agelasines J, K and L from the Solomon Islands marine sponge Agelas cf. mauritiana, J. Nat. Prod., 2008, 71, 1451–1454.

Appenzeller J., Tilvi S., Martin M.T., Gallard J.F., El-Bitar H., Tran Huu Dau E., Debitus C., Laurent D., Moriou C., Al-Mourabit A., Benzosceptrins A and B with a unique benzocyclobutane skeleton and nagelamide S and T from Pacific sponges, Org. Lett., 2009, 11, 4874–4877.

Béasse, A. (2009). Isolement de produits actifs à partir d'extraits d'organismes marins. Rapport de Master, Université de Nantes (ISOMer-MMS), 31 pp.

Chandra M. (2009). Secondary metabolites composition and geographical distribution of marine sponges of the genus Dysidea. Master thesis, University of the South Pacific - - School of Biological & Chemical Sciences, 160 pp.

Debitus C. (2008). Biodiversity and marine natural products of Solomon Islands. Debriefing Solomon Islands, PowerPoint presentation, 32 p.

Debitus C., Payri C., Beurier J.-P. (2008). Biodiversity and bioactive compounds of Solomon Islands. Project report, IRD, 22 pp

De Marino S., Festa C., D'Auria M.V., Bourguet-Kondracki M.-L., Petek S., Debitus C., Payà M., Zampella A., Coscinolactames A and B: new nitrogen-containing sesterterpenoids from the marine sponge Coscinoderma mathewsi, Tetrahedron, 2009, 65, 2905–2909.

Ferret C. (2008). Etude de la teneur en composés phénoliques et du potentiel antioxydant associé à ces composés, de plusieurs espèces de Sargassaceae du Pacifique Sud. Mémoire de master, Université de Bretagne Occidentale, Institut Universitaire Européen de la Mer, 28 p.

Festa C., De Marino S., Sepe V., Monti M. C., Luciano P., D'Auria M. V., Debitus C., Bucci M., Vellecco V., Zampella A., Perthamides C and D, two new potent anti-inflammatory cyclopeptides from a Solomon Lithistid sponge Theonella swinhoei, Tetrahedron, 2009, 65, 10424–10429.

Festa C., De Marino S., Sepe V., D'Auria M. V., Bifulco G., Debitus C., Bucci M., Vellecco V., Zampella A. (In press). Solomonamides A and B, new anti-inflammatory Peptides from Theonella swinhoei, Org. Lett.

Gabant M., Schmitz-Afonso I., Gallard J. F., Menou J.-L., Laurent D., Debitus C., Al-Mourabit A., Sulfated steroids: ptilosteroids A-C and ptilosaponosides A and B from the Solomon Islands marine sponge Ptilocaulis spiculifer, J. Nat. Prod., 2009, 72 (4), 760–763.

Kientz B. (2008). Recherche de molécules anti Phospholipase A2 à partir de l'éponge marine Rhopaloides odorabile. Rapport de stage de master, Université Montpellier II, 6 p.

Le Lann K. (2006). Connaissance chimiotaxonomique du genre Turbinaria et Etude des composés de défense de différentes espèces de Sargassacées des Îles Salomon. Mémoire de master, Université de Bretagne Occidentale–Institut Universitaire Européen de la mer, 56 p.

Le Lann K. (2009). Etude de la biodiversité des Sargassaceae (Fucales, Phaeophyceae) en milieu tempéré et tropical : écologie, chimiotaxonomie et source de composés bioactifs. Thèse de doctorat, Université de Bretagne Occidentale, Institut Universitaire Européen de la Mer, 334 p.

Lhuillery M. (2006). Variations interspécifiques des composés phénoliques chez des sargasses des Îles Salomon et test de leur activité antibactérienne. Mémoire de master, Université de Bretagne Occidentale – Institut Universitaire Européen de la Mer, 25 p.

Logeon A., Copp B.R., Roué M., Dubois J., Valentin A., Petek S., Debitus C., Bourguet-Kondracki M.-L., New bioactive halenaquinone derivatives from South Pacific marine sponges of the genus Xestospongia, Bioorg Med Chem. 2010, 18 (16): 6006–6011.

Mani L. (2011). Antiplasmodial compounds from marine sponges of the Solomon Islands. Thèse de doctorat, Université Paul Sabatier Toulouse III, xx p.

Mani L., Petek S., Valentin A., Chevalley S., Folcher E., Aalbersberg W., Debitus C. (In press). The in vivo antiplasmodial activity of Haliclonacyclamine A, an alkaloid form the marine sponge, Haliclona sp., Nat. Prod. Res.

Patel K. (2010). Extraction de métabolites bioactifs d'éponges marines du Pacifique Sud. Thèse de doctorat, Museum National Histoire Naturelle, 230 p.

Patel K., Laville R., Martin M.T., Tilvi S., Moriou C., Gallard J.F., Ermolenko L., Debitus C., Al-Mourabit A., Unprecedented stylissazoles A–C from Stylissa carteri: another dimension for marine pyrrole-2-aminoimidazole metabolite diversity, Angew. Chem. Int. Ed., 2010, 49, 4775–4779.

Roué M. (2007). Recherche et caractérisation de molecules potentiellement anti-inflammatoires chez l'éponge marine Xestospongia testudinaria. Mémoire de master, Université Pierre et Marie Curie, 28 p.

Saidou H. (2009). Expression of secondary metabolites by the Fiji Islands Ascidia: Diazona fungia and Polyandrocarpa polypore. Master thesis, Université de Perpignan Via Domitia, 22 pp.

Suau V. (2006). Research Recherche de nouveaux principes actifs antipaludiques dans les spongiaires des Îles Salomon. Mémoire de master, Université Paul Sabatier Toulouse III, 19 p.

Vergne C., Appenzeller J., Ratinaud C., Martin M.T., Debitus C., Zaparucha A., Al-Mourabit A., Debromodispacamides B and D: Isolation from the marine sponge Agelas mauritiana and stereoselective synthesis using biomimetic proline route, Org. Lett., 2008, 10(3), 493–496.

Wang J., Bourguet-Kondracki m.-L., Longeon A., Dubois J., Valentin A. and Copp. B.R. (In press). Chemical and biological explorations of the electrophilic reactivity of the bioactive marine natural

product halenaquinone with biomimetic nucleophiles, Bioorganic & Medicinal Chemistry Letters.

Communications on active marine substances

Appenzeller J., Adeline M.-T., Martin M.-T., Gallard J.-F., Boury-Esnault N., Hooper J., Petek S.,Maurel S., Valentin A., Zaparucha A., Al-Mourabit A., Debitus C., Agelasines J and K from the Solomon Islands marine sponge Agelas sp., 5th European Conference on Marine Natural Products, Ischia, Italie, 16–21 Sep. 2007, Poster.

Appenzeller J., Debitus C., Martin M.-T., Adeline M.-T., Gallard J.-F., Tran Huu Dau E., Zaparucha A., Al-Mourabit A., Non brominated pyrrole-2 amino-imidazoles alkaloids from the Pacific marine sponge Agelas sp., 5th European Conference on Marine Natural Products, Ischia, Italie, 16–21 Sep. 2007, Poster.

Bontemps-Subielos N., Simon-Levert A., Lopez-Legentil S., Banaigs B., Pyridoacridine alkaloids within purple morphs of Cystodytes spp., 5th European Conference on Marine Natural Products, Ischia, Italie, 16–21 Sep. 2007, Poster.

Chandra M., Lagneau D., Bonnard I., Erpenbeck D., Folcher E., Chevalley S., Perio P., Biard J.F., Hooper J., Banaigs B., Debitus C., Petek S., Anti-plasmodial activity and chemotaxonomy of Pacific Dysidea sponges, 11th Pacific Science Inter-Congress 2009, Tahiti, Polynésie française, 02–06 mars 2009, Poster.

Chandra M., Sotheeswaran S., Ali S., Bonnard I., Banaigs B., Petek S., Debitus C., Preliminary chemotaxonomic and anti-fungal analyses of the marine sponge, Dysidea (Lamellodysidea) herbacea, 11th International Symposium on Natural Product Chemistry, Karachi, Pakistan, 29 Oct.–01 Nov. 2008, Poster.

Le Lann K., Bourguet-Kondracki M.L., Longeon A., ioannou E., Roussis V., Payri C., Debitus C., Dedslandes E., Stiger-Pouvreau V., Potent anti-inflammatory active compounds from marine brown algae (Sargassaceae, Fucales) from the Solomon Islands, South Pacific, 5th European Conference on Marine Natural Products, Ischia, Italie, 16–21 Sep. 2007, Poster.

Mani L., Antimalarial compounds from marine sponges of the Solomon Islands, Doctoriales Midi-Pyrénées, Toulouse, France, 01–07 juin 2008, Présentation PowerPoint 14 p.

Patel K., Isolement et identification structurale des métabolites bioactifs d'éponges marines du Pacifique, Doctoriales Midi-Pyrénées, Toulouse, France, 01–07 juin 2008, Présentation PowerPoint 39 p.

Patel K., Sarasinosides of the sponge Amorphinopsis excavans from Solomon Islands, 11th Pacific Science Inter-Congress 2009, Tahiti, Polynésie française, 02–06 mars 2009, Présentation PowerPoint, 20 p.

Vergne C., Appenzeller J., Martin M.-T., Zaparucha A., Menou J.-L., Boury-Esnault N., Laurent D., Payri C., Debitus C., Al-Mourabit A. Isolation from Agelas sp. sponge and biomimetic synthesis of two new members of the dispacamide family. 12th International Symposium on Marine Natural Products, Queenstown, Nouvelle-Zélande, 05–09 févr. 2007.

Legal framework

Beurier J.-P., La Protection Juridique de la biodiversité marine, Dalloz, Col. Pour un droit commun de l'environnement : mélanges en l'honneur de Michel Prieur, 2007, 803–818.

Beurier J.P., Zakovska K., Guilloux B. (2008a). Le droit de la biodiversité marine aux Iles Fidji, Salomon et Vanuatu. Rapport final. 118 p.

Beurier J.P., Zakovska K., Guilloux B. (2008b). Marine biodiversity law in Fiji, Solomon and Vanuatu Islands. CRISP final report, 118 pp.

Beurier J.P., Zakovska K., Guilloux B. (2008c). Le droit de la biodiversité marine aux Iles Fidji, Salomon et Vanuatu. Synthèse du rapport final, 24 p.

Beurier J.P., Zakovska K., Guilloux B. (2008d). Marine biodiversity law in Vanuatu and the Solomon Islands. Synthesis of the final report, 24 pp.

Beurier J.P., Guilloux B., Zakovska K. (2007a). Analyse du cadre juridique lié à la valorisation des substances actives marines, Zone atelier n°1 – Fidji. Rapport final, 126 p.

Beurier J.P., Guilloux B., Zakovska K., (2007b). Analyse du cadre juridique lié à la valorisation des substances actives marines, Zone atelier n°2 – Iles Salomon. Rapport final, 39 p.

Beurier J.P., Guilloux B., Zakovska K. (2007c). Analyse du cadre juridique lié à la valorisation des substances actives marines, Zone atelier n°3 – Vanuatu. Rapport préliminaire, 124 p.

Communications on the legal framework

Beurier J.-P., Droit de la protection et de l'utilisation durable de la biodiversité marine en Mélanésie, Étude de cas : Fidji, Iles Salomon, Vanuatu, Atelier ABS, IIe Inter-congrès des Sciences du Pacifique 2009, Tahiti, Polynésie française, 02–06 mars 2009, Présentation PowerPoint, 24 p.

Guilloux B., Le droit international des biotechnologies et ses relations avec la biodiversité, Atelier ABS, IIe Inter-congrès des Sciences du Pacifique 2009, Tahiti, Polynésie française, 02–06 mars 2009, Présentation PowerPoint, 13 p.

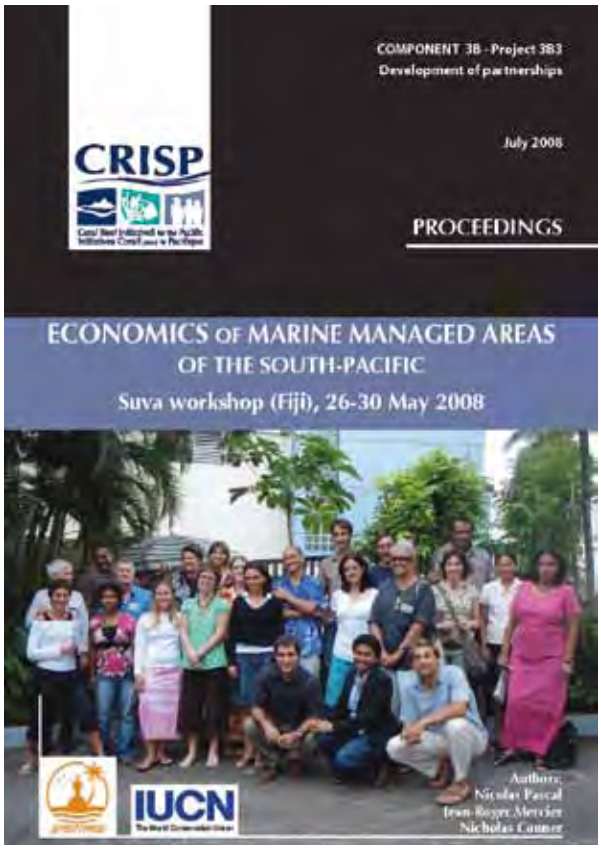
Guilloux B., Le droit applicable à la bioprospection marine en Mélanésie : l'exemple des Iles Fidji, Iles Salomon et du Vanuatu, Atelier ABS, IIe Inter-congrès des Sciences du Pacifique 2009, Tahiti, Polynésie française, 02–06 mars 2009, Présentation PowerPoint, 15 p.

8. Economic value of coral reefs and economic effectiveness of MPAs

While this theme was not identified as such when CRISP was being designed, it took on increasing importance as the programme developed. Beginning in 2007, some concrete economic assessments were carried out, e.g. David et al. and O'Garra; in 2008, the CRISP Coordination Unit hired a specialist to fully develop this theme.

In collaboration with IUCN and SPREP, in May 2008 the CRISP Coordination Unit held a workshop in Suva, Fiji on "The economy of marine managed areas (MMAs) in the South Pacific". The goal was to bring together scientists, MPA managers and MPA economic analysts to review the state of the art in applying economic analysis to the creation, monitoring-evaluation and ex post evaluation of MPAs in the Pacific (Pascal et al., 2008). This workshop was attended by about 30 participants and allowed:

- an exchange of experiences in terms of approaches, methods, their applicability and some recorded results;
- a consensus on the prerequisites for applying economic analysis approaches;
- identification of pilot sites in the Pacific for applying new economic analysis methods, with CRISP's support.



Economic valuation of reefs (according to J.R. Mercier, in Gabrié et al, 2009)

By identifying and quantifying the goods and services rendered by ecosystems, economic vauation helps to boost awareness among political decision-makers about the need to sustainably manage natural environments.

For environmental economists, the economic value of a natural environment, i.e. the total economic value (TEV), is made up of several different components (in Miraud et al, 2007) :

- the use value, related to all the direct and indirect uses of the environment. It includes marketable goods and services, e.g. fishing, tourism, and non-market services (protecting the coasts, carbon sequestration, water purification, etc.);
- the option value, which represents the price to be paid to safeguard the option of future uses of the environment, which are not always known;
- the existence value that resides in the simple existence of environmental goods, independent of any use;
- the bequest value or use value for future generations.

Due to the ecological functions that characterise them, coral reef ecosystems, sea grass beds, mangroves, etc. provide services people can benefit from directly or indirectly, and they have an economic and social value.

Fishing is the main market benefit of MPAs, along with tourism. In coral environments, it accounts for 10% to 25% of world fisheries. The aquarium trade also leads to significant catch levels, corresponding to about 12 to15 million fish traded each year.

Tourism contributes very significantly to gross domestic product and to jobs in many Pacific Island countries. It has been growing constantly since the Second World War. When it is conducted in a sustainable way, it can assist, through the income it generates, in preserving MPA ecosystems, but often, it contributes more to damaging them. In addition, outlook studies on energy cost trends have shown that caution is needed with models relying solely on income from tourism, as the sustainability of such activities in not ensured everywhere.

Coastal protection is also one of the important values that can be attributed to the environment. A large number of islands owe their entire existence to coral reefs, such as the 84 atolls in French Polynesia or the scattered coral islands in the Indian Ocean. Fringing reefs and barrier reefs play an important role in reducing the effects storms have on the coastline and in beach sedimentation. The same is true for mangroves. Their deterioration or disappearance could have catastrophic economic effects. These values are estimated in the economic calculations.

Finally, medical products whose active substances come from marine organisms, pearl oyster farming, the cultural role of these areas, e.g. sacred or tabu zones at certain Pacific sites, are all goods and services that could be included in the economic calculations for MPAs.

Therefore, MPA ecosystems and the benefits they provide do have a value since people profit from their use (directly or indirectly) or simply because they exist.

Following that workshop, a working group was set up specifically for the reef economy, with the technical support of Nicolas Pascal, environmental economist, who was working at the same time for IFRECOR in New Caledonia.

In November 2010, a second workshop was held in Noumea, in collaboration with the Secretariat of the Pacific Community (SPC). The goal was to review the lessons learnt from economic surveys on coral reefs and to lay out a strategy to convince decision-makers and donors of the economic effectiveness of investing in their sustainable development. Discussions covered various methodological aspects, e.g. calculating contributing factors, spatial distribution of ecosystem services, determining the maximum sustainable values for fishing and tourism, managing uncertainties, non-use values, value transfer and discount rates. Discussions also covered implementing payments for coral-reef-related ecosystem services, e.g. (negotiable permits, incentives, remuneration) and their feasibility in the Pacific.

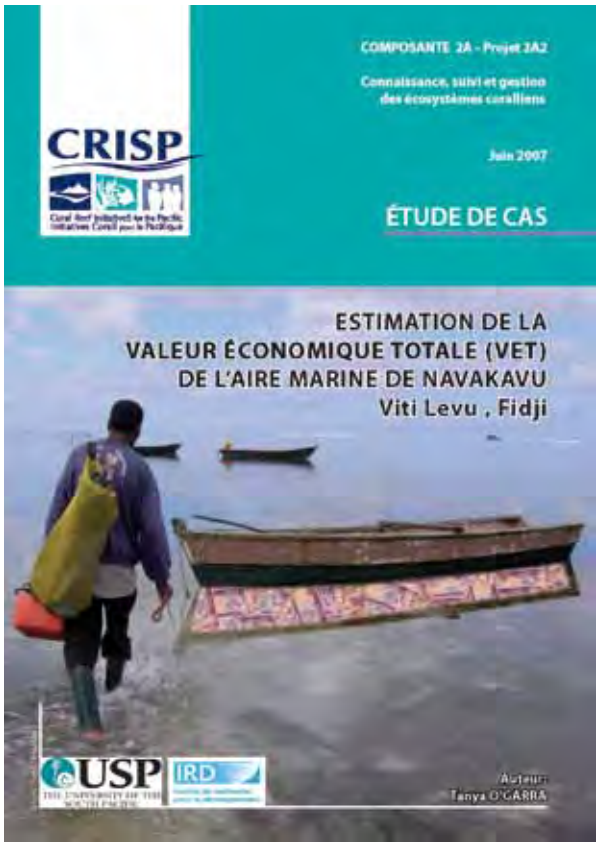
As part of CRISP, several studies looked at the value of reefs or MPAs by calculating the total economic value (TEV) or analysing the costs and benefits associated with an activity (cost benefit analysis or CBA) (see the list of these studies in the inset). Work carried out as part of the implementation of SEM-Pasifika also contributed to a better understanding of the socio-economic aspects of coral reefs (see section on "Expanding knowledge" [p.83]). Finally, CRISP contributed to a large-scale study carried out by a specialist, Hugh Govan, on the status of locally managed marine areas (LMMAs) in the South Pacific and their potential to meet nature conservation and sustainable livelihood goals (Govan, 2009 – see Chapter 4).

8.1 Values in the Pacific

A meta-analysis was carried out on economic valuation studies of coral reef ecosystems in the South Pacific (N. Pascal, 2008). It identified 14 studies in the Pacific, carried out from 2000 to 2007 in Hawaii, Palau, Kiribati, Marshall Islands, Northern Mariana Islands, Samoa and American Samoa. Use values for coral reefs were estimated, depending on the study, at between € 4,643 and 33,305 /sq km/year, which accounts for 13% to 45% of the total value (use and non–use).

Studies carried out under the auspices of CRISP

- a study by David, Herrenschmidt, Mirault and Thomassin (June, 2007) covered methodological components of work on the economic value of Pacific Island coral reefs and presented the different types of value generally considered: direct and indirect use value, existence value, bequest value or option value (see inset);
- one study calculated the total economic value (TEV) of the reefs in the Navakavu marine area in Fiji (O'Garra T., 2007);
- one study (Korovulavula I. et al., 2008) looked at the economic value of traditional fishing grounds in Fiji (called *iqoliqolis*);
- one study estimated the total financial value of the services generated by coral reefs and related ecosystems (mangroves, sea grass beds, soft bottoms) in New Caledonia (Pascal, 2010); mainly funded by IFRECOR, this study received support from CRISP and New Caledonia's Southern Province;
- one study calculated the economic value of lemon sharks in Moorea, based on the benefits provided by the ecotourism activity of "shark-feeding" (Clua et al., 2010);
- a business plan was formulated for the Moorea PGEM (Charles, 2010);
- a study assessed the social and economic impact of MPAs in Vanuatu (Pascal, 2010).



8.2 Value of the Navakavu LMMA in Fiji

The total economic value (TEV) of the coastal ecosystems in the Navakavu marine area was estimated using a contingent valuation questionnaire and a catch survey and by calculating side benefits. The study also included the water purification role of mangroves. The TEV was about €1.4 million annually (about €736/ha/year); the present value of these ecosystems, over a 20-year period, reached about €10.5 million, using a discount rate of 10%. Fisheries associated with these ecosystems accounted for 45% of this value. Next was coastal protection with 33% of the TEV and water purification by the mangroves at 20%. Learning, education and research values only accounted for 2%. There was no tourism value as there is no activity of that kind at this site. The bequest value, estimated by contingent evaluation, was €2.5/person/month and the commitment level was 16–28 people/month. Some 78% of the local community felt that the bequest value was the most important reason for preserving these fishing grounds.

The impact of creating the reserve, in January 2002, was seen in an increase of 3% in fish catches (in weight) between mid-2002 and late 2006, i.e. about XPF 2.7 million (€22,300) in benefits for the local communities.

8.3 Value of traditional fishing grounds in Fiji

Iqoliqolis are traditional fishing grounds in Fiji that extend from the beach to the barrier reef. The study tried to assess the value of this area and its resources as part of possible compensation, on the basis of the use value (non-use values could not be calculated; Korovulavula et al., 2008). The 11 *iqoliqolis* studied were assessed, for the direct use value linked to fishing, at from €1.3–3.4 million/sq km/year (scenario A), to €32,500–236,000 (scenario B). The use value for the mangrove was estimated at €0.8 million/sq km/year. The tourism value was estimated at €32 million/year (€335 per tourist in 2003).

8.4 Value of the reefs in New Caledonia

In New Caledonia, the consolidated financial value for all services was estimated at between €190 and 320 million per year, i.e. from €39,411/sq km/year to €66,561/sq km/year (Pascal, 2010). The most important service in economic terms for the territory was protection of the coastline, which accounted for two-thirds of the total value. It was followed by fishing (20% of the total value) and tourism (10%). Based on real financial flows used to calculate the GDP, reefs generate income in the Territory of between €78 and 103 million per year. Fisheries are in first place (about 70%), followed by tourism (28%) and research and education. Recreational and subsistence fishing hold important places (27% and 22%, respectively).

8.5 Value of lemon sharks in Moorea

Since the environmental arguments used to protect sharks have little impact on management policies, the economic value of lemon sharks in feeding zones was suggested as a new tool for the conservation of this species (Clua et al., 2010). During a long-term study (57 months), 39 lemon sharks which serve as the basis for the eco-tourism activity of "shark-feeding" on Moorea (French Polynesia) were identified. Based on the expenditures of local and foreign divers, the overall income generated by the feeding site has been estimated at 5.4 million USD (€4 M), with the 13 sharks observed most often contributing about USD316,699 (€230,000) each. Over the course of each shark's life (20 years of being used for ecotourism), it accounts for a contribution of USD2.64 million (about €2 million).

8.6 Value of the LMMAs in Vanuatu

While it is generally felt that MPAs provide a large range of benefits on the biological, social and economic levels, currently there are still too few studies to support this idea and several claims have yet to be proved. This is one of the objectives AFD set for itself and, through CRISP, AFD has supported several MMAs and MPAs over the past five years in the Pacific. AFD hopes to broaden knowledge about the impact MPAs have on economic growth and poverty reduction, as well as on world biodiversity and, at the same time, as a donor, to assess the return on its investments.

An initial study in this direction was carried out in Vanuatu (Pascal, 2009, 2010). It is one of the few studies to date to conduct an in-depth analysis of the impact of MPAs. It was based, in part, on data from socio-economic surveys (Herrenschmidt and David, 2007), but most especially on more than a year's worth of field data. Five villages in northern Efate (Emua, Piliura, Unkap, Worasifiu, Laonamoa – see Fig. 10), which have similar characteristics, e.g. mainly fringing reefs and an MMA managed by the community for at least five years, were selected along with two control villages (Nekapa and Saama) so as to assess the effects on fishing. An estimated 60% of the adult population is involved in fishing (by net or underwater).

As an assessment was made of the role MPAs play as a source of funding and the significance of the benefits they bring to the gross domestic incomes of the villages, based on the impact observed five years after the reserves were created and with 25-year projections. Donor investments were assessed using a cost-benefit analysis (CBA) and calculating return on investments. Thanks to these precise criteria, the main impacts MPAs have on fishing (study on CPUE, fishing effort and underwater monitoring), tourism (interviews and surveys), and social capital (interviews) were evaluated along with coastal protection and the option value. The results were compared to those of villages without MPAs (control sites). The costs and benefits were identified by village stakeholders and at the national and international levels.

Main outcomes

Total investments varied from €5,000 to €19,000 per MPA (for the initial phase), then operating costs came to between €900 and €4000 per MPA per year. In total investment, the cost of technical assistance (NGO or other) is high (from 40% to 50% of total); in all, investment in the zone is about €14,000/sq km of protected area.

The average economic impact of MPAs in 2009 was estimated at €8,900/year (minimum: €6,000 and maximum: €13,400 depending on the MPA). On average, the total net benefit for all the MPAs was about €50,000 per sq km of MPA.

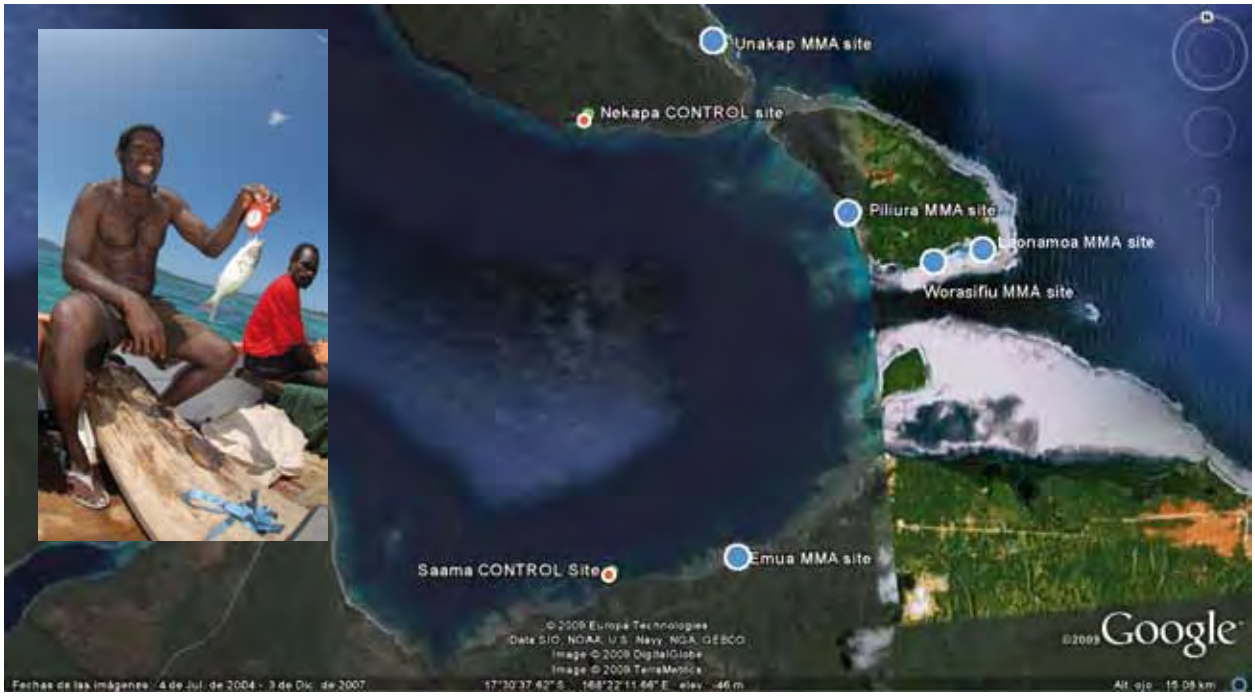
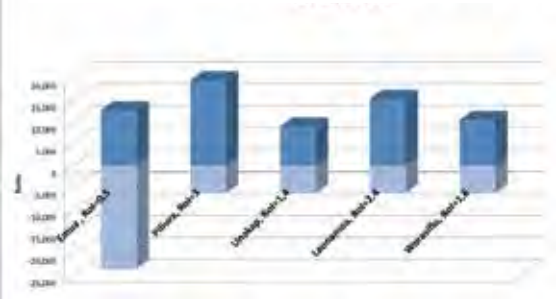


Figure 10: MPAs of northern Efate, Vanuatu

Rural tourism and fishing accounted respectively for 55% and 25% of this total benefit. The impact was also positive for social and human capital, the service of protecting the ecosystem from swell and the value option attached to the ecosystem, which accounted for 20% of the total benefits for the five MPAs. Some 70% of the benefits generated go to the village, which is 7% of of the villages' gross domestic product, with a potential of 15–30%. National stakeholders benefit from the remaining 30%, mainly through tourist activities.

The return on investment was 1.8 after five years (+- 0.9) (see Fig. 11) and 5.4 after 25 years (+- 2.5). Not all the investments were recovered after five years, and for certain MPAs, the return on investment after 25 years remained close to one (1) when the main uncertainties on estimates were applied. So, caution must be used in terms of decisions about investing in MPAs.

Figure 11: Return on investment in MPAs five years after their creation



While return on investment is a deciding factor in the choice of investments, the levels of development in terms of coastal fisheries and rural tourism must be taken into account as part of the assessment. Even if a site meets the requirements for a successful MPA (such as an adequate environmental context and effective monitoring), the optimal amount to be invested in it will depend on the fisheries and tourism sectors. The study showed that villages with reduced fishing efforts and low tourism potential had returns on investments that were too low.

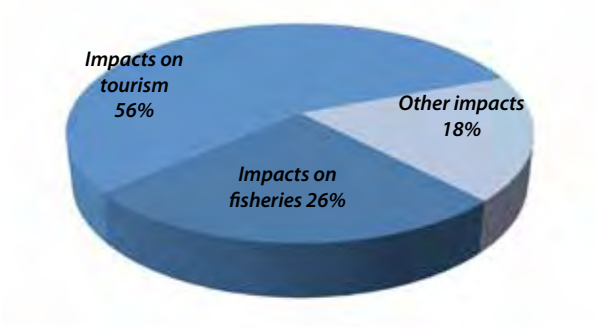
The benefits that MPAs have on the **fisheries** sector come about from an improvement in productivity for the main types of gear (between + 4 and + 33% once context effects have been removed). This increase in productivity affects subsistence and artisanal fisheries as well as commercial fisheries. Other effects were observed: (1) more stable catches for each fishing trip and (2) higher mean maximum sizes per species for villages with MPAs. The effects of MPAs for the main species generally follow a gradient from the edge of the MPA to 500 m, before disappearing. For revolving MPAs, the impact of occasionally opening the reserve seems to be very low (less than 100 kg/year) but it is, however, important for the villages, as this allows them to see the higher catches and share them with the community. Little effect was seen on invertebrates (trochus). In general, such impacts on productivity are hard for local communities to see.

Even if the study showed a positive effect on fishing beyond the boundaries of MPAs, there is still the issue of operating small MPAs: do they really create and export additional biomass or do they simply concentrate biomass like FADs, for example? Whatever the answer may be, the value of these community MPAs in improving fishing productivity seems to have finally been demonstrated economically.

Benefits in the **tourism** sector were observed for the rural tourism niche market (through family-run guest houses and tour operators). On average, the existence of an MPA seems to have an influence of between 40 and 75% in tourists' choice of sites. In the same way, it was noted that for 60% of visitors, on average, at least one member of the group took part in snorkelling activities. The visitor traffic and the relative importance of species biodiversity factors influenced by the MPA, such as iconic species or high live coral coverage, as compared to other factors such as infrastructure, transport or price, could not be estimated due to a lack of control sites.

The other impacts of MPAs (see Fig. 12) involved benefits on **social and human capital**, on value options for local communities and on protection from swell. The former were observed through their impact on the level of knowledge acquired during training sessions and workshops. The **option values**, estimated through benefit transfer, are expressed as an agreement to work to maintain certain ecosystem attributes like fishing or the potential for tourism.

Figure 12: Distribution of benefits from northern Efate MPAs



The final benefit is the MPA's role in maintaining the coral reef ecosystem service of **protection from the swell**. These three benefits accounted for 20% of the total benefits from the five MPAs.

At this point in the study, there has not yet been any confirmation that MPAs can ensure sustainable revenue (through fishing and tourism) with intergenerational benefits.

The opportunity costs observed at the local level were low and no local stakeholders could be identified as really having been affected by the creation of an MPA. If we add that the direct costs were covered by outside agencies, the cost-benefit ratio for villages will, very likely, be positive even when benefits are low. So therefore, was no need for compensation for setting up a reserve in the MPAs studied.

Continuing research

As a follow-up to the Vanuatu study, a project aimed at estimating the net economic benefits of MPAs for the economy of small islands is under way in Vanuatu and Fiji over two years, with sponsorship from IUNC, AFD, and local partners, in the wake of the dynamics created by CRISP. In North Efate, the study is concentrating on a cost-benefit approach, beginning with an assessment of the socio-economic and environmental impacts observed after the creation of an MPA and a projection of these impacts. The study covers four sites in two countries. Two sites are in North Efate in Vanuatu; the third site, also in Vanuatu, will be a site with dynamic economic development. The fourth site will be selected in Fiji. Sites with and without MPAs will be compared. Emphasis will be on the effects MPAs have on fishery yields and productivity. The perception of the various participants (local and other) will be systematically highlighted.

8.7 Moorea PGEM's "business plan"

1. **Use rights,** with an estimated funding potential of €160,000 per year, would be the simplest and quickest avenue, particularly for tourism.

2. The **public sector** shows significant potential, e.g.:

- re-allocating part of the **room tax** which the township currently uses to welcome local and international visitors has been proposed. Allotting 20% of the €335,000 (40 million XPF) received each year would allow fairly sustainable funding of nearly half the PGEM's operation budget.
- A tiny increase of a few per cent of the **fee for temporary occupation of the public maritime domain** has been identified; this would require a change in French Polynesian law. No estimates were possible due to the lack of data from the Lands Department.

3. Memberships in the association (goal: about €2,000 per year) and various voluntary contributions were included in the study. The study explained that funding could be sought as part of project dynamics:

4. Private sector: certain local businesses could be approached.

5. Over the longer term, a **trust fund** could be created regionally, funded by private sector and public funding, of about €5 million (to fund all of the PGEM's operations).

6. Aid from national and international **foundations**.

7. The system of **auctioning conservation items,** an innovative funding mechanism, could be implemented on a regular basis and held at the same time in French Polynesia and France, e.g. during the Third International Conference on Marine Protected Areas to be held in Marseille in 2013.

Key points

This thematic sector, which hadn't actually been part of the programme at the beginning of CRISP, became one of its key activities as the programme moved forward and one in which CRISP is one of the obvious leaders in the Pacific.

There were several studies: a literature survey of reef values in the Pacific (Pascal, 2006), the total economic value of the Navakavu LMMA (Fiji; O'Garra, 2007); the use value of fishing in traditional fishing grounds (*iqoliqolis*) in Fiji (Korovulavula et al., 2008): the use value of reefs in New Caledonia, as part of IFRECOR (Pascal, 2010), the use value of lemon sharks on Moorea (Clua et al., 2010), and a cost-benefit analysis of MPA/LMMAs in Vanuatu (Pascal, 2010).

These studies gave widely varying results (see table below) and raised the issue of methods. They showed that results depend heavily on fishing and tourism activities. The coastline protection value was sometimes very high, as in New Caledonia (matching the results in Martinique, for example, as part of IFRECOR).

Some figures from the various studies

- UV* coral reefs in the Pacific: between €4,643 and €33,305/sq km/year (from 13% to 45% of TEV).
- TEV of the Navakavu LMMA (Fiji) €73,600/sq km/year; fishing 45%; protection: 33%.
- *Iqoliqoli*: UV fishing: €1.3 to 3.4 million /sq km/year (scenario A), or €32,500 to 236,000/sq km/year (scenario B).
- UV reefs in New Caledonia between €39,411/km/year and €66,561/km/year; coastal protection 70%; fishing, 20%; tourism, 10%.
- UV lemon sharks on Moorea: over a shark's lifetime, it accounts for a contribution of about €2 million.
- MPAs in Vanuatu (CBA): the net mean benefit for the MPAs created or supported as part of CRISP is about €50,000/sq km; including tourism 55%; fishing 25%; the mean return on investment is 1.8, with a potential of 5.4 for 25-year projections (minimum 1.3; maximum 5.2 depending on the MPA).
- TEV for Moorea (PGEM) of 8 out of 20 ecosystems: €50 million, i.e. €1 million/sq km/year, including 50% for tourism, 36% for the lagoon's aesthetic value and 9% for protection.

For comparison, some values from other French research work:

- As part of the FFEM's project capitalisation work, the internal rate of return calculated for three MPAs was from 3.2% for Mnazi Bay, to 25% for Bamboung and 52.4% for Quirimbas (Mercier, in Gabrié et al., 2010);
- As part of IFRECOR, the TEV of the reefs in Martinique was calculated at €245 million/year; Coastal protection: 31%; Fisheries: 7%; Tourism: 50%;
- Cost of destruction linked to destructive fishing techniques in Kiribati: about €2 million per year.

**UV: use value; NUV: non-use value; TEV: total economic value; CBA: cost-benefit analysis.*

Finally, although they are still rare for MPAs, a business plan was formulated for the island of Moorea which has a maritime area management plan (PGEM) that covers eight MPAs (Charles, 2010). Possible funding sources were examined: use right (there is a lot of tourism on the island), re-allocating certain existing taxes (room tax, temporary occupation of public maritime domain fees), participation by the private sector, appeals to foundations, and creating a trust fund.

Besides these studies, two workshops and the creation of a working group should be noted. They made it possible to bring together the main international and national experts in economic evaluation to discuss the value of these economic approaches to the various phases of creating and managing marine protected areas and to discuss methods, which experts do not always agree on, particularly the most appropriate methods for MPA/MMAs in the Pacific. While total economic value (TEV) methods are still the most widely used, CRISP, in particular, showed that more dynamic methods could be used along with them such, as cost-benefit analysis (CBA) or other conservation funding assessments, (how much needs to be invested to maintain/develop these services?). The workshops allowed discussions on how these methods can be combined to be used as part of decision-making processes for these ecosystems.

While it is generally felt that MPAs provide a number of benefits in the biological, social and economic spheres, there is still too little research to confirm this idea and several claims still have to be proven. That is one of the goals that AFD set for itself. Through CRISP, AFD provided support to several MMAs and MPAs over the past five years in the Pacific. AFD hopes to broaden knowledge on the impact MPAs have on economic growth and on reducing poverty as well as on global biodiversity, and, at the same time, as a donor, evaluate the return on its investments. Initial cost-benefit analysis work on was done in Vanuatu and involved five MPAs (Pascal, 2010); the main findings of this study showed that:

- For investments of about €14,000 /sq km of protected area in the study zone, the net benefit for all the MPAs totalled, on average, about €50,000 per sq km of MPA; so the leverage effects on investments in such small MPAs can be demonstrated; €1 invested in an MPA produces, on average, about €2, with an estimated potential of between €4 and 21;
- MPAs play a significant role in the gross domestic income of villages, with a potential that ranges from 15 to 30%;
- Effects were observed on reef fishing productivity, with a CPUE that increased, over five years, from 4 to 33% depending on the gear; greater stability in catches; and higher mean maximum sizes per species for villages with MPAs. But it can be difficult for local communities to see any benefits in their very informal fisheries. Fishing is important for subsistence needs and represents a solution for reducing villages' monetary needs;
- The effects on tourism can be seen at the village scale or at the national level and they are significant in terms of monetary income for the village, but income distribution tends to be concentrated on a small number of beneficiaries;
- In the end, investments by donors only play a small role with regards to natural capital but are mainly felt in terms of human capital.

The results of these economic analyses are vital in terms of the creation of marine protected areas, as an argument to convince decision-makers and donors of the value of protection. They will also be used to formulate conservation and resource management policies. They can strengthen certain potentially competing management choices, e.g. commercial fisheries or maritime tourism, or even serve as the basis for compensation for damages brought about by a land development project, e.g. port, mining, road projects.

This work led to papers at several seminars and workshops. Two scientific publications are underway:

- One about the effects MMAs have on increasing reef fisheries productivity;
- The other on the role MMAs play in the local economy at the village level.

A flyer was produced on the Navakavu case study (how much does a coral reef "bring in"?). In addition, a publication on different methods and their uses in the Pacific is under way, following the workshop in Noumea in 2010 (Laurans et al., *In prep.*).

This work is tied to ICRI's Economic Valuation of Coral Reefs and Related Ecosystems and its ad-hoc committee, created in 2008 and directed by the WRI.

It will continue as part of an additional two-year project, using a cost-benefit approach for several MPAs in Vanuatu and Fiji.

Bibliography

Clua E., Buray N., Legendre P., Mourier J., Planes S. (In press). Business partner or simple catch? The economic value of the sicklefin lemon shark in French Polynesia, Mar. Freshwater Res.

Clua E., Buray N., Legendre P., Mourier J., Planes S., Business partner or simple prey? The economic value of the sicklefin lemon shark (Negarpion acutidens) in French Polynesia, Sharks International Conference, Cairns, Australia, PowerPoint Presentation, 17 pp.

Charles M., De Villers P. (2010). Etude du financement pérenne de l'association du Plan de Gestion de l'Espace Maritime (PGEM) de l'île de Moorea, Polynésie française. Rapport d'étude, PROE, 109 p. + 8 annexes

David G., Herrenschmidt J.-B., Mirault E., Thomassin A. (2007). Valeur sociale et économique des récifs coralliens du Pacifique insulaire. Eléments méthodologiques, IRD Unité Espace, 47 p.

Gabrié C. Clément T., Mercier J.R., Yoou H., Calas J. (2010). Aires marines protégées : capitalisation des expériences du FFEM. Rapport FFEM, 88 p.

Gerbeaux P., Conner N., Vieux C., Incorporating resource valuation studies of coral reefs, mangroves and river catchments into decision and policy making processes: a way forward for the Pacific?, Building Capacity and Cooperation for Sustainable Development of Pacific Coastal Resources Forum, Townsville, Australia, 01–07 Sep. 2007, PowerPoint presentation, 36 pp.

Korovulavula I., O'Garra T., Fong P., Ratuniata R. (2008). Economic valuation – Iqoliqoli – Tourism study report in Fiji. Report, USP, 50 pp.

O'Garra, T., Bequest Values for Marine Resources: How important for indigenous communities in less-developed economies?, Environmental and Resource Economics, 2009, 44 (2): 179–202.

O'Garra, T. (2007). Estimating the total economic value (TEV) of the Navakavu locally-managed marine area, Viti Levu, Fiji. Study report, USP/IRD, 138 pp.

O'Garra, T. (2007). Combien « rapporte » un récif corallien ? Estimation de la valeur économique totale (VET) de l'aire marine de Navakavu, Viti Levu, Fidji – Etude de cas. Flyer, USP/IRD, 2 p.

Pascal N., Mercier J.-R., Conner N. (2008). Economics of Marine Managed Areas of the South Pacific, Suva, Fiji, 26–30 May 2008. Workshop proceedings, CRISP/PROE/IUCN, 40 pp.

Pascal N. (2010). Cost-benefit analysis of community-based marine protected areas: 5 case studies in Vanuatu, South Pacific. Research report, CRISP, 112 p.

Pascal N. (2010). Ecosystèmes coralliens de la Nouvelle-Calédonie, Valeur économique des services écosystémiques – Partie 1 : Valeur financière. Rapport d'étude, IFRECOR, 164 p.

Pascal N., Clua E., Govan H., Gereva S., Effects of MPA on small scale reef fisheries and communities: evidence from Vanuatu (South Pacific), International Institute for Fisheries Economics and Trade, Montpellier, France, 13–16 Jul. 2010. PowerPoint presentation, 27 pp.

Ratuniata R. (2010). Quantifying the gross monetary benefit of implementing marine management within three traditional fishing grounds in Fiji. Master Thesis, University of the South Pacific, 80 p.

Vieux C. (2008). Preliminary socioeconomic assessment of Sunalailai area – Training-of-trainers Workshop, Galahi Papua New Guinea, 29 Oct.–02 Nov. 2007. Technical report, PROE, 15 pp.

Wongbusarakum S., Pomeroy B., Loper C., Vieux C., Guilbeaux M. Levine A., Barttlett C. (2008). SEM-Pasifika: Socioeconomic Monitoring Guidelines for Coastal Managers in Pacific Island Countries. Manual, PROE/NOAA, 138 pp.

9. Promoting sustainable tourism

Activities for tour operators designed to support the development of sustainable tourism in the Pacific were carried out as part of CRISP by The French Polynesian association Te Mana O Te Moana. They began in Fiji in 2005 with the formulation of technical specifications for hotels, so they could take part in eco-friendly certification approach (see inset). Beginning in 2008, this work continued in French Polynesia, where tourism puts a lot of pressure on the natural environment, particularly on reef ecosystems.

The French version of the guide "Making small hotels and resorts environmentally sustainable: a simple checklist for Fiji operators" was published (Gorchakova, 2010). This guide is meant for all hotel facilities located in tropical areas and covers, in particular, issues specific to French Polynesia ("Mon hôtel devient durable" - My hotel goes sustainable). This document is made up of fact sheets that discuss several parts of the eco-friendly approach and cover eight topics:

- Saving energy
- Saving water
- Waste management
- Reducing pollution
- Choosing suppliers
- Educating employees and customers
- Support for conservation activities and for the local community
- Regulations and ecolabels

On each sheet, actions are divided by either the type of use or place of use. Most of the proposed measures are simple to set up and are very effective.

A **practical guide on environmentally friendly approaches** was produced for tourist services and companies that use them (Petit, 2010). It summarises the recommendations and initiatives used at the local and international levels with a view to sustainable and responsible marine tourism. In particular, this guide deals with the issues of wastes at sea, navigation, boat mooring, diving and underwater trails, fish feeding and marine mammal watching, as well as recreational fishing. The environmental-friendly approaches to

be used, questions about controversial practices and reminders about local regulations are all provided.

CRISP also supported a partnership between Te Mana O Te Moana and the company BoraEcoFish, which is developing the concept of "Postlarvae-reseeded coral gardens"; the idea being that PCC could contribute to eco-friendly certification for hotels (see Chapter 6).

Economic surveys were undertaken on the value of the ecosystem services provided by coral reefs, particularly in the area of tourism (see Chapter 8).

Bibliography

Clua E. (2009). Use of postlarvae and coral gardens for ecotourism-based activities, in Development of economically viable postlarval capture and culture (PCC) based activities in Bora Bora (French Polynesia). Brochure, 4 pp.

Gorchakova E. (2010). Mon hôtel devient durable : fiches pratiques pour améliorer la gestion de mon hôtel et protéger notre fenua. Guide Te Mana O Te Moana, 20 p.

Petit M. (2010). Guide pratique des gestes écoresponsables – Tourisme nautique et protection du milieu marin en Polynésie française. Guide Te Mana O Te Moana, 20 p.

Petit M. (2010). Développement de la promotion du tourisme durable en Polynésie française. Rapport final d'activités, Te Mana O Te Moana, 24 p.

Sykes H., Reddy C. (2007). BlueStar Coral Reef Friendly Tourism : Promoting, protecting and improving marine tourism in the South Pacific. PowerPoint presentation for tourism operators, 16 pp.

Sykes H., Reddy C. (2007) BlueStar Coral Reef Friendly Tourism: Benchmarking & Certification Checklist, 20 pp.

Sykes H, Reddy C. (2007). BlueStar Coral Reef Friendly Tourism: Benchmarking & Certification Report, 20 pp.

Expanding knowledge on biodiversity and on ecosystem status and functioning

10. Expanding knowledge

The CRISP Programme's contribution to improving our understanding of biodiversity in the Pacific and monitoring its status deserves special mention: many sites were explored for the first time, taxonomic and biological knowledge on a number of taxa have expanded (coral, algae, fish, crustaceans, sharks, marine mammals), as has our grasp of some aspects of reef ecology such as fish-habitat relationships, resilience and connectivity, without forgetting all the work on fish and invertebrate recruitment carried out as part of the work on PCC (see relevant section).

10.1 Surveys at unexplored or inadequately understood sites

With the support of CRISP, 11 survey trips helped improve knowledge about the biodiversity of some little-known and unexplored sites in the Pacific. The research focused on New Caledonia, as part of the efforts to have New Caledonia's coral reefs added to the World Heritage site list, but the work was also extended to Fiji, Vanuatu and Solomon Islands under the active marine substance activity (see Table 3, p. 85).

New Caledonia

Diahot River (Northern Province)
A rapid biodiversity survey was performed in the Diahot River area (Gabrié et al., 2008), located in the far northwest of the main island of New Caledonia. A total of 25 stations were explored, covering the main reef and lagoon environment formations in the region (see Fig. 13).

While the diversity of purely coral habitats is rather low in comparison with New Caledonia as a whole (S. Andréfouët), total habitat diversity is high, e.g. mangrove, seagrass beds and islets, and this zone sustains a high number of different species. Some 507 species of fish were identified (see below), as were 216 species of coral, or 70% of all known species in New Caledonia, three of which were previously unreported for New Caledonia. 238 coral specimens were added to New Caledonia's collection. The marine and coastal avifauna is very rich, including a significant proportion of the Northern Province nesting population of Wedge-tailed Shearwater *(Puffinus pacificus)* and Ardeid concentrations that are particularly high in New Caledonia. In contrast, certain species, like dugongs, are undergoing heavy pressure. The area is not (or no longer) a turtle egg-laying site, but remains a feeding site for three species.

Figure 13: Stations studied in Diahot River area

Poum-Koumac (Northern Province)
A rapid biodiversity survey was carried out on the coral reefs in the area lying between Yandé Island and Koumac (McKenna et al., 2009; see Fig. 14). Some 62 reef stations were surveyed, covering all the types of reef in the area. Other sites of special interest (*tabu* islands or frequently visited islands) were also assessed.

Figure 14: Poum–Koumac study site

A total of 322 species of Scleractinian corals[20*] were identified. The fringing reefs around the island of Yandé were the richest. A total of 526 species of reef fish were observed there, including 164 species with fishery potential, representing 52% of known diversity in New Caledonia. The sea cucumber and mollusc survey (*Trochus niloticus* and giant clams) covered 28 stations and 49% of these stations had reefs in good or very good health. Also, two areas that are important for marine bird conservation were identified by the New Caledonian Ornithological Society. A new nesting species, the Beach Stone-curlew (*Esacus magnirostris*) was observed and a number of first or new observations were recorded during the survey.

Great Northern Lagoon

A survey of the Scleractinian corals was carried out in the Great Northern Lagoon area of New Caledonia (Lasne, 2010) which extends, in the northern part of the main island of New Caledonia from Koumac (northwest) to Balabio (northeast) and to the "Grand Passage", i.e. the southern boundary of the d'Entrecasteaux Reefs. Representing more than a third of the total lagoon area of New Caledonia, the Great Northern Lagoon differs significantly from the Southern Lagoon and the South-western Lagoon.

A total of 49 stations were sampled in the Belep and Yandé islands area, in the northern segment of the ″Récif des Français" and on Cook Reef. The coral reefs offer exceptional species diversity with 277 taxa observed, including 3 species of Ahermatypic coral and three species of *Hydrozoa* (Milleporidae). This trip added 328 specimens representing 203 taxa to the collection. Of the specimens collected, 13 species were new to New Caledonia.

The Chesterfield Reefs

The atolls of Chesterfield and Bellona are situated some 550 km to the north-west of the main island of New Caledonia. In 2010, a multi-disciplinary group explored 20 stations over the southern part of Chesterfield Atoll. This mission confirmed the generally healthy status of the reefs; 218 species of scleractinians were recorded (including 189 identified to species level), as well as four species of *Millepora*. Some 25 species of Scleractinians were new for the Chesterfields, bringing the number of species recorded from all the various surveys to 249 (G. Lasne, *in press*). Several new specimens were added to the IRD collection, including *A. chesterfieldiensis*.

Invertebrates are present in quantities that would allow commercial exploitation. A total of 12 species of sea cucumbers and four species of giant clam suitable for human consumption (*Tricadacna* spp) were identified. Only two specimens of trochus (*Trochus niloticus*) were recorded. In contrast, green top shells (*Tectus pyramis*) occurred in high densities. Evidence of harvesting was significant at depths of between 0 and 10 m. Suitable regulations should be introduced as soon as possible.

A total of 144 species of fish of commercial interest were observed. Average fish sizes were large overall, but densities were much lower than around the main island of New Caledonia. Some 20 new species were added to the ichthyologic inventory for the Chesterfields. Genetic specimens were taken from coastal sharks and a number were tagged. Accounts and observations (very low coastal shark density, very small average size) indicate that sedentary shark populations have recently been subject to extremely worrisome intense poaching. In contrast, the density of tiger sharks (*Galeocerdo cuvier*), which are more mobile, is satisfactory.

Figure 15: Map of study site and stations in Yambé-Diahoué MPA

20 *Verification is still needed for a number of species.

The period was not favourable for observing whales (a sole male humpback, *Megaptera novangliae*). In contrast, the sighting of a group of large *Tursiops truncatus* dolphins, seemed surprising in an island group so far from the main island.

Finally, 10 species of birds were recorded breeding at 14 different sites, accounting for a total of 130,288 breeding couples. This survey confirms the value of this area as a marine bird nesting site and more specifically its status as a breeding area for the endemic New Caledonia Fairy Tern *Sterna nereis.*

Yambé-Diahoué Marine Protected Area (Northern Province)

A baseline study of the biocenotic communities, before the introduction of strictly protected areas, was carried out within the Yambé-Diahoué Marine Protected Area (Wantiez et al., 2010). A total of 21 stations over three main reef geomorphologic types, i.e. outer slope, inner barrier and intermediate reef, and three stations in coastal seagrass beds were sampled (see Fig. 15).

The reefs are in excellent health, especially the barrier reef, as demonstrated by the presence and/or frequency of certain iconic species (humphead (napoleon) wrasse, manta ray, whale shark, sharks) and other species infrequently observed in New Caledonia (*Apolemichthys trimaculatus*, *Pomacanthus xanthometopon*, *Neoglyphidodon carlsoni* and *Siganus punctatissimus*). Some 322 species of fish (44 families) were recorded. Living coral formed most of the living substrate (66.1%) and occured in diverse forms.

Yves Merlet reserve (Southern Province)

The Southern Province of New Caledonia, with support from WWF–France under the CRISP Programme umbrella, undertook a baseline study of the living coral communities and the habitat of the Merlet fully protected area as part of the process to have New Caledonia's coral reefs listed as a World Heritage site (Wantiez et al., 2008). This reserve, established in 1970 and one of France's oldest, had not received scientific attention for a long time and this research represents a reference point. The results showed that the habitat and communities in the reserve are in an excellent state of preservation after almost 40 years of protected status, demonstrating the value of long-term protection. The reef fish populations comprised 277 species (34 families). The humphead wrasse (*Cheilinus undulatus*) is a relatively common species (20% of stations). Edible species (130 species) and commercial species (74 species) are very well represented; the latter account for over 66% of the total biomass, which is quite exceptional. Invertebrates of interest for active marine substances and those of Wallis and Futuna, which focused on crustaceans, are discussed in the relevant paragraphs

Tuvalu

Located in the central Pacific, this group comprises nine islands (four low islands and five atolls), spread over 900,000 sq. km of ocean, with a total land area of 26 sq. km. A review of the existing literature on the marine biodiversity was carried out (Job, 2009). A total of 1,453 species was recorded: 532 fish, 411 macro-invertebrates, 379 cnidarians, 59 algae, 41 birds, 21 mammals, 4 sponges, 4 turtles and 2 species of mangrove tree.

Table 3: Survey trips undertaken with the support of CRISP

Country	Site surveyed	Groups recorded or analysed under CRISP arrangements	Number of stations
New Caledonia	Diahot	Coral, fish, marine mammals, turtles, birds	25
	Poum-Koumac	Coral, fish invertebrates, birds	62
	Touho-Ponerihouen	Report not yet available	?
	Chesterfields	Coral, sharks, fish and commercial invertebrates, marine mammals, birds	20
	Great Northern Lagoon	Coral	49
	Yambé-Diahoué MPA	Fish, molluscs, echinoderms, coral	21
	Yves Merlet MPA	Fish, molluscs, echinoderms	21
Wallis and Futuna		Crustaceans	31
Solomon Is	New Georgia island group	Algae, sponges, ascidians	41
Fiji	Northern Vanua Levu, Ringgold atolls, N'Gau and Kaduvu islands	Algae, sponges, ascidians	31
Vanuatu	Southern Espiritu Santo	Algae	45
Tuvalu		Bibliographic inventory of biodiversity	
Pacific		Bibliographic inventory of crustaceans	

10.2 Atlas of the Coral Reefs of the South Pacific

The first atlas of the reefs of Papua New Guinea was produced as a CRISP initiative in 2006 (see inset at right). It was supplemented between 2007 and 2010 by similar work for the 22 other countries in the region, except Fiji, whose crude data has still not been processed. This reef mapping project is part of the Millennium Coral Reef Mapping initiative initiated in 2001 at the Institute for Marine Remote Sensing of the University of South Florida (IMaRS/USF) in the USA. Funded by NASA's Oceanography Program, this project's goal is to characterise and map all the reefs on the planet using standard data sets and methods. The resulting atlases will notably make it possible to calculate reef surface areas (see Table 4).

Table 4: Reef surface areas in eight Pacific countries and territories

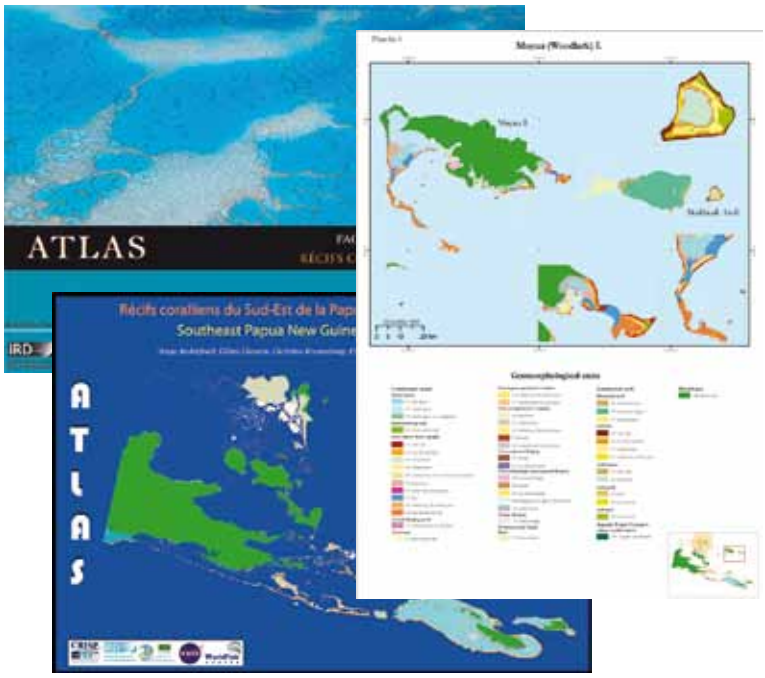
Country	Surface area (sq. km)	Reef surface area (sq. km)	Number of classes (level 5)
New Caledonia	18,757	4,573	163
Wallis and Futuna	141	424	25
French Polynesia	1,727	3,000	66
American Samoa	199	67	16
Samoa	2,830	200	28
Tonga	672	3,587	70
Vanuatu	12,221	708	58
PNG		3,009	170

10.3 Expanding knowledge on biodiversity

Corals

After a bibliographic review (Lasne, 2007), the first taxonomic approach focused on the collections assembled over some 30 years by IRD divers (Pichon, 2006a). Since 2005, courtesy of IRD and CRISP, five sampling campaigns and some occasional trips have augmented the collection and produced inventories of species in previously unknown or relatively unexplored zones of New Caledonia (see Fig. 16, after Lasne, 2010), such as the Diahot and Northeastern area (Pichon, 2006 b), the Great Northern Lagoon (Lasne, 2010) and the Northwest (McKenna et al., 2009) (see Table 5).

New Caledonia is characterised by a multitude of biotopes and very high species richness, with coral featuring very unusual morphology. So far, 401



species of Scleractinians have been recorded (Lasne 2010). The most frequently sampled species are those with broad ecological distribution, occurring in most of the reef areas of the Indo-Pacific. The number of coral genera and species discovered suggests that New Caledonia belongs to the area of optimum species distribution (Lasne, 2007).[20] The barrier reef as a whole is the richest reef environment. Coral fauna gradually declines in richness from offshore towards the shoreline of the main island of New Caledonia, because of the increase in sedimentation nearer the coast. The fauna also gradually becomes less diversified along a north-south axis, possibly due to the reduction in sea temperatures from north to south

20 * NB: in this IRD review, only coral species duly identified by recognised taxonomists have been considered; the corals identified in the CI RAP have therefore not been included.

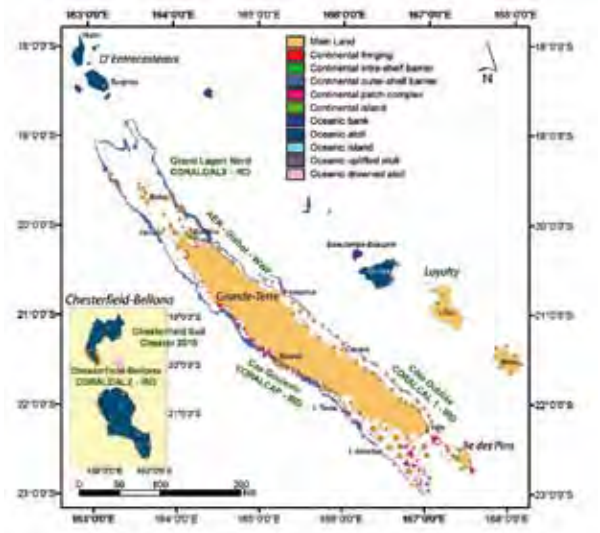


Figure 16: Map of sampling sites in New Caledonia

(theory requiring verification). Work by Lasne has augmented an already very rich collection. If sampling efforts between the two areas are compared, it is possible that New Caledonia (401 species), where less research has been done, could ultimately possess a higher species richness than Australia's Great Barrier Reef (some 400 species, Pichon in Gabrié et al., 2008).

The list of species prepared on the basis of the literature review (extracted from existing marine biodiversity data) on **Tuvalu** (Job, 2009) yielded a list of 379 cnidarians, within which the scleractinians represented the most highly diversified taxonomic group (365 species).

Finally, based on this new knowledge and a bibliographical review, a revised map of the distribution of species richness in the Pacific was produced with support from the CRISP unit (Lasne 2010).

Algae

Algae research initially focused on material brought back from active marine substance identification trips, as part of CRISP (Solomon Islands, 2004 and Fiji, 2007 – see relevant section), but also from previous IRD cruises.[21]

In Solomon Islands, 41 sites were surveyed at depths of between 20 and 60 metres in the New Georgia group. More than 900 specimens of seaweed and phanerogams were collected. A total of 216 species belonging to the Rhodophytes (58%, or 125 species), Chlorophytes (32%; 69 species) and Ochrophytes (10%; 22) and eight species of marine phanerogams were identified. Of these, 132 species were newly described for this area, including three species new to science. Taking previous surveys into consideration, this increased the number of species of algal flora in this zone to 332 (Debitus et al., 2008) (see Table 6, p. 88).

In Fiji, surveys were carried out at 31 stations in reef environments at depths of between 0 and 60 m located in the provinces of Bua, Macuata (Vanua Levu), Cakaudrauve (Ringgold atolls), Lomaiviti (N'Gau island) and Kaduvu (Payri et al., 2007). This campaign yielded descriptions of previously unexplored reef areas and made it possible to characterise the zone biogeographically through comparison with already explored groups of islands (Solomon Islands, Vanuatu, New Caledonia). The reefs are not very healthy in general, live coral cover never exceeds 30% and is often under 20%.

21 Such as the trip to Vanuatu (2004) as part of the European MAST 3 programme, the scientific expedition to the island of Santo (2006), jointly organised and funded by IRD, the French National Museum of Natural History (MNHN) and Pro-Natura, campaigns on Bellona Reefs and in the Great Northern Lagoon of New Caledonia (2009), and work on materials from French Polynesia collected during various trips.

Table 5: Sampling and identification campaigns for Scleractinian corals organised since 2005 in New Caledonia

Campaign	Date	Funding	Scientist	Zone	Results	Added value
RAP Diahot	2006	WWF, CRISP, Northern Province	Pichon, Lasne	Diahot and North-east	216 species of scleractinian identified	3 species from Vanuatu observed in NC
CoRalCal 1	2007	IRD–Alis, CRISP	Benzoni, Lasne, Folcher	'Forgotten Coast'	206 taxa of scleractinian	
Coralcap	2007	IRD, CRISP	Benzoni, Lasne	Cap Goulevain, Gail Bank	197 scleractinian specimens	
CoRalCal 2	2008	IRD–Alis, CRISP	Lasne, Butscher	Chesterfields	302 scleractinian specimens	
CoRalCal 3	2009	IRD–Alis, CRISP	Lasne, Butscher	Great Northern Lagoon	328 scleractinian specimens (203 taxa)	13 new species identified for NC
RAP North-west	2007	CI, Northern Province, CRISP	Fenner, Muir	Northwestern Lagoon	322 species of scleractinian identified	61 new species for NC (to be confirmed)
Chesterfields	2010	CRISP	Lasne	Chesterfield Reefs	218 species of scleractinian	25 new species for the zone

Most algae observations and specimens collected in Fiji concerned original material, because very little research had occurred at these sites, some of which had in fact never been prospected, such as the Ringgold group, east of Vanua Levu. The harvests from bathymetric levels under 40 m included a number of taxa recorded in Fiji waters for the first time and some that were new to science. Some 910 specimens of marine plants were collected, representing 250 species of seaweed (out of the 463 species currently known to exist in Fiji), not counting the calcareous red algae currently being studied. These species comprise 58% red algae (Rhodophytes), 37% green algae (Chlorophytes) and 5% brown algae (Phaeophyceae). A number of taxa of the genus *Rhipila*, still to be determined, could be new to science. Four marine phanerogams were recorded, including *Halophila ovalis f. bullosa*, which is endemic to Fiji.

In Vanuatu, in southern Espiritu Santo island, especially in the Luganville area (N'Yeurt & Payri, 2007), 45 stations were explored in a range of biotopes, between the surface and a depth of 60 m; some 1,145 specimens of algae and marine phanerogams were collected. These were the first investigations of this island's marine seaweed flora. South Santo looks like a relatively rich site; the phycological list prepared on the basis of research on the collections covered 284 species, including 8 marine phanerogams, 4 cyanobacteria and 272 species of algae comprising 164 species of red algae (Rhodophytes), 82 species of green algae (Chlorophytes) and 26 Ochrophytes. At least nine species are new to science.

Description of new species

A number of genera and species from the South Pacific region (Fiji, French Polynesia, Solomon Islands and Vanuatu) new to science were described and covered in publications (see inset). These discoveries revealed the importance of continuing with such surveys, particularly in isolated areas and deep habitats, which are still largely unexplored.

Several thousand herbarium plates and slides were assembled; many photographs of organisms *in situ* and their biotopes were digitised and geo-referenced. The reference collections thus assembled were sent to various museums: the Suva Herbarium (University of the South Pacific), which received a duplicate of all the algae collections, the Queensland Museum in Brisbane, the French National Museum of Natural History in Paris, etc.

A particular family of algae (Udoteaceae) is still under investigation and could also reveal new species. Taxonomic work is continuing, therefore, on the unidentified specimens which could be identified as work progresses, depending on progress of knowledge on the marine flora of other tropical areas and especially the spread of bar-coding[22] and DNA studies.

South Pacific algae genera and species new to science

- A new genus/species of red algae G*rammephora peyssonnelioides* gen. and sp. nov. (Rhodophyta, Rhodymeniaceae) from coastal and deep water sites in Solomon Islands (N'Yeurt and Payri, 2007).
- Seven new species of red algae:
  - *Sebdenia cerebriformis* for Solomon Islands, Fiji, New Caledonia, Vanuatu and the Java Sea (N'Yeurt and Payri, 2008);
  - two species of genus *Myriogramme, M. melanesiensis* sp. nov. and *M. heterostroma* sp. nov., from subtidal habitats in Solomon Islands and Vanuatu (*N'Yeurt, Wynne and Payri,* 2007);
- Four new species for the Pacific (N'Yeurt and Payri, 2007): *Chondria bullata* from the Tuamotus (French Polynesia), Vanuatu, Palmerston Atoll (Cook Islands) and Fiji; *Halymenia nukuhivensis*, from the Marquesas (French Polynesia); *Jania articulata*, from the Tuamotus and Manihiki (Cook Islands); *Meristotheca* from Fiji.
- Other new species of red algae from Vanuatu (*Martensia* sp. nov., *Rhizophyllis* sp. nov., *Rhodymenia* sp. nov., *Dumontiaceae* gen. nov., *Hypoglossum* sp. nov. and *Dudresnaya* sp. nov.) are currently being studied.

Table 6: Summary of number of species recorded by country

Algae	Number of species recorded (known number)	New taxa for science	Rhodo-phytes %	Chloro-phytes %	Ochro-phytes %
Solomon Islands	216 (332)	3	58	32	10
Fiji	250 (463)	??	58	37	5
Vanuatu	272	9 at least	60	30	10

Classification review

Sargassum seaweeds form large beds of recognised ecological and economic importance. The taxonomy of the genus was ambiguous and needed thorough revision, in particular in the Indo-Pacific bio-geographic context, which has been the subject of a dissertation (L. Mattio, 2008) and a publication (Mattio et al., 2010). A dual morphological and molecular approach applied to material from various parts of the

22 DNA sequence used, like barcodes at stores, as a taxonomic identification tool for living organisms.

Pacific (New Caledonia, French Polynesia, Vanuatu, Fiji, and Solomon Islands), revealed low genetic diversity between several polymorphous taxa belonging to the sub-genus *Sargassum* and enabled a new division to be put forward. The flora of the New Caledonian *Sargassum* would seem to be the richest of the areas investigated (12 taxa).

Various theories about the regions that may have acted as refuges during the Last Glacial Maximum and from which the current floras are thought to have dispersed and diversified are under discussion.

Turbinaria

Turbinaria ornata and *Turbinaria conoides* are two morphologically similar brown algae that can lead to confusion during identification. Two studies, one using molecular analysis (Rohfritsch et al., 2007) and the other by HR-MAS NMR spectroscopy (Le Lann et al., 2008) have confirmed that they are two distinct species.

These results cast doubt on the validity of just using morphological assessment to differentiate between species of algae and show the merit of new methods for species identification and the preselection of potential markers.

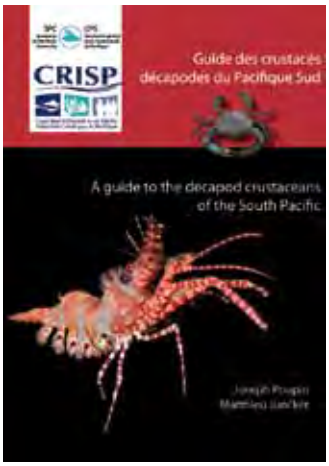
Sponges and ascidians

Sponge and ascidians were also collected during prospecting trips to identify active marine substances (see relevant section).

In Fiji, sponge collecting produced 139 items representing 133 different morphological groups. Taxonomic work currently in progress will determine the number of species, 18 of which could be new to science. To our knowledge, no survey of sponges (Porifera) is yet available for this region; initial findings reveal a typically Indo-Pacific fauna (Hoover, in Payri 2007).

In Solomon Islands, sponges are especially abundant; 194 species were collected and identified by the Queensland Museum in Brisbane, 85 of which are common to the Indo-Pacific region, 74 are from the central/western Pacific and 35 species are new for the region and maybe for science. This leads to an endemism estimate of less than 18%.

Crustaceans



In New Caledonia, the most common species of decapod and stomatopod crustaceans were sampled and photographed; 19 stations, spread over three zones were explored (Southern Province, Rédika and Ka islets; Northern Province, between Pindaï peninsula and Voh; and in the Loyalty Islands, on Lifou). Some 176 different species of decapods and stomatopods were identified, corresponding to only 20% of the local fauna. Despite extensive previous research in the area, several dozen specimens recorded are thought to be new for New Caledonia, including the lobster *Panulirus femoristriga* (Von Martens, 1872) and the Ocypodidae mud crab *Macrophthalmus darwinensis* (Barnes, 1971). Using previous data, the preliminary list of species of terrestrial and shallow-water (<100 m) stomatopod and decapod crustaceans comprises 939 species.

In Wallis and Futuna, crustaceans were surveyed (Poupin and Juncker, 2008) at 31 stations on Alofi (9 stations), Futuna (14 stations) and Wallis (8 stations) (see Table 7). The land environment, rivers and estuaries, mangroves, and marine environment, from the supra-tidal zone to the upper part of the reef slope, were explored. The carcinological fauna is typical of the Indo-West Pacific, with species having broad bio-geographical distribution. The provisional outcome is 127 species, or probably less than 10% of the real richness. The survey did not record any endemic species in the islands, but at least 11 species with commercial potential were identified.

Finally, 223 easily identifiable species were described in the illustrated *Guide to the decapod crustaceans of the South Pacific* by Poupin and Juncker (2010), which includes 343 previously unpublished photographs. This guide focuses on the species recorded from the Australian coast to Easter Island, with specific observations made in New Caledonia, the Loyalty Islands, Vanuatu, Wallis and Futuna and French Polynesia.

Table 7: Summary of biodiversity surveys

Country	Site	Taxa	Stations	Coral	Algae	Fish	Crustaceans
New Caledonia	Diahot	Coral, fish, marine mammals, turtles, birds	25	216 (SNT: 3)		507 Potential richness: 759 (SNT: 8; SNS: 1)	
	Poum-Koumac	Coral, fish invertebrates, birds	62	322 (SNL: 61 to be verified)		526	
	Touho-Ponerihouen	Report not yet available	?				
	Chesterfields	Coral, sharks, commercial fish and invertebrates, marine mammals, birds	20	218 (SNL: 25)		144 commercial (SNT: 20)	
	Great Northern Lagoon	Coral	49	277 (SNT: 13)			
	Yambé-Diahoué MPA	Fish, molluscs, echinoderms, coral	21			322	
	Yves Merlet MPA	Fish, molluscs, echinoderms	21			277	
	3 Provinces						176 described (939 altogether in NC) (SNT: 10)
Wallis		Crustaceans	31				127 species (less than 10% of probable total)
		Fish (guide)				70 juveniles	
Solomon Islands	New Georgia island group	Algae, sponges ascidians	41		216 (SNT: 132; SNS: 3)		
Fiji	Northern Vanua Levu, Ringgold atolls, N'Gau and Kaduvu islands	Algae, sponges ascidians	31		250 (out of the existing 463) (SNS: X)		
Vanuatu		Algae			284 (SNT: 284; SNS: 9)		
Tuvalu		Bibliographic inventory of biodiversity	45	379	59	532	
Pacific							223

SNS: species new to science; SNT: species new to the territory; SNL: species new to the location.

Fish

Research was done on fish in New Caledonia, Fiji and Tuvalu.

In **New Caledonia**, a number of surveys were carried out: **Diahot-Balabio,** within a rapid survey of biodiversity in the area (Gabrié et al., 2008) in the Northwestern Lagoon; between **Koumac and Yandé** (McKenna et al., 2009); at **Yambé-Diahoué** and in the Yves Merlet reserve (Wantiez et al., 2010). Also, bibliographical research and interviews with scientists enabled the project to assemble existing data on fish during the marine eco-regional assessment (MEA) of New Caledonia (MEA fish groups in Gabrié et al., 2008).

The ichtyological fauna of New Caledonia is characterised by a high diversity of populations, comparable to that of Australia's Great Barrier Reef, at equal latitudes. Some 3000 species have been recorded, with coastal fish species being the majority with over 1,700 species. But this is a provisional figure, as more than 200 species have probably not been recorded yet. New Caledonian fish populations are similar to most of those encountered in the island areas of the tropical Pacific, with relatively low endemism levels (5.2% of species of coastal fish). Various iconic fish species endangered elsewhere in the world are still abundant, such as the humphead (napoleon) wrasse and the larger groupers, with many breeding sites, some of which are rare on a worldwide scale (Kulibcki, in Gabrié et al., 2008).

The Diahot area and the reefs in the far north of the country (Cook, Belep, 'des Français') appear to be particularly rich in fish species in comparison to other parts of New Caledonia and to various other sites in the Pacific. At Diahot, despite the speed at which the survey was performed and the limited number of stations explored, 507 species of fish were recorded

(G. Allen), with a potential richness of 759 species (using G. Allen's predictive method). At least eight species new to New Caledonia, as well as one species new to science were discovered. The humphead wrasse *(Cheilinus undulatus)*, a species on the IUCN Red List, was frequently observed (70% of stations), but adults were scarce. The leopard coral grouper, classified as a "near-threatened" species on the IUCN Red List, was also present in large numbers at almost all the sites on Cook Reef.

The survey carried out in the **Northwestern Lagoon** observed 526 species. The highest fish diversity was recorded forward of and on the outer slope of the barrier reef. *Labridae*, *Pomacentridae* and *Gobiidae* are the most diverse groups there.

At **Yambé-Diahoué**, 322 species of fish were recorded (44 families). The communities were significantly more diversified and abundant on the reefs (85.1 species per station on average) than in the seagrass beds.

Concerning **commercial species,** the resources were abundant, the stocks rich and hardly affected by fishing in the Diahot area. Some 190 species were recorded as species targeted by reef fishing (mean biomass per site of some 306 t/km^2). In the Northwestern Lagoon, between Koumac and Yandé, 127 of the 164 targeted species were listed. Commercial species were also very well represented in the Yambé-Diahoué Marine Protected Area (87 species), and in the Yves Merlet reserve, commercial species (74 species) accounted for over 66% of total biomass, which is quite exceptional. In the Chesterfields, 144 species of commercial fish (20 species new to the area) were observed, with large specimens present, but in lower densities than on the main island of New Caledonia.

Lastly, CRISP supported the dissemination of results relating to the exploitation of reef fish stocks in the Voh-Koné-Pouembout area (New Caledonia; Guillemot, 2009).

In Tuvalu, the bibliographic review listed 532 species of fish, belonging to 72 families, out of a total of 1,453 species, with 55 species are on the IUCN Red List, seven of which are considered "endangered" and 16 "near-threatened".

Fish databases

Regional database on Pacific fish biodiversity: a compilation of known coastal fish species was produced for the whole **Tropical Western Pacific** (from Southeast Asia to Hawaii, the Marquesas and Easter Island). For each species the following features were recorded, using broad categories: species size, food, gregariousness, home range. A brief bibliography was also prepared for each country (17 countries and territories), and for each major fish family. The result is presented in the form of species lists in the tables available on CD-ROM. These lists are not complete fauna lists, but focus on the most common species and those for which the most information is available. Regional lists are also available for some countries, e.g. French Polynesia, New Caledonia and the Federated States of Micronesia have several 'sub-lists'. The number of species in the compilation exceeds 3,000 (out of more than 5,700 species in the region (Kulbicki, in progress)

In addition, **the Fisheye/SI database** developed by IRD, with support from CRISP, contains IRD data on Pacific reef fish. It is available at the following website http://fisheye.ird.nc.

10.4 Ecosystem biology and functioning

Larvae dispersal, connectivity and recruitment in fish stocks

In addition to the extensive research carried out on larval recruitment as part of PCC work (see relevant section), several studies covered connectivity and larval dispersal, in Papua New Guinea (Almany et al., 2007; Planes et al., 2008, 2009; Saenz-Agudelo et al., 2009), and on a broader scale in the Pacific (Swarup, 2008). This work shed new light on these topics and provided valuable information for developing marine protected areas.

In Papua New Guinea, connectivity and larval dispersal were assessed in a study in the marine area network of Kimbe Bay (New Britain) that is still in progress (Almany et al., 2007, Saenz-Agudelo et al., 2009 and Planes et al., 2009). Two reef fish species with different reproduction strategies, i.e. Pomacentridae (*Amphiprion percula* – duration of pelagic phase: 11 days) and Chaetodontidae (*Chaetodon vagabundus* – duration of pelagic phase: almost 35 days), were selected (Almany et al., 2007). 176 female clown fish and 123 butterfly fish were caught and tagged; then juveniles were collected from the same habitats in order to estimate self-recruitment levels. These proved to be higher than expected since, after pelagic larval phases of varying durations, some 60% of juveniles returned to their home reef.

At the same time, again at Kimbe, clown fish *Amphiprion percula* kinship analyses were performed (Planes et al., 2009). The DNA of 506 adult clown fish was analysed and compared to that of 400 juveniles caught a little later at the same site. This method produced an estimate of 40% local recruitment. The authors of this study also identified larval dispersal over a distance of up to 35 km, the longest distance ever validated for reef fish. These dispersals are thought to contribute at least 10% of recruitment in the adjacent MPAs. Recruitment in the reserves is therefore both local and from adjacent reserves.

Lastly, two methods (assignment test and kinship analysis) were compared in order to estimate larval retention and connectivity between clown fish populations in Bootless Bay south of Port Moresby and on Kimbe Island (Saenz-Agudelo et al., 2009). The methodological comparison showed that kinship analysis was the best choice for estimating small-scale larval dispersal in populations with low levels of genetic variation; otherwise, the assignment test is more suitable.

These results imply that the spatial scales to be considered when planning for marine protected areas are smaller than previous estimations suggested. Although this recent work underlines local retention and self-recruitment on an ecological time scale, this does not prevent the existence, an evolutionary scale, of sporadic large-scale dispersal events propagating molecular variants throughout the Indo-Pacific region (Planes et al. 2008).

On a broader scale, three reef systems with differing degrees of fragmentation were compared to study the influence fragmentation has on the connectivity of *Dascyllus aruanus* populations (Swarup, 2008). The genetic diversity of 765 fish sampled at 65 sites in New Caledonia (continuous system), five sites in Fiji (intermediate system) and six sites in French Polynesia (highly fragmented system) was observed. A comparison of these three systems revealed a strong genetic diversity gradient from New Caledonia to French Polynesia and underscored the positive correlation between the species and genetic diversity results, never previously revealed in connection with the marine environment. Overall, the samples are genetically homogeneous on a small scale, within each system, even in French Polynesia in a fragmented habitat, but at a larger geographical scale, very clear genetic differences exist between the systems. These results confirm that there is a high degree of connectivity between populations of *D. aruanus,* both as regards continuous habitat and for fragmented habitats, at the spatial scales considered. Lastly, the study shows that gene flow between populations, linked to migrations, tends to counterbalance the effects of genetic drift and, in so doing, balances the variations in allelic frequencies.

Distinguishing fish populations by sound

In another register, a study used the differences in the sounds produced by the species to try to distinguish between the species, the populations of different regions, and the populations of the same region. In fact, most research on fish sound emissions show that these sounds are specific to each species, with spectral characteristics. The question therefore arose as to whether these sounds could be used to understand the phyletic relations between species and what acoustic parameters are subject to variations between species. Research was carried out on the sounds emitted by four species of Dascyllus from various regions (Madagascar, Moorea, Rangiroa, and Hawaii). Certain characteristics (length of sound) vary between different species, while other characteristics are variable between populations. In *D. trimaculatus,* for example, the pulse period differs between populations in Madagascar and those in French Polynesia. Pulse length did not, however, show any difference. In regions sustaining sympatric populations (living in the same geographical area), sound variability is apparently limited (Parmentier et al, 2009).

A second study took place in the Moorea lagoon (French Polynesia) between January and March 2009 (Parmentier et al., 2010). The behaviour of damselfish (*Dascyllus flavicaudus*) was studied using synchronous underwater audiovisual recordings and a passive sound detector. The fish produced sounds relating to six different kinds of behaviour, while assuming three different colour patterns. The sounds were grouped into three categories: sounds associated with (1) fighting; (2) mating/visiting and (3) hunting and jumping. They are thought to be emitted by single pulses (teeth clicking). Daily recordings showed that sound production rates were higher at sunrise and sunset than during the day and that no sounds were produced during the night. The signals were different however: at dawn, they are thought to be mainly associated with breeding/visiting, while at sunset they appear to be mainly associated with hunting and jumping.

Shark connectivity and movements

Several studies were carried out on sharks, which today face severe threats, mainly concerning tiger sharks, bull sharks, great whites, lemon sharks and blacktips in New Caledonia and French Polynesia.

In New Caledonia, the international research programme SharkCal, initiated in 2009, aims to gain a better understanding of large-shark movements and the connectivity between their habitats in New Caledonian waters and with reef habitats in the rest of the South Pacific. Two reports (Werry et al., 2009; 2010; Read, 2010) describe the observations made during various research missions, mainly concerning **tiger shark (*Galeocerdo cuvier*) and bull shark (*Carcharhinus leucas*)** movements, during which the sharks were caught and tagged. Initial results from these trips reveal the diversity in tiger sharks' movements, medium range migrations and loyalty to location. They indicate the importance of lagoon areas for these species, the connectivity between lagoons and coastal habitats and the co-occurrence of these large-sized species. A photo-identification method was also proposed to provide new information on tiger sharks in New Caledonia (Read, 2010).

A postdoctoral student is examining types of connectivity between **tiger shark** populations (and those of other large shark species) in New Caledonia and those in Australia's Great Barrier Reef (Werry, 2009). Also, Clua and Séret (2010) documented a fatal great white shark attack on a young woman in Lifou in 2007. In a review of knowledge on this species in New Caledonia, the same authors summarised observations concerning 52 **great white shark** sightings in New Caledonian waters between 1943 and 2010 (Clua and Séret, *In press* a and c). The winter peak in the presence of this species suggests that New Caledonia could be a hibernation destination for great white sharks in the Southwest Pacific.

A bibliographic review was carried out on methods for capturing tiger and great white sharks, for the purpose of worldwide scientific research (Read, 2009); fishing effort and catch rates from the various studies were compared so as to determine the best method (efficiency and catch survival).

In French Polynesia, a joint CRIOBE-SPC team studied the consequences the fast-growing 'shark-feeding' trend has had on lemon shark behaviour in feeding zones around Moorea, and the impact of feeding on their residence at the site (Buray et al., 2009; Clua et al., 2010a and b). The observations (949 dives in 44 months in the same area) revealed that during the period concerned, their residence at the site increased significantly, in particular for males, which, given the reduction in shark mobility, intensifies the risk of in-breeding. The authors suggest that a temporary ban on such feeding should be introduced during the lemon shark breeding period.

A method for determining the economic value of such sharks involved in an eco-tourism activity has been suggested as a new tool and argument in favour of the conservation of this species and of sharks in general (Clua et al., *In press* b – see Chapter 8).

The genetic structure of **blacktip shark** populations was studied in fragmented environments (in five islands of French Polynesia: Moorea, Tetiaroa, Rangiroa, Fakahina, Maria). Genetic analysis was carried out on 165 specimens. Three or four genetically distinct populations coincide with an island or a small island group. The low dispersal capacity of the species demonstrates the importance of sustainably maintaining each separate population. Marine protected areas should therefore be designed in an appropriate manner so as to accommodate the biological and geographic characteristics of sharks, as suggested by Vignaud et al. (2010).

As an adjunct to these this fieldwork, a **bibliographic review** presented the current knowledge on shark catches in the Pacific (Juncker, 2006). The limited amount of recent research has shown a drastic decline in populations. Up to, 70 million sharks may be caught annually (Clarke et al, 2006), mainly for their fins.

Relationships between richness, habitat and environmental disturbances

A number of studies were carried out on the influence habitat and disturbances have on fish communities, e.g. modelling the influence that disturbances due to human activities have on the species richness structure of fish aggregations in atolls of the Tuamotu group (**Mellin et al., 2008**); identifying and modelling the spatial distribution of reef fish communities as influenced by habitat in Fiji, **(De Mazières, 2008);** the relationship between reef fish and benthic habitat in an *iqoliqoli* area (traditional fishing ground) at **Navutulevu** (Saladrau, 2008).

Coral diseases: a very preliminary investigation was carried out on the diseases that affect coral in New Caledonia (Tribollet et al., 2010). This initial approach listed 23 coral diseases affecting 14 coral genera. They were observed at 92% of the sites concerned, but at low levels of abundance. It should be noted that this project included the need to coordinate this study with the process to define the coral ecosystem monitoring method, in accordance with the requirements associated with UNESCO World Heritage site listing.

10.5 Erosion and sedimentation

The GERSA component focused on understanding and quantifying hydrological processes and erosion problems (see Chapter 4), particularly through methodological research conducted by students. Work was done in Fiji, on Efate in Vanuatu and on Moorea and Tahiti in French Polynesia.

Land use mapping is needed to study erosion events; the model the GERSA programme used to quantify the potential of eroded soils did, in fact, depend on knowing what type of plant cover is present. These mapping exercises are conducted by analysing very high resolution satellite imagery. Two land use classification systems were used and compared for zones on Efate in Vanuatu (Despinoy 2007 and Laurent, 2007; Aubert and Despinoy, 2008) from SPOT and FORMOSAT images: the conventional pixel-based classification method and the object-oriented approach. The object-oriented approach, with FORMOSAT 2, showed its potential, as its high spatial resolution suited the complexity of the composition of tropical environments.

Several projects covered erosion and sedimentation modelling. In 2007 (Batti et al., 2007), an initial approach looked at the various erosion assessment methods used in island environments, by referring to recent studies in the South Pacific and the Indian Ocean.

More recently, research was carried out on Efate in Vanuatu (Fossey, 2007, 2008 a and b; Gueyte, 2008); in Fiji in northern Viti Levu and the Tavua and Yaqar watersheds; in New Caledonia (Dumas et al., Gay et al.); and in the Tehapuoo peninsula of Tahiti, (Printemps, 2007, 2008) for the purpose of modelling and spatialising the watershed vulnerability to erosion and runoff, assessing the water erosion hazard and quantifying soil losses (see Figs. 17a and b). This work was based on the USLE (Universal Soil Loss Equation) method, which can be used to quantify such losses at the source (Wischmeier and Smith, 1965; 1978). The model uses various factors including rainfall, flow, topography, pedology, ground cover, erodibility, land use and type of management.

To estimate sedimentation at sea, a hydrological model needs to be added. This model therefore needs very significant quantities of data and should be adapted to suit the quantity and quality of data available; coupled with a GIS, it can be used to develop decision-making tools. Data gathered from all the research sites to run the models, particularly hydrological data, were used to produce a database for Fiji, Vanuatu and French Polynesia (Fossey, 2008 b). This modelling sometimes also used field study data sources, notably in Vanuatu, where experimental plots were set up in the Tagabe watershed.

Some erosion values set through this research

In Fiji, the results suggest potential erosion values of between 0 and 1,984 t/ha/yr; the mean value is 7.77 t/ha/yr, corresponding to a soil loss of 0.51 mm/sq m/yr; 81% of the pixels have a potential erosion rate of less than 10 t/ha/yr and mainly correspond to areas covered in thick vegetation (forest); only 2% of the area had potential loss values above 100 t/ha/yr, corresponding mainly to cropped zones (sugar cane) on steep slopes.

In Vanuatu (Efate), the results provided a fairly high range of potential erosion values of between 0 and 1,720 t/ha/yr, i.e. between 0 and 163 mm/yr. Mean soil loss is 8 t/ha/yr (0.75 mm/yr). Because of the concentration of human activities there, the coastline and especially plains and gently sloping areas, except for the north-west zone, had higher potential soil loss profiles with maximum values of 1,720 t/ha/yr. Despite having steeper slopes, albeit covered in dense forest, the island's central area, as well as the offshore islets to the northwest, seem to be healthy areas with particularly low values.

In New Caledonia, in the Voh-Koné-Pouembout area, the mean erosion rate is 137 t/ha/yr. Some 74% of the area studied had an erosion rate of less than 200 t/ha/yr. These zones are the least susceptible to erosion, and mainly correspond to floodplains and flat areas of the forested central range. The highest soil loss reading (6% of the area studied) at over 1,000 t/ha/yr is around the summits. This is the result of intense mining activity, heavy rainfall and the slope factor.

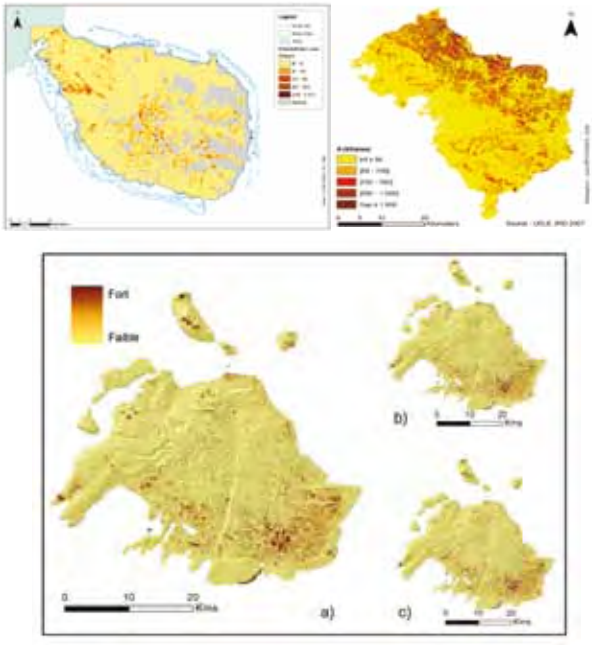


Figure 17a: Mapping Potential Erosion Risks in Tahiti Peninsula, Efate (Vanuatu) and New Caledonia (Voh-Koné-Pouembout)

Coral reef damage due to watershed use practices

In New Caledonia, research was conducted in Dumbéa Bay (Cedat, 2008), in order to develop a methodology for the integrated analysis of the impact of activities in a watershed on coral reefs. The ultimate goal would be to couple knowledge acquired on changes in the lagoon's physical and chemical parameters and on sensitivity thresholds of coral species for each parameter, with the erosion and transport models along the hydrographical system in order to define risk indices for the 'downstream' coral communities. This is a very preliminary approach requiring further development before it can be properly applied.

In Fiji, research on the reefs of Nakorotubu Tikina (Ra Province, island of Viti Levu), from observations on the reefs and sediment traps, clearly showed the impact of sedimentation on the health status of reefs, even those lying some way offshore (Comley, 2010).

Except for the final work concerning Fiji, all these initiatives were carried out by IRD Noumea.

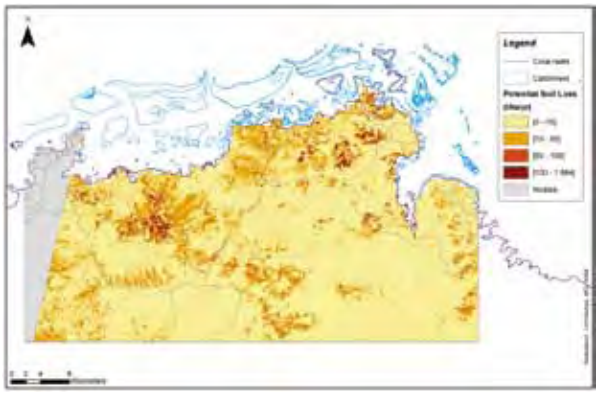


Figure 17b: Mapping Potential Erosion Risks in North Viti Levu (Fiji) using the USLE Model and a GIS (Component 1A, project 1A4), Julia Printemps, Septembre 2008.

Coral reefs and climate change

Two bibliographical reviews addressed the issue of the impact of climate warming on the coral reefs of the South Pacific. An assessment of the impact of water acidification on reefs was produced by Bernard Salvat, of the 'École pratique des hautes Études' (Practical School of Higher Studies - EPHE), a CRISP scientific adviser, in conjunction with Denis Allemand, an international expert working for Monaco Oceanographic Museum (Salvat et al., 2009). A bibliographical review addressed the impact of human-produced CO_2 on coral (Naudan, 2007). Also, Lo-Yat (2010) explored the consequences of extreme weather events on ocean productivity and fish larvae supply in tropical ecosystems.

Impact of water acidification on reefs (Salvat et al., 2009)
Any increase in atmospheric CO_2 induces an increase in the aqueous CO_2 dissolved in the oceans, leading to an increase in hydrogen ions and therefore a drop in pH. The carbonate ion concentration will then diminish. Since the calcification rate is usually correlated to this parameter, calcification will also decline in organisms with a calcareous test or skeleton, including coral. The risk of an excessive drop in calcium carbonate saturation level raises fears that dissolution factors, when associated with mechanical reef destruction and bio-erosion action on reefs, will reverse reef construction processes and replace them with dissolution. It is usually assumed that the atmospheric CO_2 concentration, currently 386 ppm, would have to remain below 450–500 ppm level to avoid such a situation. According to IPCC, however, such values are likely to be reached in less than 100 years. Various research directions should be developed in order to accurately gauge the effects water acidification has on coral species and especially physiological studies on coral and their symbiotic zooxanthellae in order to establish whether certain species have adapted.

Impact of extreme weather events on ocean productivity and larval supply in tropical ecosystems (Lo-Yat, 2010)
Between January 1996 and March 2000, remote-sensing data (sea surface temperature (SST) anomalies, surface current flows, Chl-a concentrations) were compared with monthly reef fish larvae supply trends in the coastal waters of Rangiroa Atoll (French Polynesia). The period covered El Niño events (April 1997–May 1998) and La Niña events (January–March 1996, August 1998–March 2000). During the El Niño event (high temperatures), an increase in the SST anomaly was observed (up to 3.5°C above mean values) and a reduction in strength of the western surface current towards the reef, coinciding with low Chl-a concentrations (0.06 mg m-3, SE 0,004) and a 51% drop in larval supply in comparison with mean values. Conversely, when La Niña conditions prevailed, the SST anomalies were almost 2°C under mean values, the westward surface current was strong, Chl-a concentrations were 150% higher than mean values and larval supply rose by 249%. Ocean warming will therefore have negative effects on reef fish reproduction and on the survival of their planktonic larvae, impacting ultimately on the reconstitution of benthic populations.

10.6 Traditional knowledge

CRISP carried out a range of work on customary knowledge and traditional management methods, with one of the objectives being to see how useful they could be for management of resources and marine protected area management and how these traditional practices could be transposed into modern law.

Ethno-biodiversity work on fish by R. Thaman aimed at compiling fishers' traditional knowledge. A list of fish vernacular names in the Navakavu language, in Fiji, was drawn up (226 names for 682 species of fish); this is the fruit of more than 10 years of collaboration between scientists of the University of the South Pacific and fishers of four villages of Navakavu Vanua on Viti Levu **(Thaman et al., 2008).** The results showed the extensive nature of local peoples' knowledge of the taxonomy, biology and ecology of various species of fish, but that this knowledge is being lost for various reasons, e.g. ageing fishers, loss in diversity, role of the market.

In New Caledonia, as part of a study conducted in 2006, the social and cultural roles of traditional environmental knowledge were researched in connection with community resource management on Ouvea (**Léopold et al., 2008**). Some 51 interviews were conducted with traditional leaders from various clans so as to gather knowledge about past and present fishing practices, maritime land rights, *tabu* areas and place names, traditional authorities, socio-cultural practices and beliefs relating to marine resources, and vernacular and taxonomic knowledge of marine organisms. This study also concluded that this knowledge is being lost. The authors suggested that greater recognition of relevant social and cultural aspects in resource management could contribute directly to raising awareness about resource depletion and the loss in biodiversity and assist with sustainable management of Melanesian ecosystems.

As part of the New Caledonia ERA, J.-B. Herrenschmidt worked in two locations in the Northern Province, i.e. the **Diahot River and Hienghène**. His work in these two areas covered a study of customary

social and territorial organisation, indigenous knowledge about biodiversity, and customary marine environment management approaches and practices. He concluded that the custom methods were not the same in these two areas. The former traditional management systems were well known but no longer active. The survey of these systems requested by some traditional leaders in the Diahot River area would, for example, make it possible to reformulate and adapt management systems. This would need to be accompanied by preliminary work to revive customary knowledge and practices, when they seem to be sustainable **(Herrenschmidt, 2006 and 2008).**

On **Ouvéa**, in the Loyalty Islands Province, a study on fishery organisation in the Mouli district was performed by IRD. It showed that more than 90% of the customary territory was maritime and that fishing was regulated by custom, e.g. permanent custom reserves, protection for the coconut crab and lobsters (see poster).

Key points

CRISP achieved substantial progress in knowledge about biodiversity in this region (see summary in inset on p.98): 14 unknown areas were prospected at more than 350 stations, and a total of several thousand species were described; several hundred species were new to the territories concerned and over 50 species are new to science. These results demonstrate the importance of continuing with the surveys, especially prospecting remote and deep-water areas. This work led to scientific collaboration projects between regional scientists; partnerships were established with the University of Fiji, in particular, but also with Australia, New Zealand and a number of universities in Europe. This made it possible to contribute to the collections of various museums (Paris, Brisbane) and the University of the South Pacific to acquire a herbarium.

Thorough mapping of the entire Pacific reef complex is nearly complete. Atlases for Papua New Guinea, Samoa, Tuvalu, Tonga, Vanuatu, New Caledonia, French Polynesia and Wallis and Futuna are already available; this task has revealed the extreme diversity of reef formations in the region, notably in New Caledonia, but especially in Papua New Guinea, which offers the greatest diversity so far observed in a single country (170 geomorphologic classes). In their role as essential management tools, mapping approaches have been developed as part of the Millennium Coral Reef Mapping initiative, using an identical approach for all the reefs of the region, making it possible to work on homogeneous geomorphologic layers, which are also useful for habitat description purposes; this approach has also helped to update reef surface area statistics.

A number of ecological studies on ecosystem functioning have yielded especially interesting and often novel results, with practical applications for management and especially for developing MPA networks:

- Various studies on connectivity and larval dispersal (Almany et al., 2007; Planes et al., 2009; Saenz-Agudelo et al., 2009), show that self-recruitment occurs on a bigger scale than previously thought but that larvae can disperse over long distances (up to 35 km, the greatest distance ever recorded for a species of reef fish) and supply adjacent reserves;

- Genetic research on the New Caledonia-Fiji-French Polynesia continuum show that the populations are genetically comparable on a small scale, while genetic differences are clearer on a large scale; it revealed high local connectivity between populations, in both continuous habitats and fragmented habitats. It demonstrated the importance of migrations, which alter the effects of genetic drift. For the first time in the marine environment, this work proved the positive correlation between species richness and genetic diversity (Swarup, 2008).
- Studies on the sounds produced by fish of the genus *Dascyllus* showed that they could also possibly be used to distinguish between species, populations and behavioural patterns (Parmentier et al., 2009, 2010);
- Work on sharks showed that, contrary to generally accepted thinking, demographic interaction with neighbouring populations is relatively limited and that some populations are isolated, particularly in fragmented environments.

All this work suggests that the spatial scales to apply in coral reef conservation work could be smaller than previous research suggested and sheds light on the tasks associated with developing marine protected areas.

The value of modelling for estimating the relative importance of the factors that influence functional diversity within communities was investigated (Mellin et al., 2008). Other work showed the importance of habitat on the composition of fish populations and here again the potential contributions of modelling (De Mazières, 2008; Saladrau, 2008).

Methods were developed to map land use and quantify hydrological processes and erosion problems.

Bernard Salvat and Denis Allemand produced an assessment of the impact of water acidification on reefs (Salvat et al., 2009): the risk of an excessive drop in calcium carbonate saturation raises fears that the dissolution factors, when combined with the mechanical actions of reef destruction and bio-erosion, will reverse reef construction processes and replace them with dissolution. Work by Lo-Yat (2010) on the impact extreme weather events have on ocean productivity and larval supply in tropical ecosystems suggested that ocean warming will have negative effects on reef fish reproduction and the survival of their planktonic larvae, ultimately impacting on the reconstitution of benthic populations.

Finally, CRISP also led to a better understanding of cultural and traditional aspects, indigenous knowledge and traditional resource management, particularly in New Caledonia, but also throughout the Pacific. Traditional management approaches still exist (*tabu* areas, temporary protection for species), but some research shows that the knowledge is being lost and that work is needed to revive such knowledge and former customary practices, where they are sustainable and the elders so wish (Herrenschmidt, 2006 and 2008, Léopold et al., 2008). A list of fish vernacular names in the Navakavu language of Fiji prepared by R. Thaman was the result of more than a decade of collaboration between USP and fishers from four villages of Navakavu Vanua (southeastern Viti Levu).

The main outcomes of biodiversity surveys carried out by CRISP

In 11 survey missions, 14 new and never previously explored regions in New Caledonia, Wallis and Futuna, and Vanuatu and deep-water and remote locations in Solomon Islands and Fiji were covered by fauna and/or flora surveys. More than 350 research stations thus revealed the richness of this region. Reference databases (geomorphologic characterisation and bionomic description) were developed for these different sites.

The focus was on coral and fish in New Caledonia and on algae and crustaceans in the rest of the region.

Our understanding of the coral of New Caledonia (Pichon, Lasne) has made great strides and the species richness of this country is now known with greater certainty through work by Pichon and Lasne. Some 401 species have now been entered on the updated list, making 100 new species for New Caledonia since the last full inventory carried out as part of the BIODEC biodiversity forum (2006). This richness in coral is close to that of Australia's Great Barrier Reef and could even equal it once all of New Caledonia has been surveyed. The collections of IRD have proved their usefulness and the collection of the French National Museum of Natural History (MNHN) has been augmented. These data on coral contributed to the completeness of the application for UNESCO World heritage listing, obtained in 2008.

The active marine substance bio-prospecting work carried out made a major contribution to knowledge on the marine flora of this part of the Pacific (Payri, N'Yeurt): 2283 specimens of algae collected and 419 species identified; 60% of the species described in Solomon Islands and 100% of the Vanuatu species were new for these countries, and 14 species that were new to science were described. Biogeographically, the work done in these various areas, representative of the organism dispersal gradient in the Pacific, in latitude (Melanesian ridge) and longitude (axis from New Caledonia to French Polynesia), made it possible to describe the continuum of algal flora in the Melanesian region, from Solomon Islands to Fiji, passing through Vanuatu, revealing the affinities in the marine flora of these zones, in the bio-geographical context of the Indo-Pacific region. Lastly, contributions from Mattio, Rohfritsch and Le Lann produced a revision of two major algae genera for the region, i.e. *Sargassos* and *Turbinaria*. Several thousand herbarium accessions were prepared and, as with coral, the collections of the Paris MNHN, the Museum of Brisbane (Australia) and of USP (Suva, Fiji) received new material. This major taxonomic work was given added value by 15 top-level scientific publications.

In addition to the work on seaweed, these bio-prospecting missions led to the identification of 169 species of marine invertebrates (essentially sponges and ascidians). In all, more than 30 species of sponges new to science were described.

Knowledge of crustaceans in New Caledonia and Wallis and Futuna was also improved (respectively 176 and 127 species described). A major publication was produced by Poupin and Junker for the South Pacific (223 species described and illustrated).

Fish were surveyed in northern New Caledonia (Allen, in Gabrié et al., 2008; McKenna et al., 2009; Wantiez et al., 2008 and 2010) and in Fiji. A species that is probably new to science was described. As part of PCC work, illustrated guides were produced on the fish larvae of French Polynesia (140 species) and young fish of Wallis and Futuna (70 species); ethno-biodiversity research made it possible to collect the traditional knowledge of Fijian fish names (local names for fish), but this knowledge is rapidly being lost.

Various studies focused on sharks (Werry, Clua, Séret, Buray): on the medium-range migrations of tiger and bull sharks (scale of New Caledonia) and also longer-range movements (New Caledonia-Australia) and on loyalty to location. They point to the importance of New Caledonia's lagoons for these species, the connectivity between lagoons and coastal habitats and the co-occurrence of these large species. The research suggests that New Caledonia could be a hibernation destination for the great white sharks of the South Pacific (Clua and Séret, *In press* a and c). Work on the changes to the behaviour of lemon sharks as a result of sharkfeeding revealed the risks that this activity poses for these species (Buray et al., 2009; Clua et al., 2010a and b). New protocols were tested and the economic value of these sharks in such feeding areas has been proposed as a new tool for the conservation of this species. The value of a shark, over its lifespan, is estimated at some USD5 million (Clua et al., in press b). Work on the genetics of the blacktip shark in French Polynesia shows that, in fragmented environments, the populations are genetically distinct. Five reports and four scientific publications were produced.

Research on cetaceans in New Caledonia (Garrigue) showed the importance of the lagoon for humpback whale reproduction. It also indicated a low level of demographic interaction with populations in neighbouring areas of Australia and the Pacific and the demographic and reproductive isolation of the population.

Bibliography

Sites

Andrefouet S., Chauvin C., Kranenburg C., Muller-Karger F., Noordeloos M. (2006). Atlas Des Récifs Coralliens de Sud-Est de la Papouasie-Nouvelle-Guinée (ouvrage bilingue), IRD/USF/NASA/WFC, 44 p.

Andrefouet S., Chauvin C., Kranenburg C. (2010). Atlas des récifs coralliens du Pacifique. IRD/USF/NASA/WFC, Accessible via ReefBase Pacifique http://pacificgis.reefbase.org/.

Clua E., Baudat J., Guarrigue C., Kinch J., Lasne G., Malcom F., Oremus M., Van Dijken S., Vieux C., Vignaud T., Wangunu N., Werry J., McKenna S.A. (2011). Contribution à l'inventaire biologique et à l'évaluation des ressources sur les récifs des Chesterfield, Mission CHESTER2010, 06–21 août 2010. Rapport de synthèse CPS/PROE, 160 p.

Gabrié C., Allen G., Bouilleret F., Downer A., Garrigue C., Géraux H., Herrenschmidt J.-B., Ody D., Petit M., Pichon M., Seguin F., Virly S., You H. (2008). Evaluation rapide de la Biodiversité et du contexte socioéconomique de la zone marine du Diahot-Balabio. Rapport WWF, 152 p.

Job S. (2009). Tuvalu marine life project. Synthèse bibliographique, 139 p.

Lasne G. (2010). Inventaire des coraux scléractiniaires du Grand Lagon Nord de la Nouvelle-Calédonie, Rapport CRISP, 124 p.

McKenna S.A., Baillon N., Spaggiari J. (2009). Rapid Marine Biodiversity Assessment of the Coral Reefs of the Northwest Lagoon, between Koumac and Yandé, Province Nord, New Caledonia. RAP Bulletin of Biological Assessment 53. Conservation International, Arlington, VA, USA. 148 pp. + 4 annexes.

N'Yeurt A., Payri C. (2007). Liste des algues de l'expédition SANTO 2006 (Vanuatu). 42 p.

Payri C., Petek S., Menou J.-L., Lasne G., Butscher J. (2007). Biodiversité et substances marines des Îles Fidji : Algues, Eponges, Ascidies, Echinodermes - Mission à Fidji, 07–27 mai 2007. Rapport de mission, IRD, 79 p.

Poupin J., Juncker M. (2008). Crustacés des îles Wallis et Futuna : inventaire illustré, espèces commercialisables et capture des formes larvaires. Rapport technique. 48 p.

Wantiez L., Sarramégna S. et Virly S. (2008). Communautés biologiques et habitats coralliens de la réserve intégrale Merlet. Province Sud de la Nouvelle-Calédonie, Aquarium des lagons. 77 p.

Wantiez L., Faninoz S., Bouilleret F., Gil O. (2010). État zéro des communautés biocénotiques avant la mise en place de zones de type I.B. Aire marine protégée de Yambé-Diahoué. Rapport technique UNC/WWF/Province Nord, 66 p.

Corals

Lasne G. (2007). Les coraux de la Nouvelle-Calédonie. Synthèse bibliographique, IRD, 93 p.

Lasne G. (2010). Inventaire des coraux scléractiniaires du Grand Lagon Nord de la Nouvelle-Calédonie, Campagne CORALCAL–III, 10–30 mars 2009. Rapport CRISP/IRD/Biocénose, 124 p.

Lasne, G. (2010). Inventaire des coraux scléractiniaires des atolls Chesterfield (barrières de l'Est et du Sud-Ouest), Nouvelle-Calédonie. Rapport scientifique, 60 p.

Pichon M. (2006a). Biodoversité des coraux scléractiniaires de la Nouvelle-Calédonie, Phase I : 04–21 mai 2006. Rapport de mission, IRD/EPHE/MNHN/Province Nord, 12 p.

Pichon M. (2006b). Biodoversité des coraux scléractiniaires de la Nouvelle-Calédonie, Phase 2 : 17 nov. – 12 déc. 2006. Rapport de mission, WWF/IRD/EPHE/Province Nord, 12 p.

Algae

Le Lann K., Kervarec N., Payri C., Deslandes E., Stiger-Pouvreau V., Discrimination of allied species within the genus Turbinaria (Fucales, Phaeophyceae) using HRMAS NMR spectroscopy. Talanta, 2008, Vol. 74: 1079–1083.

Mattio L., Taxonomie du genre Sargassum (Fucales, Phaeophyceae) en Nouvelle-Calédonie et dans le Pacifique Sud, Approches morphologique et moléculaire, Thèse de doctorat, Université Aix–Marseille II, 2008, 353 p.

Mattio L., Payri C.E., Taxonomic revision of Sargassum species (fucales, phaeophyceae) from New Caledonia based on morphological and molecular analyses, J. Phycol., 2009, 45(6): 1374–1388.

Mattio L., Payri C.E., Verlaque M., Taxonomic revision and geographic distribution of the subgenus Sargassum (fucales, phaeophyceae) in the western and central Pacific based on morphological and molecular analyses, J. Phycol., 2009, 45(5): 1213–1227.

Mattio L., Payri C., Verlaque M., De Reviers B., New insights on the classification of the Sargassum subgenus sargassum (phaeophyceae, fucales) from a three-DNA markers phylogeny and morphological analyses, 9th International Phycological Congress, Tokyo, Japan, 02–08 Aug. 2009, PowerPoint presentation, 31 p.

Mattio L., Payri C.E., Verlaque M., Reviers B., Taxonomic revision of Sargassum sect. Acanthocarpicae (Fucales, Phaeophyceae), Taxon, 2010, 59(3): 896–904.

N'Yeurt A.D.R. (2006). Liste des algues de l'expédition SANTO 2006 (Vanuatu). Post-doctoral research report, 42 p.

N'Yeurt A.D.R., Payri C.E., Grammephora peyssonnelioides gen. et sp. nov. (Rhodophyta, Rhodymeniaceae) from the Solomon Islands, South Pacific, Phycological Research, 2007, 55(4): 286–294.

N'yeurt, A.D.R., & Payri, C.E., Sebdenia cerebriformis sp. nov. (Sebdeniaceae, Sebdeniales) from the southwestern Pacific Ocean, Phycological Research, 2008, 56(1): 13–20.

N'Yeurt, A.D.R., Wynne, M. and Payri, C.E., Myriogramme melanesiensis sp. nov. and M. heterostroma sp. nov. (Delesseriaceae, Rhodophyta), two common species from the Solomon Islands and Vanuatu, University of Michigan Herbarium, 2007, 25: 213–224.

N'Yeurt, A.D.R., Wynne, M. and Payri, C.E., Four new species of Rhodophyceae from Fiji, Polynesia and Vanuatu, South Pacific, Phycological Research, 2009, 57(1): 12–24.

Payri C., Petek S., Menou J.-L., Lasne G., Butscher J. (2007). Biodiversité et substances marines des Îles Fidji : Algues, Eponges, Ascidies, Echinodermes, Mission à Fidji, 07–27 mai 2007. Rapport de mission, IRD, 79 p.

Rohfritsch A., Payri C.E., Stiger V., Bonhomme F., Molecular and morphological relationships between two closely related species, Turbinaria ornata and T. conoides (Sargassaceae, Phaeophyceae), Biochem. Syst. Ecol., 2007, 35(2): 91–98.

Sponges and ascidians

Debitus C., Payri C., Beurier J.-P. (2008). Biodiversity and bioactive compounds of Solomon Islands. Project report, 22 pp.

Payri C., Petek S., Menou J.-L., Lasne G., Butscher J. (2007). Biodiversité et substances marines des Îles Fidji : Algues, Eponges, Ascidies, Echinodermes, Mission à Fidji, 07–27 mai 2007. Rapport de mission, IRD, 79 p.

Crustaceans

Juncker M., Poupin J. (2009). Inventaire : Crustacés de Nouvelle-Calédonie (Décapodes & Stomatopodes). Rapport scientifique, 116 p.

Poupin J., Juncker M. (2008). Crustacés des îles Wallis et Futuna : inventaire illustré, espèces commercialisables et capture des formes larvaires. Rapport technique. 48 p.

Poupin J., Juncker M. (2010). Guide des crustacés décapodes du Pacifique Sud (ouvrage bilingue). Edition CRISP et CPS, Nouméa, Nouvelle-Calédonie, 320 p. 366 photos.

Fish

De Mazières J. (2008). Spatial distribution of reef fish communities: an investigation of the coral coast, Fiji Islands. Technical report, 115 pp.

Gabrié C., Allen G., Bouilleret F., Downer A., Garrigue C., Géraux H., Herrenschmidt J.-B., Ody D., Petit M., Pichon M., Seguin F., Virly S., You H. (2008). Evaluation rapide de la Biodiversité et du contexte socioéconomique de la zone marine du Diahot-Balabio. Rapport WWF, 152 p.

Gabrié et al. (2008). Analyse écorégionale marine de la Nouvelle-Calédonie. WWF, 104 p.

Guillemot N., Le Pape O., Léopold M., Kulbicki M., Jollit I., Chabanet P., Toward appropriate indicators to assess the impact of coastal fisheries on reef fish communities in New Caledonia, 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, PowerPoint presentation, 8 pp.

Job S. (2009). Tuvalu marine life project. Literature review. 139 pp.

McKenna S.A., Baillon N., Spaggiari J. (2009). Rapid Marine Biodiversity Assessment of the Coral Reefs of the Northwest Lagoon, between Koumac and Yandé, Province Nord, New Caledonia. RAP Bulletin of Biological Assessment 53. Conservation International, Arlington, VA, USA. 148 pp. + 4 annexes.

Saladrau W.R. (2008). Examination of the relationship between coral reef fish population and benthic habitats at Navutulevu. Technical report. 42pages.

Thaman R., Fong T., Balawa A. (2008). Biodiversity and ethnobiodiversity of finfishes of Vanua Navakavu, Viti Levu, Fiji Islands. Technical report, 54 pp.

Wantiez L., Faninoz S., Bouilleret F., Gil O. (2010). Etat zéro des communautés biocénotiques avant la mise en place de zones de type I.B aire marine protégée de Yambé-Diahoué. Rapport technique, 66 p.

Sharks

Buray N., Mourier J., Planes S., Clua E., Underwater photo-identification of sicklefin lemon sharks, Negaprion acutidens, at Moorea (French Polynesia). Cybium, 2009, 33(1): 21–27.

Clua E., Séret B. (In press a). Unprovoked fatal shark attack in Lifou island (Loyalty Islands, New Caledonia, South Pacific) by a Great White Shark, Carcharodon carcharias, American Journal of Forensic Medicine and Pathology.

Clua E., Buray N., Legendre P., Mourier J., Planes S., (2010.a) Behavioural response of the sicklefin lemon shark Negaprion acutidens to underwater feeding for ecotourism purposes. Marine Ecology Progress Series, 2010, 414: 257–266.

Clua E., Buray N., Legendre P., Mourier J., Planes S., Effects of provisioning on shark behaviour: Reply to Brunnschweiler & McKenzie (2010b), Marine Ecology Progress Series, 420: 285–288.

Clua E., Buray N., Legendre P., Mourier J., Planes S. (In press b), Business partner or simple catch? The economic value of the sicklefin lemon shark in French Polynesia. Marine and Freshwater research.

Clua E., Séret B. (In press c), The potential role of New Caledonia (South Pacific) as a tropical wintering ground for the white shark, Carcharodon carcharias, Proceedings of the International White Shark Symposium,. Hawaii, Ed. Michael Domier, Taylor & Francis Press.

Clua E., Séret B., Elements of ecology of the Great White Shark (Carcharodon carcharias) in New Caledonia (South West Pacific), International White Shark Symposium, Honolulu (Hawaii), 07–10 Feb. 2010, PowerPoint presentation, 22 pp.

Juncker M., Robert M., Clua E. (2006). Coastal shark fisheries in the Pacific. A brief overview of current knowledge. CRISP report, 38 pp.

Read T. (2009). Literature review on catching methods of tiger sharks (Galeocerdo cuvier) & white sharks (Carcharodon carcharias) around the world. Bachelor's degree training, The University of Queensland, 12 pp.

Read T. (2010). Mark-recapture of tiger shark (Galeocerdo cuvier) in New Caledonia: a photo-identification approach. Master intership report, Griffith University, 31 pp.

Thaman R., Fong T., Balawa A. (2008). Biodiversity and ethnobiodiversity of finfishes of Vanua Navakavu. Viti Levu, Fiji Islands. Technical report, 54 pp.

Vignaud T., Clua E., Mourier J., Planes S. (In press), Microsatellite analyses of reef shark populations in a fragmented environment indicates the need to adapt conservation strategies. Conservation Biology.

Werry J. (2009). Connectivity of Tiger (Galeocerdo cuvier) and other large shark species in the South Pacific: A focus on inter-connectedness of Great Barrier Reef Marine Park (Australia) and New Caledonia populations. Postdoc project, Griffith University, 12 pp.

Werry J., Clua E., Planes S. (2009). Large shark tagging programme in New Caledonia. Report mission SharkCal 02 (09–19 Jan. 2009) and 03 (08–17 Jul. 2009). Technical report, 11 pp.

Werry J., Clua E., Planes S. (2010). Large shark tagging programme in New Caledonia. Report mission SharkCal 04 (Southern Province, Jan. 2010) and 05 (Northern Province, Mar. 2010). Technical report. 15 p.

Crustaceans

Juncker M., Poupin J. (2009) Inventaire : Crustacés de Nouvelle-Calédonie (Décapodes & Stomatopodes). Rapport scientifique. 116 p.

Poupin J., Juncker M. (2008) Crustacés des îles Wallis et Futuna : inventaire illustré, espèces commercialisables et capture des formes larvaires. Rapport technique. 48 p.

Poupin J., Juncker M. (2010) Guide des crustacés décapodes du Pacifique Sud. Edition CRISP–CPS, Nouméa, Nouvelle-Calédonie, 320 p., 366 photos.

Cetaceans

Garrigue C., 2005. Analyse écorégionale : rapport sur les mammifères marins. Rapport interne pour le WWF, 54p

Ecology

Almany G., Berumen M., Thorrold S., Planes S., Jones G., Local Replenishment of Coral Reef Fish Populations in a Marine Reserve, Science, 2007, 316: 742–744.

De Mazières J. (2008). Spatial distribution of reef fish communities: an investigation of the Coral Coast, Fiji Islands. Technical report, 115 pp.

Mellin C. (2007). Sélection de l'habitat à l'installation et utilisation de l'habitat postinstallation chez les poissons récifaux-lagonaires de Nouvelle-Calédonie. Thèse de doctorat, Université Pierre et Marie Curie/Ecole Pratique des Hautes Etudes, 220 p.

Mellin C., Ferraris J., Galzin R., Harmelin-Vivien M.,Kulbicki M., Lison de Loma T., Natural and anthropogenic influences on the species richness of reef fish assemblages in the Tuamotu archipelago (French Polynesia), European Conference on Ecological Modelling, Trieste, Italy, 27–30 Nov. 2007, PowerPoint presentation, 16 pp.

Parmentier E., Kéver L., Casadevall M., Lecchini D., Diversity and complexity in the acoustic behaviour of Dascyllus flavicaudus (Pomacentridae), Marine Biology, 2010, 157 (10): 2317–2327.

Parmentier E., Lecchini D., Frederich B., Brie C., Mann D., Sound production in four damselfish (Dascyllus) species: phyletic relationships?, Biological Journal of the Linnean Society, 2009, 97: 928–940.

Planes S., Fauvelot C., Messmer V., Swarup S., Leray M., Tison J.-L., Absence of common geographic barriers across the indo-Pacific province for coral reefs. 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, PowerPoint presentation, 15 pp.

Planes S., Jones G.P., Thorrold S., Larval dispersal connects fish populations in a network of marine protected areas, Proceedings of the National Academy of Science USA, 2009, Vol. 106: 5693–5697.

Saenz-Agudelo P., Jones G.P., Thorrold S., Planes S., Estimating connectivity in marine populations: an empirical evaluation of assignment tests and parentage analysis at different spatial scales, Molecular Ecology, 2009, 18: 1765–1776.

Swarup S. (2008). Influence of fragmentation on the connectivity of populations of Dascyllus aruanus in three reef systems. Technical report, 34 pp.

Traditional knowledge

Herrenschmidt J.-B., 2008. Etude des usages de pêche à Arama (Province Nord, Nouvelle-Calédonie). Rapport interne WWF, 31 pp.

Herrenschmidt J.-B., 2006. Etude de sciences humaines appliquées à la gestion participative de l'environnement côtier marin dans les zones pilotes du Diahot et du Mont Panié (Province Nord, Nouvelle-Calédonie). Rapport interne, WWF, 41 p.

Léopold M., Herrenschmidt J.-B., Thaman R., The relevance of traditional ecological knowledge for modern management of coral reef fisheries in the South Pacific, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, PowerPoint presentation, 8 pp.

Thaman R., Fong T., Balawa A. (2008). Biodiversity and ethnobiodiversity of Finfishes of Vanua Navakavu, Viti Levu, Fiji Islands. Technical report, 54 pp.

11. Developing reef and resource monitoring

11.1 Monitoring reef health

CRISP has played an influential role in the area of regional reef health and resource surveillance: such work was supported in various parts of the Pacific, notably as part of GCRMN and Reef Check initiatives; partnerships were established to be able to monitor and report on reef health status, strengthen existing networks and rationalise methods. Extensive work was done on monitoring methods, new methods were tested and the methods already in use were compared.

Methods: GCRMN and Reef Check

GCRMN (Global Coral Reef Monitoring Network) is a worldwide coral reef health monitoring network. It was started in 1995 as an operational unit of ICRI (International Coral Reef Initiative), with the goal of encouraging countries to conduct simple but regular monitoring of their reefs in order to achieve better management, but, more especially, for the purpose of raising decision-makers' awareness.

In French Polynesia and the southwest Pacific, CRISP has been a major contributor to the GCRMN surveillance network since 2005 (Wilkinson, 2008). It provided key support to two Pacific networks, i.e. the southwest Pacific network with its Fiji-based hub, which comprises six countries (Vanuatu, Tuvalu, New Caledonia, Solomon Islands, Samoa and Fiji) and the central and eastern network, whose hub is in French Polynesia and which serves seven countries (Cook Islands, French Polynesia, Niue, Kiribati, Tonga, Tokelau and Wallis and Futuna). GCRMN's overall strategy is to involve monitoring specialists in each GCRMN node and to train personnel in each participating country in how to gather data on the health status of the coral reefs. Basically, there are two types of monitoring: ecological and socioeconomic. GCRMN currently uses several methods, as described in the guide on "Methods for Ecological Monitoring of Coral Reefs" by Hill and Wilkinson.

In addition to monitoring physical parameters, the network offers three interlinked levels of biological monitoring:

- a very simple monitoring approach using the Reef Check methodology (see below) and the services of volunteers (communities, divers, etc.);
- an intermediate level monitoring task by managers and scientists;
- an "expert" monitoring task performed by researchers.

These monitoring levels are of increasing complexity, involving very high numbers of parameters and taxa, from the family (simple system) to the species (scientific monitoring), from a small number of target species to all species, from a quick look at the nature of the bottom to the monitoring of the growth of coral colonies, etc.

The **Reef Check** network was started in 1997, with the goal of training local communities and enthusiasts (divers and others) in a simple standard method for monitoring reef ecosystems. In French Polynesia, the Reef Check programme was launched in 2000. In 2006, a partnership agreement was signed between CRISP and the Reef Check Foundation to help develop the project on that country.

Status of Coral Reefs of the World (Wilkinson, 2008)

Between 2004 and 2008, the world lost almost 19% of its coral reefs. Some 15% of the remaining reefs are under serious threat of disappearance over the next 10 to 20 years and another 20% are threatened with extinction within 20 to 40 years. These estimates were prepared without taking into account threats due to climate warming, nor the resources that might be found to efficiently conserve reefs and their resources. 46% of the world's coral reefs are however considered to be in good condition and not under immediate threat of destruction, except due to climate warming, the effects of which are not easy to assess at present.

Monitoring sites

GCRMN node for the central and eastern Pacific

Under CRISP arrangements, the status of coral reefs in **Fiji** was covered in a report in 2007. It related to results from monitoring work done between 2005 and 2006 and its comparison with the results obtained since 2000, when the FCRMN (Fiji Coral Reef Monitoring Network) was set up (Sykes, 2007; Lovell and Sykes, 2008). A total of 13 sites were monitored (see Fig. 18). For one of them (the Rotuma site), a specific monitoring operation was designed (Rotuma Coral Reef Conservation Project, RCRCP). The "Rotuma Island Coral Reef Survey" report contains the results obtained during the third monitoring visit in November 2006.

In March 2006, the GCRMN meeting in Fiji brought together 45 representatives of institutions, NGOs and governments, in order to identify the strategies needed to collect coral reef surveillance data and coordinate monitoring efficiently. It was also an opportunity to see how communication could be improved within the network and how the public at large could be informed about coral bleaching (Kaur and Swarup, 2006). Temperature monitoring was also introduced (see below).

French Polynesia has seven regular coral reef surveillance networks, which also monitor exceptional events such as coral bleaching or explosive growth of *Acanthaster* crown-of-thorns starfish populations (since 2006). CRISP has, in particular, breathed new life into the Reef Check network, which today can count on over 90 volunteers involved in the surveillance of 61 sites, located in 11 islands in the Society, Tuamotu and Austral island groups. Two reports address the state of development of the Reef Check network (Lagouy 2006; 2007) and a review of the network's activities was published in 2008 (Lagouy, 2008). In addition to coral reef surveillance, awareness-raising, communication and control work on the *Acanthaster* crown-of-thorns starfish was carried out.

Southwest Pacific GCRMN node

A report has summarised data from surveillance work in various areas forming the **southwest Pacific node** (Whippy-Morris, 2008 and 2009; Morris et al., 2008). In **New Caledonia**, 10 sites (31 stations) were monitored annually between 2003 and 2006 (see Fig. 19A). Many sites had already been established, but CRISP made monitoring possible in **Samoa**, (see Fig. 19B) at 10 sites; in Solomon Islands at 20 stations (see Fig. 19C); in **Tuvalu,** at six sites (see Fig. 19D) and in **Vanuatu** with 57 stations at 11 sites in various islands (see Fig. 19E).

Also, with CRISP's support, the two Pacific nodes, (Polynesia Mana and the southwest node) made contributions to the 2008 wilkinson review of the status of coral reefs in the world (Wilkinson, 2008). Trends in reef health from 2004 to 2008 were described and recommendations are put forward.

Trends in reef health status

Southwest Pacific GCRMN node

In Fiji, a massive coral bleaching event was observed in 2000, following a rise in sea surface temperature (Sykes, 2007; Lovell and Sykes, 2008). The coral cover showed significant losses during this event. From 2001/2002 onward, it began to expand again. In 2005, coral cover levels reached and even exceeded the figures recorded prior to bleaching. In 2006, reef health was good overall, in particular for deeper sites (over six metres). Coral cover was 40% on average. In comparison, the health of shallower reefs was not so good, except on Rotuma and Vatu-i-Ra where coral cover could reach 80%.

After more than nine years of monitoring, during a period including massive bleaching and explosive growth in *Acanthaster (*crown-of-thorns starfish*)* populations, the results show the remarkable resilience of Fiji's reef system.

In the other countries of the node, surveillance of the reefs of the southwest Pacific between 2003 and 2007 revealed a contrasting range of developments. Substrate

Figure 18: Map of sites surveyed in Rotuma (left) and Fiji (right)

cover showed positive or negative changes (due to local disturbances, natural predation on coral or natural disasters). On average, for the monitored sites, coral cover was 45% in Fiji, 27% in New Caledonia, 43% in Samoa, 30% in Solomon Islands, 65% in Tuvalu and 26% in Vanuatu. Monitoring over nine to 10 years in Fiji and New Caledonia indicated that these reefs have adapted well to stresses of natural and human origin, without any disastrous changes occurring. The earthquake and tsunami of April 2007 damaged the reefs and other coastal habitats of Solomon Islands. The most dramatic effect was the upraising of the reef flats and their exposure to the open air. The main human-induced disturbances are overfishing, pollution, sedimentation, eutrophication and coastal development.

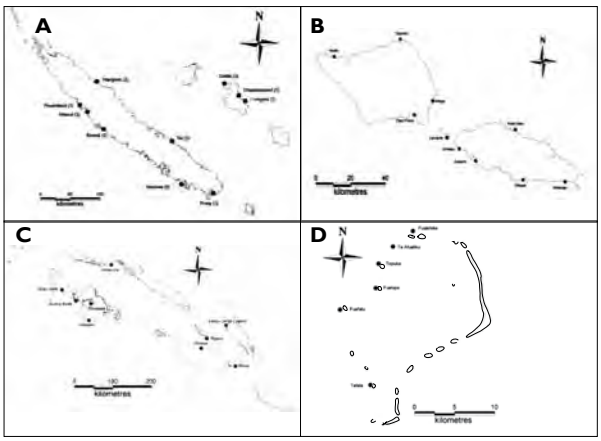
Central and eastern Pacific GCRMN node

The 2008 report (Vieux et al., in Wilkinson, 2008) showed that, overall, in this region, the reefs were in good health and under little threat because human population density was low; some reefs had, however, been damaged by natural events such as tropical cyclones in Niue and in Cook Islands, explosive growth of *Acanthaster* populations in French Polynesia and coral bleaching events in Kiribati; locally, human activities added to the pressures undergone by coral reefs.

CoReMo

All the data acquired over the monitoring period is sent to the Reef Base database managed by WorldFish Center (Reefbase.org), using an appropriate software package (CoReMo for **Co**ral **Re**ef **Mo**nitoring), developed by ARVAM (Reunion Island). http://www.coremo3.com/FR/PAGE_Presentation.htm).

CRISP facilitated the development of Version 3 of this software (CoReMo 3). This version was introduced in April 2009 and, through CRISP, benefitted from an international partnership with the WorldFish Center (WFC).



This version, which runs on Windows, offers simpler, more efficient and more standardised protocols for counting coral and other benthic fauna and fish populations. It allows individuals and institutions participating in coral reef monitoring programmes to make, record and modify data entries; perform basic analysis; display results in the form of tables or graphs; and include these in reports. It is also possible to export the data for safe storage in ReefBase at the WorldFish Center (Quod et al., 2010).

11.2 Resource assessment for fishery management and MPA monitoring

Underwater Visual Census (UVC) survey methods are those most commonly used for counting fish, in order to assess biodiversity or resource status and trends following exploitation. Various UVC methods can be used (e.g. dive surveys/observation from the surface transects, fixed points), at varying levels of detail and with consequent effects in terms of the cost and time needed. For that reason, scientists are today trying to develop better approaches (quality/effectiveness/cost).

The approach is increasingly an ecosystem-based one and the benefit of very closely associating fishers, along with other types of volunteers such as divers or students, in resource monitoring is being increasingly recognised; it is a low-cost data collection solution that makes it possible to step up sampling effort and frequency and is also a good way of involving stakeholders in management and educating them. Surveys, such as perception or consumer surveys, are also being tested. Some valuable research (Emmanuelli, 2006; Brenier, 2009; Léopold et al., 2009; Dumas et al., 2009; Hubert, 2008) reported on these participatory experiments, compared the various UVC methods and compared scientific approaches with participatory approaches, as well as with the perception fishers themselves have of trends affecting the resources they exploit. A number of workshops allowed interaction on these methods and provided training on monitoring methods to local communities and other concerned parties (Fiji, 2006 and 2008).

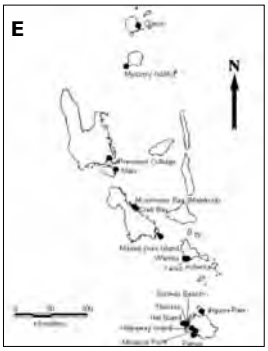


Figure 19: Map of sites surveyed in (A) New Caledonia, (B) Samoa, (C) Solomon Islands, (D) Tuvalu and (E) Vanuatu

Acquiring environmental parameters

In Fiji, temperature recorders have been installed at a number of sites since 1996. Bleaching events seem to coincide with high water temperatures over consecutive periods. Apparently, partial bleaching occurs most years, but only develops into a massive event when temperatures remain consistently high (29–29.5 °C) for more than 8 to 12 weeks. Weather conditions, including the number of tropical cyclones each year, annual rainfall and sunshine hours do not seem to have any direct connection with the intensity of bleaching events (Sykes, 2007; Kaur et al, 2006).

A network of temperature loggers was set up in the southwest Pacific in order to collect long-term data on the relationship between temperature and coral bleaching (Whippy-Morris, 2009).

Also, as part of efforts to improve the quality and quantity of data gathered by the Polynesia Mana node, CRISP invested €65,000 in the purchase and installation of six data acquisition probes for environmental parameters (temperature, sea level, dissolved oxygen, pH) in five countries of the central and eastern Pacific. The funding support also included technical supervision by CRIOBE.

In 2006, a joint IRD/USP workshop was held in Fiji in order to review the monitoring techniques in use and discuss their effectiveness (Comparison of Different UVC Methodologies for Assessing the Effect of MPAs on Reef Fish Abundance in Fiji, **2006**). The comparison related to data acquired during work done at Muaivoso, using four different UVC methods, i.e. the one FLMMA uses for community monitoring, the Reef Check method, the Akuila method and the one used by Coral Cay Conservation. The number of variables observed and their taxonomic level varied depending on the method used. The conclusions were that the FLMMA method is the most appropriate one, especially for detecting any significant differences between protected areas and exploited ones. The use of a long list of indicators, with high taxonomic complexity, at the species level, is often less productive for measuring MPA effectiveness in terms of fish abundance than a shorter list using a lower level of taxonomic resolution.

In Fiji, three UVC monitoring methods were compared on Navakavu, Viti Levu island **(Léopold et al., 2009),** and the perceptions of fishers were used to quantify resource abundance trends between 2002 and 2006 **(Hubert, 2008).** Two non-scientific approaches, one developed by divers from the village (five local target species) and the other developed by non-resident volunteers using the Reef Check method (nine target taxa from the list of fish of the Indo-Pacific), were cross-checked with the results of a full scientific study (all fish recorded at the species level in 12 families). The data obtained by the volunteers and scientists were consistent as regards abundance, but the Reef Check target taxa proved to be inappropriate for monitoring this marine area. On the other hand, the target taxa chosen by local fishers were appropriate but the census results were over-estimated and inaccurate.

The three methods reveal major differences between species richness and the overall abundance of certain species of fish (but not others) between the strictly protected area (NTZ) and fishing grounds, suggesting that the Navakavu NTZ is having a positive impact on fishery resources. Some of the results recorded by volunteers or members of the community are however, inconsistent with or even contradict those of the scientists, e.g. Lethrinidae and Mullidae abundance, as community members tended to exaggerate the differences between the two areas so as to demonstrate the effectiveness of their NTZ. The study also shows that the spatial variations between habitats had a very marked impact on the distribution of abundance within and outside the NTZ and that the choice of sampling strategy is an essential factor, in particular in a context of limited resources.

In Vanuatu, training in participatory monitoring was conducted in 2008 on the island of Emau (North Efate; Dumas et al., 2009a and b). The objective was to improve the techniques used by villagers, who have been involved in monitoring their reefs since 2006, and to secure relevant data for resource management. A field study was carried out in several villages on protected areas and unprotected ones (see Fig. 20), and four villagers took part. Underwater visual census (UVC) methods on fish and invertebrates were used and substrate cover was estimated by a photographic method. The results show that the resources have been relatively heavily exploited.

Figure 20: Map of survey stations on Emau Island

Whatever the site, the impact of *tabu* areas on the abundance of fishery resources was not observed (except for "Red-Mouth" at Wiana), but the monitoring was in all likelihood too spotty. In contrast, the effect of the Marow MPA was clearly visible for invertebrate populations, with large giant clams and trochus being more abundant within the MPA than outside it.

The study highlighted the importance of the time factor in MPA monitoring: the speed of the conservation response depends on the life strategy of the species (rapid effects for fast-growing and fast-maturing species, longer term effects for larger, slow-growth species like giant clams). The size of the MPA is also important: smaller protected areas such as Emau can achieve increases in stocks of species with small ranges or which are highly territorial. The *tabu* area could become more effective if it was more extensive. These results have helped in drafting very practical recommendations for future monitoring, especially in terms of methods, and simple measuring tools are proposed (see inset).

Recommendations for optimising monitoring by the local community in Vanuatu (Dumas et al., 2009):

For fish monitoring:

- Transects should be at least 50 m in length and should not be marked out on the bottom, in order to avoid disturbing the fish. Transect width (10 m minimum) should be adapted to suit visibility conditions. The swimming speed to be observed by divers should be determined in advance.
- Monitoring operations should be done at high tide.
- For each transect, two divers each focus on four of the eight target taxa, on either side of each transect. Divers should be trained in species identification and in estimating the size of the specimens concerned before the monitoring takes place.

For invertebrate monitoring:

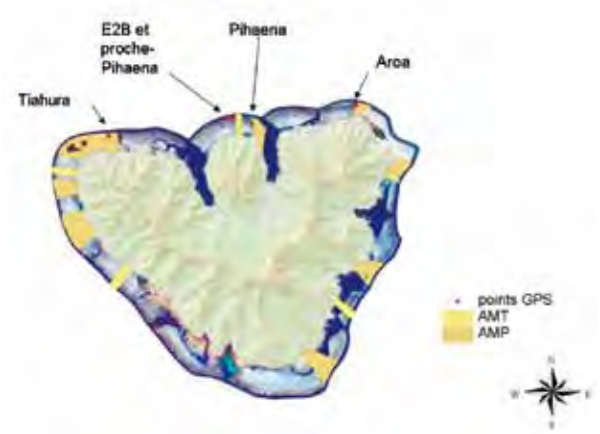
- Transects, marked out on the bottom, should be a minimum of 50 m long and 4 m wide.
- Where possible, monitoring work should be carried out at low tide.
- Specimen size and abundance are to be recorded by two divers per transect, with each one focusing on a 2 m 'corridor'. Special attention should be paid to complying with the corridor size requirement.

Monitoring programme design:

- Monitoring should draw on 5 to 10 permanent stations, inside and outside the *tabu* area, lying along the reef crest.
- It should be performed at least once annually and every six months if possible (hot and cool seasons).

Also in Vanuatu, fishery monitoring inside and outside an MPA was done as part of a study on the economic value of MPAs (Pascal, 2010). The results showed that the MPA did have an effect on fishing productivity, the size of catches or the sustainability of catch levels (see Chapter 8).

In French Polynesia, a monitoring protocol was set up for the MPAs on Moorea and involved student volunteers **(Emmanuelli, 2006**). Two visual census methods, i.e. the transect method and the "timed-swim" method, were used and compared so as to estimate biomass and species richness for key fish and invertebrate species in three MPAs and two control sites (see Fig. 21). Important differences between the methods emerged and the conclusions suggested three important points to consider in order to improve the protocol, i.e. have an appropriate list of key species for the volunteers, add a simple size indicator (small/large) for the fish census and couple a socio-economic study on fishing effort to the biological monitoring procedure.



In his dissertation, Brenier wondered about the relevance of participatory approaches for ecosystem-based monitoring of reef fisheries (**Brenier, 2009**). While this approach is now being increasingly used, some scientists are querying the validity and reliability of data collected by non-professionals and their relevance for resource status monitoring. A protocol was developed and tested at three contrasting sites (Moorea and Tikehau in French Polynesia and Tulear in Madagascar), involving a range of complementary approaches: continuous monitoring of catches, periodic visual censuses by volunteer divers or fishers as well as consumer and fishing activity surveys by schoolchildren within fishers' families (see inset).

The study concluded that participatory approaches can be relevant for ecosystem-based monitoring of reef fisheries and that scientifically valid data can be obtained. The limiting factors are the availability of volunteers and their commitment to long-term involvement. The involvement of volunteers is relevant for collecting data during occasional large-scale sampling projects but less clearly beneficial for ongoing data collection over long time scales; such work requires almost constant attention and supervision. Community involvement prior to the data collection phase and small-scale demonstrations of the value of monitoring activities are essential, as are the dissemination of and capitalisation on the results. The benefit of participatory approaches lies mostly in the awareness raising and education offered to civil society in regards to environmental conservation issues.

An original assessment approach (Brenier, 2009).

A questionnaire was distributed and explained in school classrooms. Its purpose was to gather general information on fishing activities and, household fish consumption, plus the name, size and number of fish consumed at meals taken over the past three days. The last part of the questionnaire addressed fishers in those households so as to record their fishing activity. Students had the responsibility of completing the questionnaire at home and bringing it back to school a few days later.

In Fiji (at Navakavu), fishers' views were used to quantify resource status trends (yields, mean size) between 2002 and 2006 (**Hubert, 2008**). The study showed that the use of fishers' views only reveals marked resource status trends; in particular those concerning the most exploited fish at the time of the interview. This perception also varies depending on the gear type under consideration.

New methods

Video-based fish census methods: in New Caledonia, a rotating video system was developed; the technique uses a fixed, rotating video system, in mono mode (a single camera), not baited and deployed at shallow depths (up to 20 m) (see Fig. 22). The rotating motor allows the camera to rotate over 60° every 30 seconds. A complete rotation is therefore made in three minutes and comprises six segments corresponding to the camera's static shot position between every 60° rotation. A methodological guide described how the system operates (Guilpart et al., 2008).

Three video techniques were compared with a view to assessing the resources and biodiversity of reefs and lagoons in New Caledonia (Pelletier & Leleu, 2008). The first technique involved rotating video cameras used at static stations, in most cases without bait. In the second technique, transects were investigated by divers to determine the spatial variability between observations and to obtain a quantitative comparison with visual counting methods. In the third technique, a towed video system was set up, offering better spatial cover. The study concluded that these video methods were beneficial, easy to implement, did not require high-level expertise in the field and came at a reasonable cost. The images offered a large volume of information, with extensive spatial cover and high observability of fish aggregations and habitats.

Figure 22: Rotating video system

Identification at a species level in environmental studies requires the attention of specialists; these studies are therefore relatively costly. An original piece of research **(Jimenez et al., 2010)** addressed the use of **taxonomic levels higher** than the species level (genus, family, class or phylum), to characterise invertebrate communities of different habitats (seagrass or coral bottoms) and detect their reactions to exploitation. The results showed that the family level is a good descriptor for the composition of invertebrate communities; however, the use of a high taxonomic level depends on the habitat and should be applied with caution when the goal is to detect changes in these communities as a result of exploitation: on soft habitats, genus and family proved adequate; on coral habitats the species level was still required.

Work was carried out in Fiji to try to find a method that could be a more robust and reliable alternative to UVC. Funded in part by CRISP, the approach was based on fishers themselves recording **catch per unit effort (CPUE)** in a fishing log. It was tested on some 60 communities; data (see Fig. 23) from more than 3,000 fishing trips and 250,000 fish and invertebrates

Figure 23: CPUE survey in Fiji

are available and the results are highly revealing (see inset). One of the main drivers of the success of the CPUE survey was direct community participation. The results were shared with them in a briefing in the local language. Monitoring procedures within the Fiji LMMA network are under review. A multi-level monitoring system is being considered (community perception, standardised data collection by means of methods such as CPUE surveys and scientific research). In future, CPUE surveys will probably be used in 15 villages and make it possible to compile long-term time series. (Comley in "Reef Fisheries Management in the Pacific: Success stories", ICRI flyer. Village-based catch survey in Fiji).

Results of CPUE-based research in Fiji (Comley)

The results confirmed that coastal fishing in Fiji is under threat. Of the two most commonly targeted fish families, 74% and 88% of catches involved specimens that have not reached their adult size. Also, an increasing proportion of these catches is being sold (70% of the fish and invertebrates caught during the survey went to market despite laws prohibiting such sales). Further research in the no-take zones (NTZ) suggested that they contain large numbers of mature adult breeding specimens (Clements et al., In prep.) and so are of crucial importance in ensuring the stability of fisheries resources.

Catch assessment through **fish consumption surveys** is another method that is sometimes used. The accuracy and introduced bias in fish consumption estimates from household surveys were assessed in a study relating to Haapiti (Moorea, French Polynesia) (Gilbert et al., 2007).

11.3 Indicators

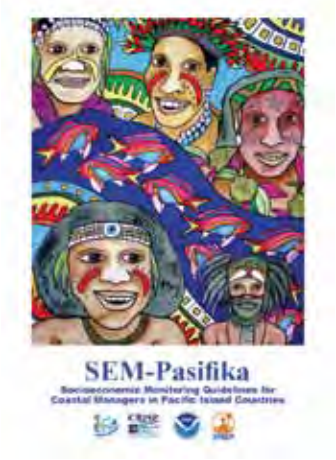
A workshop was held from 10 to 14 April 2006 in Suva (Fiji) in order to share progress and knowledge on indicators after the first year of the CRISP programme and to identify the problems encountered (Kaur & Emmanuelli, 2006). More specifically, the objectives were to discuss the use of indicators in assessing the health of coral reefs and fisheries.

Data collected in Tonga between 2001 and 2002 were used to test the theory of dominance reversal in the Scaridae family (parrotfish) **(Clua & Legendre, 2008)**. Against the background of interspecies competition within the Scaridae family, the stress associated with fishing seems to be a factor favouring the replacement of species with larger-sized specimens and life features that favour low resilience by species offering the opposite kind of attributes. For reef fishery management purposes, the **density of resilient species,** which increases with fishing pressure, could be used as an indicator of the degree of over-exploitation of reef fish communities.

Emmanuelli turned his attention to indicators (**Emmanuelli et al., 2007**) based on an analysis of CRIOBE's historical data on the MPAs in the Moorea 'PGEM'. These data came from monitoring carried out using the BACIPS (Before After Control Impact Paired-Series) method every six months for four years, since 2004, before and after the establishment of the MPAs, at 39 stations distributed over a range of habitats, both inside and outside the MPAs. The goal was to define a baseline status for fish populations and statistically study changes and variability so as to identify relevant and useful indicator species for monitoring by managers (see indicators).

Based on all the resource surveillance and monitoring activities carried out as part of CRISP, a summary guide concerning indicators is due for publication and will be downloadable over Internet. It comprises 20 individual sections (10 method sheets, 10 indicator sheets) highlighting practical considerations, illustrated by CRISP programme activities in various South Pacific island countries ("A Practical Guide to Coral Ecosystem Assessment and Monitoring Indicators: collecting, analysing and interpreting data on the health status of coral reefs and fisheries; application in islands of the South Pacific" – Ferraris et al., 2011).

11.4 Socio-economic monitoring



Biological monitoring procedures for coral reefs were developed in the 1990s. Only very recently, at the same time as the GCRMN was being implemented, has socio-economic data monitoring been developed at a worldwide scale, in order to report not only on the scale of coral environment exploitation but also the changes in these uses as a result of changes in the health status of coral reefs.

In a way that closely complements biological monitoring, socio-economic monitoring looks at the social, cultural and economic conditions experienced by the communities living close to an MPA. Its aim is to understand how the community uses, perceives and interacts with the MPA and assess the scale of their resource dependency. It should enable managers to determine which stakeholders play a determining role in resource management. The goal is also to measure the benefits provided to communities by MPAs.

The most widely used socio-economic monitoring method in MPAs today worldwide is the SocMon approach (Global Socioeconomic Monitoring Initiative for Coastal Management). Introduced by GCRMN, SocMon is a local-scale monitoring programme (on one MPA, for example) aimed at gaining a better understanding of the human dimension of marine and coastal resource use. The method is implemented over a number of phases: preparatory activities (defining objectives, selecting variables, identifying survey sites and stakeholders), survey planning, collection (bibliography and interviews), data analysis, and finally communication and adaptive management. The socio-economic parameters collected are many in number (52 in the Indian Ocean, for example) and depend on the MPA's situation and the relevant objectives.

CRISP provided support to adapt the SocMon method to the special characteristics of the South Pacific, which resulted in the SEM-Pasifika method. A SEM-Pasifika guide was issued for managers (Wongbusarakum & Pomeroy, 2008). It supplies the tools needed for monitoring and offers a descriptive list of the various indicators (53) to consider, referring to other existing methods (e.g. SocMon, FSPI methods). Training in the method has been developed for managers. A training-for-trainers event took place in Sunalailai (Papua New Guinea) as part of a workshop on socio-economic monitoring approaches in the Pacific region (Vieux, 2008).

Socio-economic monitoring projects were also conducted in Vanuatu, under the GERSA project (see Chapter 4) and in Fiji, where a survey was conducted on the socio-economic activities of Navutulevu in a context of PCC (see relevant section). Over 30% of families were questioned (Cavakigali, in Lecaillon, 2008 – see inset below).

Navutulevu socio-economic study (Fiji)

- The village's main resources are fishing (50%), the hospitality sector (30%), livestock farming (15%), handicrafts (5%), and other areas (5%);
- For over 80% of the population, fishing is one of the three main income sources;
- The most active fishers are between 20 and 35 years of age and 40% of them possess knowledge about the life cycle of the species they fish for, e.g. breeding period, period of abundance;
- 95% of catches are sold, with only 5% being used for subsistence purposes;
- Nearly 40% of the population are unemployed and 75% are children or young people;
- The main problems villagers have to cope with are, in order of decreasing importance, natural hazards (35%), the cost of transport (20%), disputes between clans (15%), and lack of opportunities (13%);
- The main expenditure items are, in order of decreasing importance, food, education and electricity.

11.5 Workshops for general discussion and training in surveillance methods

The topic of coral reef and reef resource monitoring was covered in many events:

- Two workshops to **address methods** in Fiji in 2006: on GCRMN and monitoring strategies in Fiji (March) and on the comparison of different monitoring methods (December);
- A workshop in Fiji in 2006 on **indicators**;
- Various meetings to formulate and disseminate **SEM-Pasifika.**

The USP Institute of Marine Resources, in conjunction with WRI (World Resources Institute) and ICRAN (International Coral Reef Action Network), held a three-day workshop on current threats to coral reefs "Reefs at risk" (www.wri.org/project/reefs-at-risk) (Fiji, March 2009). Funded in part by CRISP, the event brought together 32 experts belonging to 20 local

and regional organisations in the Pacific, to present and discuss the method and its application in the Pacific (see main conclusions in inset).

Main conclusions of the "Reefs at risk" workshop (2009)

- The principal hazards to which Pacific reefs are exposed are: fishing-related hazards, land-based hazards, marine pollution, coastal development, invasive species, climate change, overpopulation, diseases, predation, military activities and the disappearance of traditional management practices;
- The Pacific region has a unique geomorphology which should represent a more important factor in hazard modelling; in particular, more attention should be paid to the substantial differences between volcanic islands and atolls, the diverse nature of soils and the open or closed configuration of atolls;
- Climate hazards are an important section of the report; the results from some preliminary modelling of past and future events linked to heat stress should, however, be refined to take into consideration their frequency and severity and adjusted to account for temperature variability in the past.

CRISP also facilitated capacity-building efforts, through numerous training courses:

- Training in **resource monitoring** (Fiji, December 2006).
- A training session for **GCRMN** southwest Pacific node coordinators (12 to 16 November 2007). Representatives from Solomon Islands, Samoa, Vanuatu and Fiji attended the event. The objective was to train coordinators in data analysis using the MS-Excel software and reef monitoring database creation using MS-Access. The event is described in the Yakub report (2008).
- In French Polynesia, more than 90 volunteers have been trained in the **Reef Check** method since 2006, during 15 training courses. Lagouy (2006) has reported on these courses, from volunteer identification to result dissemination and including the Reef Check international database, as well as classroom and practical training in the method.
- Training in the use of the **CoReMo** software package; training was offered to trainers in September 2009 in Samoa.
- Training in the **SEM-Pasifika** method.

In 2008, another workshop on ecology and census methods, held under the auspices of CRISP, was held from 15 to 19 September 2008 in Suva, Fiji, directed by teams from USP and IRD (Nouméa). It was organised in two parts: a seminar on the ecology of coral reef marine organisms and fishery resource survey methods, and another component offering practical training in Muaivuso village, focusing on fish size estimation inside and outside MPAs, with recent habitat description and monitoring techniques and the application of new marine organism sampling methods. It brought together some 50 participants for the seminar, and around 40 for the practical field work.

Considerable 'hands-on' training was also provided to local communities as part of monitoring efforts in LMMAs and MPAs.

Significant support was provided to scientists to be able to present the results of monitoring work at various symposia (see relevant paragraph).

Key points

CRISP's supporting role within GCRMN and Reef Check activities was a determining factor: it made it possible to maintain the southwest Pacific node, based in Fiji and comprising six countries; to support the central and eastern Pacific node (Polynesia Mana) based in French Polynesia, with its seven member countries; and to give fresh vigour to the Reef Check network in French Polynesia. The latter was given a high profile in 2008, thanks to actress Isabelle Adjani, its sponsor.

Through this support, the nodes concerned were able to make contributions to the 2008 book on the status of coral reefs in the world (Vieux in Wilkinson 2008; Whippy-Morris, 2008 and 2009; Morris et al., 2008). A GCRMN meeting in Fiji in 2006 assembled 45 participants to talk about methods (Kaur & Swarup, 2006). In addition to the GCRMN reports, specific reef health assessments were produced for Fiji (Sykes, 2007; Lovell and Sykes, 2008) and French Polynesia (Lagouy 2006, 2007, 2008). These reports stated that, in general, the reefs of the Pacific are in good health. Various bleaching events plus explosive growth of *Acanthaster* (crown-of-thorns starfish) and tsunamis occurred in the region over the period and these reports enabled us to gauge their impact on reefs and to assess rehabilitation. Work in Fiji, for example, after the 2000 bleaching, showed that the reefs have recovered remarkably well and are healthy today. These results revealed the remarkable resilience of Fiji's reef system. In French Polynesia also, the results obtained by Reef Check show that reef health is stable or has improved, even if significant events have hindered this regeneration locally (A*canthaster* population explosion). In the South-west Pacific, contrasting changes have occurred.

CRISP also made a contribution to the development of a software package for coral reef monitoring, i.e. CoReMo, facilitating its adaptation to the monitoring protocols adopted

in the South Pacific; this allowed the results to be included in the WorldFish Center regional database and to provide training to regional stakeholders in how to use this package. Another outcome was the installation of a network of temperature recorders for Polynesia Mana.

Fishery resources are of vital importance in this region but are often reported as being in decline. The CRISP Programme has been an opportunity to carry out very useful work on surveillance methods for fishery resources affected by fishing. The various visual census methods in common use were compared, and new methods were tested: video methods (Guilpart et al., 2008; Pelletier & Leleu, 2008), CPUE (Comley), use of different taxonomic levels (Jimenez et al., 2010), and new indicators such as the density of resilient species (Clua et al., 2008). Participatory monitoring and user perception methods, in increasing use, were compared to more scientific methods to determine their validity (Emmanuelli, 2006; Brenier, 2009; Léopold et al., 2009; Dumas et al., 2009a and b).

Some major conclusions can be drawn from this research:

- It showed the benefit of fisher participation,which requires long-term support;
- All the research acknowledged the value such participatory approaches have in raising awareness, building capacity and empowering management by local communities;
- It suggested that while communities frequently have the perception that the LMMAs yield benefits, scientific studies, especially on landings and catch per unit effort, are less conclusive;
- There was some consensus in the research to say that the list of target species to be monitored should be carefully chosen together with fishers, and that the Reef Check lists do not always match local-scale monitoring needs; there was also convergence on the need to use simple size measures (large/small);
- It demonstrated the value of simple methods: use of a very simple size measurement system and limited target species list, with a lower taxonomic resolution level that can be just as effective as a larger number of species monitored at species level. An original approach to taxonomic levels has shown that the use of levels higher than species is possible so as to describe invertebrate communities (family level), but may be less appropriate for describing the trends recorded in these communities when they begin to be exploited;
- It showed that the spatial variability of habitats has a major impact on the distribution of fish abundance and that a sampling strategy is essential, in particular against a background of limited resources.

Reefs and resource status assessment methods, which scientists have been working on for many years, have still not been harmonised and method testing continues, producing a range of recommendations.

Studies have also shown that fishing pressure was visible on almost all grounds where research had been carried out, that fish is being used less and less for subsistence purposes and is increasingly being sold, and that the impact of MPAs on the resource varies according to group and species; at Navakavu for example, the three methods tested revealed major differences in the species richness and overall abundance of certain fish species (but not others) between areas that are strictly protected (NTZ) and fishing zones (Léopold et al., 2009). In Vanuatu, Dumas noted no impact of *tabu* areas on fish (monitoring probably too infrequent), while N. Pascal, in a year-long study, showed that CPUEs are higher in areas with MPAs than elsewhere. The issue of the functioning of small MPAs was raised: do they really create biomass or do they just aggregate biomass in the same way as a FAD?

While biological monitoring of coral reefs was developed in the 1990s, only very recently, at the same time as the GCRMN initiative, did socio-economic data monitoring begin on a worldwide scale (SocMon method), both to explain some of the results from biological monitoring and to measure the impact that changes in reef health have on human populations. CRISP supported work to adapt the SocMon method to the special characteristics of the South Pacific, and this resulted in producing the SEM-Pasifika method. A SEM-Pasifika guide was prepared for marine and coastal area managers of the Pacific region (Wongbusarakum & Pomeroy, 2008) and training in the relevant methods was held.

With CRISP input, then, this area of work made great strides; in addition to field work, many discussion workshops on methods were held and productive capacity-building work was done at six training workshops. The Coral Reef CSI (Crime Scene Investigation) method was introduced in the Pacific. A close partnership was developed with Fiji and the University of the South Pacific, in particular; and also with the Vanuatu Fisheries Department, and this partnership is expanding beyond CRISP.

Bibliography

Corals reef monitoring

Bargetto J. (2008). Élaboration d'un système d'information sur les récifs coralliens accessible sur Internet, Réalisation des modules d'import et d'export des données. Rapport technique, IRD/SUPINFO, 38 p.

Chancerelle Y., Gulko D., Lison de Loma T., Planes S. (2009). Coral Reef Crime Scene Investigation (CSI) workshop, Moorea, French Polynesia. Final Report, UMS 2978 CNRS–EPHE, RA: 13 pp + 3 pp annexes.

Comley J, Vave R., Cakacaka A., Meo S., Tawake A. (2006) Comparison of different UVC methodologies for assessing the effect of MPAs on reef fish abundance in Fiji. CRISP/USP/IRD Workshop report, 21 pp.

Gulko D., Goddard K., Ramirez-Romero P., Brathwaite A., Barnard N. (2009). Manuel de police scientifique appliqué aux récifs coralliens – Un guide pour les gestionnaires et enquêteurs en milieu corallien. Support de formation CSI, ICRAN/NOAA/ICRI/USA Department of State, 282 p.

Kaur D., Emmanuelli E. (2006). Using indicators to assess coral reefs ecosystems and fisheries health. Workshop report, IRD/USP/EPHE/CNRS, 57 pp.

Kaur D., Swarup S., MacKay K., Morris C. (2006) Global Coral Reef Monitoring Network (GCRMN) Fiji review and planning meeting – WWF Coral bleaching rapid response meeting. Meeting report, 51 pp.

Kirata T., Vieux C., Clua E., Monitoring activities in Kiribati 2005; Comparison of results with 2004, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presentation.

Lagouy E. (2006) Développement du réseau Reef Check Polynésie française. Rapport d'activité 2006, Reef Check, 143 p.

Lagouy E. (2007) Développement du réseau Reef Check Polynésie française. Rapport d'activité 2007, Reef Check, 28 p.

Lagouy E. (2008) Bilan des activités du réseau Reef Check Polynésie française. Rapport d'activité 2008, Reef Check, 29 p.

Lagouy E., Reef Check Polynesia, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, Poster.

Lagouy E., Reef Check Polynesia coral reef monitoring network, 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, PowerPoint presentation, 6 pp.

Lovell E., Sykes H., Rapid recovery from bleaching events, Fiji Global Coral Reef Monitoring Network (FGCRMN) assessment of hard coral from 1999–2007, 11th International Coral Reef Symposium, Fort Lauderdale, 07–11 Jul. 2008, PowerPoint presentation, 31 pp.

Lovell E., Sykes H., Bonito V., Kahn Z., Quinn N., In-situ monitoring of sea temperatures in Fiji – An archipelago-wide monitoring programme, 11th International Coral Reef Symposium, Fort Lauderdale, 07–11 Jul. 2008, Poster.

Mackay K., Coral Reef Monitoring in a Sea of Islands: Lessons from the Southwest Pacific node of the GCRMN, 3rd International Tropical Marine Ecosystems Management Symposium, Cozumel, Mexico, 16–20 Oct. 2006, PowerPoint presentation, 27 pp.

Mackay K. T., Whippy-Morris C., Sykes H., Are we measuring the Correct Parameters in Coral Reef Monitoring ?Lessons from the Southwest Pacific node of the Global Coral Reef Monitoring Network, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presentation, 35 pp.

Mackay K. T., Whippy-Morris C., Coral reef monitoring in the South West Pacific 2007, 11th International Coral Reef Symposium, Fort Lauderdale, 07–11 Jul. 2008, PowerPoint presentation, 36 pp.

Morris C. (2008). Reef monitoring in Solomon Islands, 30 Jul. – 10 Aug. 2007. Mission report, GCRMN/USP, 7 pp.

Morris C., Mackay K., 2008 Status of coral reefs in the South West Pacific (Fiji, New Caledonia, Samoa, Solomon Islands, Tuvalu and Vanuatu), 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, Poster.

Pannetier P. (2010). La microflore dans des coraux présentant différents types de lésions ou maladies (Lagon néo-calédonien). Rapport de stage, IUT Brest, Université de Bretagne Occidentale, 60 p.

Quod J.-P, Salvat B., Bissery C., Terrasson S., Caugant G., Lacouture P., Raude M. (2010). CoReMo 3 Suivi de l'état de santé des récifs coralliens – Manuel de l'utilisateur, ARVAM, 66 p.

Reytar K., Burke L., Spalding M., Perry A, South R., Morris C. (2009). Compte rendu du séminaire océanien sur le projet "Reefs at Risk Revisited", IAS–USP, Suva, Fiji, 16–18 mars 2009. Rapport d'atelier WRI/ICRAN/WFC/ReefBase Pacifique/USP, 20 p.

Salvat B., Allemand D. (2009). L'acidification et les récifs coralliens – Synthèse bibliographique (document trilingue) CRIOBE/Centre Scientifique de Monaco, 32 p.

Salvat B., Coral reef monitoring in French Polynesia: Objectives, management and results, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presention.

Shah S.B. (2008). Study of heavy metal accumulation in Scleractinian corals of Viti Levu, Fiji. Master thesis, University of the South Pacific, 176 pp.

Shah S., Lovell E., Heavy metal accumulation in Scleractinian corals of Fiji Islands, 11th International Coral Reef Symposium, Fort Lauderdale, 07–11 Jul. 2008. Poster.

Sykes H. (2007). Status of Coral reefs in the Fiji Islands, 2006. GCRMN/USP/Reef Check Fiji, 65 pp.

Sykes H., Lovell E.. "A Cause for Optimism": Identification of threats and resiliency on Pacific reefs through establishment of a long term reef monitoring network in Fiji: The Fiji Coral Reef Monitoring Network (FCRMN), 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, Poster.

Sulu R. (2007). Status of coral reefs in the Southwest Pacific. GCRMN/USP/C–SPOD, 274 pp.

Tribollet A., Aeby G., Work T., Maladies coralliennes en Nouvelle-Calédonie, (2010) Présentation PowerPoint, 6 p.

Tuxson T. (2007). Rotuma island (Fiji) coral reef survey report, 08 Nov. – 07 Dec. 2006. Survey report, USP/GCRMN, 15 pp.

Vieux C. (2005a, 2005b, 2005c). Establishment of a coral reef monitoring program in Tokelau, Niue and Kiribati. CRISP mission reports, 24 + 19 + 3 pp.

Whippy-Morris C. (2009). South-West Pacific status of coral reefs report 2007. Rapport USP/GCRMN, 215 pp.

Wilkinson C. (2008). Status of coral reefs of the world: 2008. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia, 296 p.

Yakub N. (2008). South West Pacific node Reef monitoring training, 12–16 Nov. 2007. Report, 11pp.

Reef resources monitoring

Brenier A. (2009). Pertinence des approches participatives pour le suivi écosystémique des pêcheries récifales. Thèse de doctorat, Université Pierre et Marie Curie – Paris VI, Université de Tuléar – Institut Halieutique et des Sciences Marines, 225 p.

Brenier A., Ferraris J., Galzin R., Community-based monitoring of coral reef fish resources in two contrasted islands of French Polynesia, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presentation,13 pp.

Brenier A., Mahafina J., Ferraris J., Galzin R., Relevance of participatory approaches for ecosystemic monitoring of reef fisheries, 2nd International Marine Protected Areas Conference, Washington D.C., USA, 19–24 May 2009, PowerPoint presentation, 15 pp.

Clua E., Legendre P., Potential indicators of the status of reef fisheries based on the shifting dominance phenomenon among scarid species submitted to fishing pressure, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presentation,14 pp.

Clua E., Legendre P., Shifting dominance among Scarid species on reefs representing a gradient of fishing pressure, Aquatic Living Resources, 2008, 21 (3): 339–348.

Comley J., Catch per unit effort (CPUE) survey of Fiji: Preliminary results, Fiji Conservation Science Forum, Suva, Fiji, 05–07 Aug. 2009, PowerPoint presentation, 23 pp.

Comley J., Monitoring in the LMMA network, Pacific regional Conference on MMAs, Moorea, French Polynesia, 15–19 Nov. 2009, PowerPoint presentation, 6 pp.

Comley J, Vave R., Cakacaka A., Meo S., Tawake A. (2006) Comparison of different UVC methodologies for assessing the effect of MPAs on reef fish abundance in Fiji. CRISP/USP/IRD Workshop report, 21 pp.

Dumas P., Jimenez H., Léopold M. (2009). Training in community-based monitoring techniques in Emau Island, North Efate, Vanuatu. Final report, IRD, 40 pp.

Emmanuelli E. (2006). Suivi des aires marines protégées de Moorea : mise en place d'un protocole de suivi impliquant des volontaires. Mémoire de Master, EPHE/University of Florida, 48 p.

Emmanuelli E., Ferraris J., Lison De Loma T., Osenberg C. W., Galzin R., Assessing the initial state of fish assemblages to adapt monitoring protocol for managers in a network of MPAs, European MPA Symposium, Murcia, Spain, 25–28 Sep. 2007, Poster.

Ferraris J., Léopold M., Kronen M., Kulbicki M., Labrosse P., Assessment of coral reef fisheries by a multidisciplinary panel of indicators: A comparative approach of 12 sites in two Pacific Countries, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presentation,16 pp.

Gilbert A. (2007). Précision et biais des études de consommation estimations des poissons par enquête auprès des ménages – Cas du village de Haapiti, Moorea. Rapport technique, IRD, 51 p.

Guillemot N., Chabanet P., Pelletier D., Langlois T., Léopold M., Le Pape O., Impact of an expected anthropogenic disturbance in New Caledonia (South Pacific): which methods should be used to monitor reef fish communities?, 21st Pacific Science Congress, Okinawa, Japan, 12–18 June 2007, PowerPoint presentation,17 pp.

Guilpart N., Pelletier D., Leleu K., Mallet D., Hervé G. (2008). Guide méthodologique pour la mise en œuvre et l'analyse des stations vidéo rotatives. Rapport technique, IFREMER/IRD/Zoneco, 65 p.

Hubert A. (2007). Utilisation de la perception des pêcheurs dans la gestion participative des ressources, Etude de cas à Navakavu (Fidji). Rapport de stage de master, IRD – Unité CoReUs/Ecole Nationale Supérieure Agronomique de Rennes, 49 p.

Jimenez T. (2008). Impacts écologiques de l'exploitation des invertébrés marins dans le Pacifique Sud : approche écosystémique de la pêche à pied des récifs coralliens. Thèse de doctorat, Université Pierre et Marie Curie PARIS VI, xx p.

Jimenez H., Dumas P., Bigot L., Amouroux J.M., Ferraris J., Taxonomic resolution needed to describe invertebrate assemblages and to detect harvesting effects on coral reef ecosystems, Marine Ecology Progress Series, 2010, 406: 211–222.

Jimenez H., Dumas P., Ferraris J., Spatio-temporal structure of harvested tropical reef invertebrates: A case study on New Caledonian reef flats, 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, Poster.

Jimenez H., Dumas P., Ferraris J., Spatio-temporal structure and functioning of harvested intertidal marine invertebrates: application to New Caledonian reef flats, 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, PowerPoint presentation, 8 pp.

Kaur D., Emmanuelli E. 2006. Using indicators to assess coral reefs ecosystems and fisheries health. Workshop report. 68 p.

Langlois T., Anderson M., Cappo M., Chabanet P., Merritt D., Mou-Than G., Harvey E., Pelletier D., La video sous-marine avec appât : un outil pour l'estimation des populations de poissons récifaux et leur gestion, BIODEC Symposium, Noumea, New Caledonia, 30 oct. – 04 nov. 2006, Poster.

Langlois T., Chabannet P. et al. (2006). Using baited underwater video for assessing coral reef fish populations on marine protected areas. SPC Fisheries bulletin, 118: 53–57.

Lecchini D., Bala S. (2008). Coral reef ecology and survey methods workshop, Suva, Fiji, 15–19 Sep. 2008, Workshop report, IRD/USP, 21 pp.

Léopold M., Chabannet P. (2006). Indicateurs de suivi des ressources halieutiques, évaluation de la fiabilité des comptages de poissons en surface. Rapport, 20 p.

Léopold M. (2007). Social and ecological indicators for coral reef fisheries assessment. Report, 15 pp.

Léopold M., Herrenschmidt J.-B., Thaman R., The relevance of traditional ecological knowledge for modern management of coral reef fisheries in the South Pacific, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, PowerPoint presentation, 8 pp.

Léopold M., Cakacaka A., Meo S., Sikolia J., Lecchini D. 2009. Evaluation of the effectiveness of three underwater reef fish monitoring methods in Fiji. Biodivers Conserv 18:3367–3382.

Lovell E., Seeto J., Benito V., Building regional taxonomic capacity supports marine management and biodiversity conservation efforts, 11th International Coral Reef Symposium, Fort Lauderdale, 07–11 Jul. 2008, Poster.

Pelletier D., Leleu K. (2008). Utilisation de techniques vidéo pour l'observation et le suivi des ressources et des écosystèmes récifo-lagonaires. Rapport technique, Zoneco/IRD/IFREMER, 117 p. + annexes.

Pelletier D., Leleu K., Mou-Tham G., Chabanet P., Langlois T., hervé G., Guillemot N., Video-based observation techniques for monitoring fish assemblages in coral reef MPAs, European MPA Symposium, Murcia, Spain, PowerPoint presentation, 20 pp.

Saladrau W.R. 2008. Examination of the relationship between coral reef fish population and benthic habitats at Navutulevu. Technical report. 42 p.

Sykes H., Mackay K., Changes in the coral reef populations within a community managed marine protected area in the Fiji Islands 1998–2008, 11th International Coral Reef Symposium, Fort Lauderdale, 07–11 Jul. 2008, Poster.

Tuxson T. (2007). The Status of the Subsistence Fishery Resources of Rotuma Island, Fiji. Report, 21pp.

Socio-economic monitoring

Pascal N., Maynou F., Pelletier D., Mahevas S., Ferraris J., A bioeconomic approach to assess the design and impacts of the creation of small size MPA using the ISIS-Fish model with NPV approach, The case of artisanal fisheries in Garraf (Spain, NW Mediterranean) and Tikehau (French Polynesia), European MPA Symposium, Murcia, Sain, 25–28 Sep. 2007, PowerPoint presentation, 25 pp.

Vieux C. (2008). Preliminary socio-economic monitoring (SEM-Pasifika) – Assessment of Sunalailai area (Papua New Guinea). Technical report, 16 pp.

Wongbusarakum S., Pomeroy B., Loper C., Vieux C., Guilbeaux M., Levine A., Bartlett C. (2008). SEM-Pasifika Socioeconomic Monitoring Guidelines for Coastal Managers in Pacific Island Countries. Manual, NOAA/PROE, 138 pp.

12. Knowledge assessment and dissemination

From the outset, the CRISP Coordination Unit (CCU) was committed to disseminating results on a very broad basis. Various dissemination avenues have been used: participation, with strong CCU support, of CRISP partners at international workshops and seminars; and web publishing of all documentation both on a dedicated CRISP site (http://www.crisponline.info/), and on the ReefBase international site (portal http://www.pacific.reefbase.org/), for which a specific ReefBase Pacific portal was opened with support from CRISP. The results were published in various forms, e.g. scientific publications in recognised scientific journals, 'grey' literature reports, summaries and methodological guides.

All the documents produced, plus workshop and symposium reports, were regularly published on the CRISP website, making them accessible to the general public and professionals. The programme also devised some specific tools (in the form of handbooks, CD-ROMs, DVDs, etc.) sent out through various networks.

Presented in a way that was compatible with the CRISP Charter, all these documents form a major scientific and technical resource whose extensive dissemination has given CRISP high visibility in the region and beyond.

Programme outputs:

The programme produced some 500 publications, including:

- 50 scientific publications in scientific journals;
- 15 dissertations;
- 150 'grey' literature reports;
- 20 methodological guides, plus scientific summaries and public awareness documents;
- 150 presentations at congresses.
- 60 posters, flyers, press releases, etc.

12.1 Contributions to international meetings and symposia

One of the main contributions to international meetings and symposia came from the CCU, with no less than 36 presentations on the programme itself and some of its results by the project Coordinator, Eric Clua (see Annex 1, pp.139–143). His presence at these events enabled him to inform a wide range of stakeholders about the programme and to promote it at the same time.

The CRISP Coordinator spared no effort to explain and promote the programme; television programmes, newspapers, radio broadcasts, all the media were used to talk about CRISP and its activities. A DVD contains all the television broadcasts dealing with the programme.

The first significant participation of CRISP partners (USP, FSPI, IFRECOR, SPREP and CRIOBE) at an international meeting took place at the Third International Tropical Marine Ecosystem Management Symposium – **ITMEMS3**, in Cozumel (Mexico) in October 2006.

In 2007, a **regional forum** jointly organised under the auspices of CRISP by France and Australia was held at James Cook University in Townsville, Australia. This meeting, designed to strengthen cooperation efforts around support for sustainable development of coastal resources in Pacific Island countries, led to discussions on MPAs, integrated coastal management, sustainable activities and governance.

The **21st Pacific Science Congress (PSC21, Okinawa, 2007)** was also an opportunity for many CRISP partners to present projects and preliminary results (17 presentations and posters).

A €20,000 grant from the French Pacific Fund allowed CRISP to facilitate the participation of a dozen scientists contributing to the programme, at the 11th International Coral Reef Symposium (ICRS), in Florida from 7 to 11 July 2008. CRISP and SPREP shared a stand and promoted many products related to coral reef conservation. Scientists, ecologists and other stakeholders were able to gather precious scientific information. Twenty-three presentations bearing the CRISP logo were made by the programme's partners.

Among the salient events, the **11th Pacific Science Inter-congress (PSI2009)**, in Tahiti, formed one of the high points in 2009 for CRISP. No less than 17 presentations and posters, contributed by IRD, WWF, CRIOBE, USP, etc. were produced, dealing with almost all of CRISP's work areas, e.g. eco-regional assessments, active marine substances, sharks, MPAs, status of reefs, watersheds, fisheries and reef monitoring. Cécile Debitus, of CRISP, took this opportunity to organise a one-day break-out workshop on access to resources and benefit-sharing, in conjunction with IRD, Gump–University of California Berkeley Research Station for the South Pacific, as well as the Smithsonian Institute via the Consortium for the Barcode of Life. Various

other 'side-events' (Science and Education in the Pacific; Governance) allowed CRISP to expound its philosophy in these areas.

At the 2nd International Marine Protected Areas Congress (**IMPAC2**), in Washington D.C. (USA) in May 2009, Eric Clua and Jean-Brice Herrenschmidt (GIE Océanide/IRD) presented a paper on the social and cultural problems around MPA development. Ambroise Brenier, whose participation was sponsored by CRISP, presented some results from his doctoral research on participatory monitoring methods (Brenier, 2009).

No less than a dozen events addressed the development of **PCC**, whose stakeholders widely promoted their activity at some 10 different events. The first, in 2008, was co-funded by CRISP and the French Foreign Affairs Ministry; it brought together all the French PCC stakeholders for a day at the **'Aquarium tropical du Palais de la Porte Dorée'** in Paris. The **International Aquarium Congress (IAC)** took place in Shanghai in October 2008; René Galzin (EPHE) and Gilles Lecaillon (Ecocean) presented an account of PCC benefits on the aquatic environment. Presentations on PCC were also made at the **26th Meeting of European Aquarium Curators** (Valence, 2009), the **'Congrès Bourse Clam'**, (Montpellier, 2009), the World Aquaculture Congress 2009 (Veracruz, Mexico, 2009), and more recently the **Tahiti Aquaculture** workshop (Papeete, 2010). The SPC Aquaculture Section, with the assistance of CRISP, held a **Pacific Sub-Regional Marine Ornamentals Trade Workshop** in December 2008.

Results of the work on **watersheds** were presented on a number of occasions (**International Congress on Modelling and Simulation -** MODSIM, Christchurch, 2007; PSC21, Okinawa, 2007; PSI, Papeete, 2009). J.-B. Herrenschmidt spoke at a large number of events on aspects of **governance** in the region. Work on sharks was given broad currency by E. Clua (**SIC, Sharks International Conference**, Cairns, 2010; **IWSS, International White Shark Symposium** Hawaii, 2010).

Among the other thematic events held, those relating to **active marine substances** provided many opportunities for presentations: the **5th European Conference on Marine Natural Products** (Naples, 2007), the **'Doctoriales Midi-Pyrénées'**, in June 2008 (Toulouse), the **11th International Symposium on Natural Product Chemistry** in Karachi, Pakistan, (October 2008), during which Ph.D students sponsored by CRISP presented their findings. Three workshops focused entirely on the use of genetic resources and the associated traditional knowledge (Paris, 2007), benefit-sharing (Tahiti, 2009) and legal aspects, in Vanuatu. A photo exhibit was staged in Nantes, France.

Following on from the **International Marine Protected Area Congress,** which recommended pursuing MPA development in Pacific Island countries, the **Pacific Regional MPA Conference** was held on Moorea, French Polynesia, from 15 to 19 November 2009. Jointly organised by the French Marine Protected Areas Agency and IUCN, with support from CRISP, under the patronage of SPREP and SPC, and in association with the major NGOs involved in this sector in the Pacific, it brought together various regional stakeholders involved in the establishment and management of MPAs. A total of 11 presentations were made under the CRISP logo.

More recently, a workshop on **Governance of Marine Protected Areas in the South Pacific** took place at the CRIOBE research centre on Moorea, from 6 to 10 September 2010, organised by the Pacific Coral Reef Institute (IRCP) in partnership with CRISP. Some 20 government and NGO representatives attended the event.

The presentations made by CRISP's partners at congresses and symposia are listed in Appendix 1. Abstracts were prepared for some meetings: PSC21, Salvat et al.; Townsville Forum, Clua E.; 11th International Coral Reef Symposium (ICRS), Clua et al.; Pacific Science Inter-congress 2009, Dupré C.

CRISP partners thus took part in some 40 events, presenting their results in papers delivered orally or as posters: altogether, this amounts to about 150 presentations.

CRISP and ICRI

The CRISP Coordinator regularly attended meetings of ICRI (International Coral Reef Initiative), specifically in April 2005 in Mahé, Seychelles; in November 2005 in Koror, Palau; and in October 2006 in Cozumel, Mexico. At this meeting, CRISP was able to obtain an independent seat with ICRI, alongside the French representation, and secured status as a 'network' of ICRI, in the same way as ICRAN (International Coral Reef Action Network) and GCRMN (Global Coral Reef Monitoring Network). The Coordinator spoke on the progress achieved by the programme at ICRI general assemblies held in April 2007 in Tokyo, Japan; January 2008 in Washington D.C., USA; March 2009 in Phuket, Thailand; January 2009 in Monaco (where he organised a session); and in 2010 in Apia, Samoa.

Through the presence of CRISP at ICRI, a special session on reef fisheries (spawning aggregations, importance of sharks and impact of climate change on reef resources) was held for the first time in Monaco; this session was repeated in Samoa, where it focused on spawning aggregations, the role of managed marine areas in raising reef fishery productivity, CPUE (catch per unit effort) and live fish captures for human consumption.

These meetings were also an important platform for strengthening international and inter-programme cooperation. CRISP was involved in Crime Scene Investigation (CSI) and Reefs at Risk (see section on "Expanding knowledge" [p.83]); the programme developed collaboration with CRTR (Coral Reef Targeted Research), a World Bank research programme on coral reefs, in various fields: connectivity, spawning aggregations and reef rehabilitation, with two jointly produced guides.

Also within ICRI, at the Washington meeting in 2008, which was also attended by the French Minister for Overseas Territories, CRISP played a key role in the partnership between France and Australia with a view to the sustainable management of the Coral Sea.

12.2 Knowledge dissemination via ReefBase Pacific

The ReefBase portal (www.reefbase.org) developed and managed by WorldFish Center (WFC) is designed to facilitate access by a variety of stakeholders, managers and scientists, as well as the general public, to information concerning coral reefs. It disseminates information from the 'grey' literature, generally only available in hard copy in libraries.

The ReefBase Pacific Internet portal is the first regional offering of the ReefBase project (http://www.reefbase.org) and provides a unique information source for the Pacific region; funded in equal parts

by CRISP and the United Nations Foundation (UNF), it is the programme's main avenue for knowledge dissemination and experience sharing (http://www.pacific.reefbase.org/).

Thousands of documents have been scanned, indexed, filed and published online, including data on reef resources which, previously, were not part of the ReefBase products. Ultimately, the atlas of Pacific coral reefs will also be available online. Professionals will be able to download (free of charge) the data layers, with the geomorphology of the reefs, and include them in geographic information systems.

In 2007, the ReefBase Pacific project proposed the first dedicated product, available online and on DVD (v. 1.0). In 2008, version 2 of the DVD (v 2.0), "ReefBase Pacific Information Portal: Livelihoods – Fisheries – Biodiversity" was made available. This new version of the database contains much more information than the previous one: 9,986 publication titles (2,211 in French and 7,756 in English), including 8,532 complete versions (2,047 in

ReefBase Pacific: bringing grey literature off the shelves

CRISP has scanned several hundred reports and other documents from the grey literature relating to research in the South Pacific, which usually remains inaccessible and so, is soon forgotten.

PDF format and 6,659 accessible through hyperlinks), 1,389 images, 2,554 profiles of species associated with reefs, 147 project descriptions, 198 biographies of scientists, project managers, etc., and the contact details of 126 organisations.

Also accessible, via a GIS, are the "Pacific Reef Geographic Information System", country profiles, at least 603 brief descriptions of monitoring sites, 103 descriptions of MPA sites, 254 coral bleaching incident reports, and 1,108 geo-references. Through a new and powerful functionality, this DVD can be updated online.

Other resources available on the website include a toolbox for reef resource managers comprising species profiles, handbooks and guides.

12.3 CRISP website

The CRISP website was launched in mid-2005, following the launch of the programme itself in Noumea in January 2005. Initially hosted by the SPC, it was transferred to the US in 2006, out of a concern to improve accessibility to the general public. This move produced a spectacular surge in traffic. In addition, the site itself is being referenced by an increasing number of other websites operated by partner organisations or projects or simply activities related to the programme (see, for example, www.icriforum.org).

The CRISP website has constantly expanded throughout the life of the programme, and today more than 200 reports and handbooks are online. Most of the documentation produced (reports, methodological guides, etc.) is available in both English and French, courtesy of the translations done by CRISP, and this feature adds great value to the dissemination of knowledge. The "products" section is structured into nine themes, i.e. biodiversity knowledge and conservation, bio-prospecting and benefit access and sharing, integrated coastal management, PCC, reef knowledge and monitoring, reef restoration, economic and socio-economic aspects of coral reefs, public and political awareness-raising, programme monitoring and evaluation. Between 2009 and 2010, on average 7,000 pages were consulted on the site each month.

For the end of the programme, an extensive strategy to disseminate its results, in particular in the Pacific region, will be pursued by the Coordination Unit. Three documentary films on the programme's activities, produced and directed by the CCU, have already

been widely distributed. A DVD, containing all the reports, handbooks and scientific publications issued as part of CRISP, as well as the presentations made at symposia, will soon be sent out. All these reports and handbooks will also be included in SPC's digital library and disseminated through the SPC system of deposit libraries, comprising over 40 libraries for documents in English and 15 for documents in French. At the same time, a general translation strategy should be implemented in order to share the CRISP Programme's outcomes in Pacific Island countries and territories, through the SPREP and USP networks and through French embassies and consulates. SPC is also in contact with the Pacific Coral Reef Institute (IRCP), based at CRIOBE on Moorea, part of the content of the website regarding transferring to this organisation, whose goals are comparable to those of CRISP. This process should make all the products available at all times.

12.4 Communicating scientific results to countries

This phase has commenced, but was still incomplete as at the beginning of 2011. Some briefing work has, however, been done on some specific projects with local partners (officials and local communities):

- As part of the component on active marine substances, IRD organised an information-sharing trip to Honiara in March 2008 (Payri et al., 2008). An information-sharing trip to pass on results from surveys in Vanuatu and Fiji is also in the planning stage.
- As part of the integrated management and governance component, GERSA results were shared with local stakeholders in villages and stakeholder institutions in Vanuatu and French Polynesia (Herrenschmidt, 2010).

Documents produced by CRISP

Methodological guides and analytical and scientific extension documents

Knowledge transfer also occurs through issuing scientific summaries and other extension-type documents. A number of summaries and guides, totalling more than 20 documents, were produced (see Annex 2, pp.159–160).

Guides for identifying reef larvae and adults were produced, in particular as part of PCC research, for the purpose of facilitating sorting work on the species captured by industry. An identification guide for reef fish larvae in French Polynesia (**Maamaatuaiahutapu et al., 2006**), an illustrated guide to the crustaceans of Wallis and Futuna (**Poupin & Juncker, 2008**) and an illustrated guide to the decapod crustaceans of the South Pacific were produced in 2010 (**Poupin & Junker, 2010**) for scientists, reef fish managers, nature conservation groups and commercial and recreational fishers. A very educational extension document on PCC, funded by the Total Foundation, presents the applications and prospects for PCC in sustainable development and tropical and temperate marine ecosystem biodiversity conservation (Lecaillon et al., 2007).

Several publications on the status of reefs in the world (**Wilkinson et al., 2005a and b, 2008**) and methodological guides for coral reef monitoring were produced: **Quod et al., 2010** for CoReMo; **Pelletier et al., 2008 and Guilpart et al., 2008** on video monitoring techniques and **Wongbusarakum et al., 2008** for the SEM-Pasifika socio-economic monitoring guide. **Gulko et al., 2008**, issued a scientific verification handbook.

A study on the effects that ocean acidification has on coral reefs was carried out by Bernard Salvat, of 'École pratique des hautes Études' (EPHE), as a scientific adviser to CRISP, in conjunction with Denis Allemand, an international expert with the Monaco Oceanographic Museum (**Salvat & Allemand, 2009**).

A major piece of research on the status and potential of small community-based reserves in the South Pacific was conducted by Hugh Govan (**Govan et al., 2009**). This review, which included a regional inventory of LMMAs, offers remarkable diversity and interest in terms of the topics addressed, which are vital for the region and very relevant internationally. Also on the subject of MPAs, Cohen (2008) produced a bibliographic review of the socio-economic and ecological impacts of marine protected areas in the Pacific. A review of the social and economic value of reefs shed light on these approaches and assessed the various methods (David et al., 2007).

In the area of tourism, two guides were prepared, i.e. a practical guide to environmentally responsible practices for tourism companies (Petit, 2010) and a guide containing practical tips for an environmentally-friendly approach for hotels in tropical latitudes (Gorchakova, 2010).

Two guides to reef restoration (Edwards et al., 2007 and 2010) were produced in collaboration with the World Bank's CRTR project.

Key points

The dissemination of the knowledge and results acquired by the programme is one of the great successes of CRISP. Extensive participation at congresses and symposia and the distribution of documents through websites are the main routes used.

- 40 events attended by CRISP partners at which 150 papers were presented, either orally or in poster form;
- 10,000 publications, on the ReefBase Pacific site, a database set up by CRISP;
- 200 titles (reports, guides, flyers, etc.) for results obtained by CRISP available on the CRISP website.

These are impressive figures regarding communication, and they illustrate the energy behind the CRISP programme and its commitment to making its results widely known. With CRISP providing translation, many documents are available in both French and English. Also, the mandatory format for all documents produced under CRISP auspices give very high visibility to the programme as well as promoting it effectively.

The creation of ReefBase Pacific is a major step forward in knowledge dissemination in the region, considerably expanding the range of information available to reef managers in the Pacific as a whole. The CRISP website provided progress updates on a regular basis. Consolidated periodic reports by the Coordination Unit were also very useful for monitoring the programme's progress on a regular basis.

Through its very pro-active approach, CRISP was recognised as a 'network' by ICRI (International Coral Reef Initiative), along with ICRAN (International Coral Reef Action Network) and GCRMN (Global Coral Reef Monitoring Network).

Bibliography

Agence des Aires marines protégées (2011). Conférence régionale Pacifique des Aires marines, Moorea, Polynésie française, 15–19 nov. 2009. Synthèse des échanges, 36 p.

Bell J., Clua E., Fish, food security, climate change, ICRI General Meeting, Phuket, Thailand, 20–23 Apr. 2009, PowerPoint presentation, 45 pp.

Brenier A., Mahafina J., Ferraris J., Galzin R., Relevance of participatory approaches for ecosystemic monitoring of reef fisheries, 2nd International Marine Protected Areas Conference, Washington D.C., USA, 19–24 May 2009, PowerPoint presentation, 15 pp.

Chandra M., Sotheeswaran S., Ali S., Bonnard I., Banaigs B., Petek S., Debitus C., Preliminary chemotaxonomic and anti-fungal analyses of the marine sponge, Dysidea (Lamellodysidea) herbacea, 11th International Symposium on Natural Product Chemistry, Karachi, Pakistan, 29 oct.– 01 nov. 2008, Poster.

Clua E., The CRISP Programme : A specific approach for coral reef conservation and development in SIDS (Small Island Seveloping States), World Maritime Technology Conference, London, UK, 06–10 Mar. 2006, PowerPoint presentation, 20 pp.

Clua E., The CRISP, a vector for regional cooperation, Assises de la Recherche, Papeete, Polynésie française, 09–12 oct. 2006, Presentation PowerPoint, 30 p.

Clua E., Le programme CRISP : Une contribution à la conservation et à la question de la biodiversité marine dans le Pacifique Sud, BIODEC Symposium, Nouméa, Nouvelle-Calédonie, 30 oct. – 04 nov. 2006, Presentation PowerPoint, 40 p.

Clua E. (2007). Building capacity and cooperation for sustainable development of Pacific coastal resources Forum, Townsville, Australia, 03–07 Sep. 2007. Proceedings, 29 pp.

Clua E., Brief overview of the CRISP Programme, Building capacity and cooperation for sustainable development of Pacific coastal resources Forum, Townsville, Australia, 03–07 Sep. 2007, PowerPoint presentation, 41 pp.

Clua E. (2008). Séminaire sur le développement de filières postlarves pour le marché de l'aquariophilie, Aquarium de la Porte Dorée, Paris. Rapport de synthèse, 24 p.

Clua E., Le CRISP et la PCC (Capture et Culture de Postlarves), Séminaire sur le développement de filières postlarves pour le marché de l'aquariophilie, Aquarium tropical du Palais de la Porte Dorée, Paris, France, 02 juill. 2008, Présentation PowerPoint, 39 p.

Clua E., Overview of the programme CRISP, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, PowerPoint presentation, 28 pp.

Clua E., The development of PCC in the Pacific, Sub-regional Workshop on the Marine Ornamental Trade in the Pacific, Noumea, New Caledonia, 02–05 Dec. 2008, PowerPoint presentation, 25 pp.

Clua E., Le CRISP et les substances actives marines, Atelier ABS, Ile Inter-congrès des Sciences du Pacifique 2009, Tahiti, Polynésie française, 02–06 mars 2009, Présentation PowerPoint, 9 p.

Clua E., Le CRISP et la gestion intégrée, Atelier Gouvernance, Ile Inter-congrès des Sciences du Pacifique 2009, Tahiti, Polynésie française, 02–06 mars 2009, Présentation PowerPoint, 10 p.

Clua E., Le CRISP et la cooperation régionale, Atelier Cooperation en Science et Education dans le Pacifique, Ile Inter-congrès des Sciences du Pacifique 2009, Tahiti, Polynésie française, 02–06 mars 2009, Présentation PowerPoint, 11 p.

Clua E., Contribution potentielle du CRISP au GDRI (Groupement de Recherche International 'Biodiversité des Récifs Coralliens), GDRI Colloque inaugural, Monaco, Principauté de Monaco, 01–03 sept. 2009, Presentation PowerPoint, 9 p.

Clua E., Past, present and future of MMAs, Conférence régionale Pacifique des Aires marines, Moorea, Polynésie française, 15–19 nov. 2009, Presentation PowerPoint, 19 pp.

Clua E., Reef sharks: Why should they be protected?, ICRI General Meeting, Monaco, Principauté de Monaco, 12–15 Jan. 2010, PowerPoint presentation, 16 pp.

Clua E., CRISP 2005–2010: Lessons learned and next steps, ICRI General Meeting, Apia, Samoa, 08–12 Nov. 2010, PowerPoint presentation, 22 pp.

Clua E., Le CRISP et l'aquaculture, Tahiti Aquaculture 2010, Papeete, Polynésie française, 06–11 déc. 2010, Presentation PowerPoint, 24 p.

Clua E., Buray N., Mourier J., Planes S., Business partner or simple prey? The economic value of the sicklefin lemon shark (Negarpion acutidens) in French Polynesia, SIC Sharks International Conference, Cairns (Australia), 06–11 Jun. 2010, PowerPoint presentation, 17 pp.

Clua E., Lecchini D., Galzin R., Developing efficiency of capture methods of coral reef fish larvae in the South Pacific, Tahiti Aquaculture 2010, Papeete, Polynésie française, 06–11 déc. 2010, Préesentation PowerPoint, 18 pp.

Clua E., Legendre P., Potential indicators of the status of reef fisheries based on the shifting dominance phenomenon among scarid species submitted to fishing pressure, 21st Pacific Science Congress, Okinawa, Japan, 12–18 Jun. 2007.

Clua E., Seret B., Elements of ecology of the Great White Shark (Carcharodon carcharias) in New Caledonia (South West Pacific), International White Shark Symposium, Honolulu (Hawaii), 07–10 Feb. 2010, PowerPoint presentation, 22 pp

Clua E., Staub F. (2008). Participation of the CRISP to the 11th International Coral Reef Symposium (ICRS), Fort Lauderdale, Florida, 07–11 Jul. 2008. CRISP report, 32 pp.

Dupré C. (2009) La participation du CRISP à l'Inter-congrès des Sciences du Pacifique 2009 (PSI2009), 02–06 mars 2009. Rapport CRISP, 36 p.

Govan H., Rupeni E., Chenet A., Troeng F., Heaps L., Cohen P., Dupré C., Bambridge T., Herrenschmidt J.-B. (2010). Governance & Management issues of Marine Managed Areas – Pacific regional Conference on Marine Managed Areas, Moorea, French Polynesia, 15–19 Nov. 2009. Agence des Aires marines protégées, 14 pp.

Herrenschmidt J.-B., Technology and community-based management: Dilemna or challenge? – Vanuatu, Fiji, French Polynesia, New Caledonia, Building Capacity and Cooperation for Sustainable Development of Pacific Coastal Resources Forum, Townsville, Australia, 01–07 Sep. 2007, PowerPoint presentation, 49 pp.

Herrenschmidt J.-B., Heritage: the new cultural and institutional challenge of environmental governance in the Pacific Islands, 11th Pacific Science Inter-Congress, Papeete, Polynésie française, 02–06 mars 2009, PowerPoint presentation, 16 pp.

Herrenschmidt J.-B., Clua E., Vers une gestion « culturelle » des milieux naturels en Océanie ?, GECOREV Symposium, Saint-Quentin-en-Yvelines, 26–28 juin 2006, Presentation PowerPoint, 17 pp.

Herrenschmidt J.-B., Clua E., Culture and Locally-Managed Marine Areas in the South Pacific: Supporting cultural revival for good reasons, 2nd International Marine Protected Areas Conference, Washington D.C., USA, 19–24 May 2009, PowerPoint presentation, 18 pp.

Herrenschmidt J.-B., Dumas P., Coral reef management in the Pacific Islands: Governance at risk, 11th International Coral Reef Symposium, Fort Lauderdale, USA, 07–11 Jul. 2008, PowerPoint presentation, 25 pp.

Kinch J., Teitelbaum A. (2008). Proceedings of the Sub-regional Workshop on the Marine Ornamental Trade in the Pacific; 02–05 Dec. 2008, Noumea, New Caledonia. Workshop proceedings, 70 pp.

Lecaillon G., Galzin R., Positive effects on the aquatic environment of using PCC as a source of tank-raised MAT products, 7th International Aquarium Congress, Shanghai, China, 19–24 Oct. 2008, Présentation PowerPoint, 9 pp.

Le Lann K., Bourguet-Kondracki M.L., Longeon A., ioannou E., Roussis V., Payri C., Debitus C., Dedslandes E., Stiger-Pouvreau V., Potent anti-inflammatory active compounds from marine brown algae (Sargassaceae, Fucales) from the Solomon Islands, South Pacific, 5th European Conference on Marine Natural Products, Ischia, Italie, 16–21 Sep. 2007, Poster.

Mani L., Antimalarial compounds from marine sponges of the Solomon Islands, Doctoriales Midi-Pyrénées, Toulouse, France, 01–07 juin 2008, Présentation PowerPoint 14 p.

Salvat B., Clua E. (2007). Synthèse de la participation du programme CRISP au 21e Congrès des Sciences du Pacifique (PSC21), Okinawa, Japon, 12–18 juin 2007. Rapport CRISP, 28 p.

Service des Pêches de Polynésie française, Secrétariat général de la Communauté du Pacifique (2010). Aquaculture durable en milieu insulaire tropical – Tahiti Aquaculture 2010, Papeete, Polynésie française, 6–11 déc. 2010. Programme, 20 p.

Awareness-raising, capacity building and partnership development

13. Public and stakeholder awareness-raising activities

Raising the awareness of various stakeholders, e.g. decision-makers, users and operators, about the value and fragility of coral reefs remains a major issue for all management and protection initiatives. The diversity of the parties involved means that both messages and tools must be appropriate. CRISP aimed to test innovative methods for passing on information to a range of interested groups.

Through the various project components, decision-makers, technicians and managers were provided with information throughout the programme. Thus policy-makers and aid donors are urged to focus on issues relating to the economics of coral reefs; economic valuation highlighting the value of reefs and the benefits that can be drawn from reef-based services is also an awareness and information activity in its own right. Similarly, SEM-Pasifika tools, makes it possible to measure community living standards and trends, coordination meetings in the field about setting up MPAs or watershed management or, indeed, coral reef monitoring, can help sound the alarm about the critical state of resources when required.

This section will address the specific activities and tools developed for target groups such as children or tourism operators.

International Year of Coral Reefs (PYOR, 2008)

The International Year of Reefs (IYOR) was first celebrated in 1997. In 2008, ICRI launched a second drive, based mostly on awareness activities. The campaign in the Pacific (Pacific Year of the Reef 2008, PYOR 2008) was led by SPREP. A communication plan was developed on the theme "Strong Reefs, Strong Islands"; CRISP funded the regional campaign.

The campaign's objectives were to "promote coral reef conservation initiatives at community, regional and national levels, to promote behaviour change and to raise awareness of the economic value of coral reefs and their vital role in adapting to climate change."

Launched in Vanuatu by SPREP and SPC, this campaign took place from 29 February to 17 December 2008. It mainly targeted youth and the media, as an adjunct to the CRISP Programme's activities that mainly addressed coral reef managers and political leaders. The funding provided was used to support existing activities and not those specific to the campaign.

At the regional level, through a "Challengecoralreef" competition, 10 teams of students (13–18 years) received funds to implement reef conservation activities. The countries concerned were Cook Islands, Fiji, Kiribati, New Caledonia (2), Samoa, Solomon Islands (3), Vanuatu and Wallis and Futuna. Their action plans included community consultations, educational approaches, cleaning beaches, planting coral and mangrove, erecting signs in MPAs, setting up an underwater path and improving waste disposal practices.

Awareness-raising work was an integral part of the campaign from start to finish. Monthly and quarterly publications were disseminated through the media. Relevant educational and promotional materials were distributed, mainly posters, stickers, t-shirts. The existing SPREP network of national contact points, in the areas of the environment and marine education, was strengthened.

This campaign, promoted by CRISP, also concerned various international meetings (11th International Coral Reefs Symposium – ICRS, 2nd International Pacific Marine Educators Conference, 2nd International Youth Coastal Conference and the IUCN World Conservation Congress).

SPREP, through its local and national activities, also contributed to the regional impact of the CRISP Programme components.

In Cook Islands (Pacific Year of the Reefs in Cook Islands, 2008), the National Environment Service coordinated activities, with assistance from WWF–Cook Islands, the Ministry of Marine Resources, the Ministry of Labour and the Te Ipukarea Society. Competitions were organised for schools and community groups. A public exhibition on coral reefs, documentaries, radio

programmes and a "Takitunu Lagoon" day were held.
In Solomon Islands, (Pacific Year of the Reefs in Solomon Islands), the PYOR 2008 campaign was launched on 9 April 2008 in the presence of the Minister of the Environment, Conservation and Meteorology and other government, NGO and school representatives. An awareness-raising campaign on the importance of reefs went out through radio programmes. Various materials were developed and activities organised, e.g. brochures and posters for schools and the public, school competitions, distribution of materials, brochures, scarves with the PYOR logo, prizes at competitions.

Educational materials and extension activities

Original **educational materials** were produced for children, including an educational DVD on coral ecosystems, reflecting the context in New Caledonia, and related to curriculum content (primary and secondary). A "teaching kit" on protecting coral ecosystems is being developed and will be transferrable to a range of Pacific countries. In addition to the educational DVD, the kit will contain an explanatory booklet and three game components, i.e. a colouring book for children from 3 to 5 years old, a board game for children aged 6 to 9 years and a 'Happy Families' card game for children aged from 10 to 13 years. Testing these games has begun in schools in Vanuatu. The problem of how to distribute the kit has yet to be resolved.

Documents designed to communicate scientific results to a more specialised audience were produced: a flyer on the results of an economic assessment of the Navakavu marine area (O'Garra, 2007), another on the social and economic value of coral reefs in the Pacific Islands (David et al., 2007). A four-page brochure describes three PCC projects and the partners involved. Another brochure describes some of CRISP's successes in reef management in the Pacific: the catch per unit effort monitoring system in Fiji, the socio-economic monitoring of MPAs in Vanuatu, the work on aggregation sites in Palau, and the aquarium marine trade work in Kiribati (Comley et al., 2010).

A number of films, produced with support from the CRISP Coordination Unit, were broadcast on popular television channels and also distributed as DVDs. Three 26-minute documentaries on the economic value of coral reefs ("Coral reefs: a bankable investment?"), sustainable aquarium fish harvesting ("Dollar-fish Island") and the development of PCC ("Grow, grow, little fish"), were co-produced and broadcast with 'France Télévision'. Another 26-minute documentary on CRISP's work in New Caledonia was produced with support from AFD (French Development Agency) and shown on the French television channel TV5. Two other full-length documentaries (52 mins) also covered CRISP's work: one on French Polynesia "Un océan, des îles et des Polynésiens" [Ocean, Islands and Polynesians)/RFO] and another on the scientific visit to the Chesterfield Reefs ("Chesterfield, oasis de la Mer de Corail" ("Chesterfield, Oasis of the Coral Sea")/ARTE).

Reef Check

Under CRISP auspices, since 2006, extensive awareness-raising and communication efforts have been made in French Polynesia as part of Reef Check (**Lagouy, 2006; 2007; 2008**). Articles were published in the local press ('la Dépêche', 'les Nouvelles', 'Tahiti Presse') and magazines ('Te Heipuni o te tau roa Environnement durable', 'le Magazine de Moorea', 'Plongée Magazine', 'Dixit', 'Moana Vision') and six television reports were broadcast.

During the campaign to control the invasion by the *Acanthaster* 'crown-of-thorns' starfish, brochures were distributed in all the islands of the Society group to inform the community about the dangers this species represents. An information kit containing all the documents needed for the 'Reef Check Polynésie' training course and a species identification guide for volunteers were produced.

Also, the members of Reef Check took part in many events in various islands around the country, to raise public awareness and promote the association's activities. Information boards were erected and awareness materials distributed at various thematic events, e.g. World Oceans Day, World Environment Day. E. Lagouy, the Coordinator of 'Reef Check Polynésie' made presentations to students in four 1st-year secondary classes at Rangiroa junior secondary school in February 2007.

At a presentation on coral reefs, Isabelle Adjani was named honorary patron of the 'Reef Check Polynésie' association.

Bibliography

System TV (2010). Nouvelle-Calédonie : Protection des récifs coralliens. Film documentaire, Agence française de Développement, TV5 Monde, 52 mn.

Centre de Documentation pédagogique de Nouvelle-Calédonie et Institut de Recherche pour le Développement. Le récif corallien. DVD-rom, 2008, Nouméa.

Cameron E., Savu S. (2008). PYOR: Concluding campaign report. Activity report, PROE, 151 pp.

Clua E. (2009). Use of postlarvae and coral gardens for ecotourism-based activities, in Development of economically viable postlarval capture and culture (PCC) based activities in Bora Bora (French Polynesia). Brochure, 4 pp.

Clua E. (2009). Le corail à tout prix. Film documentaire CRISP, 7mn ou 26 mn.

Clua E. (2010). L'île au dollar-fish. Film documentaire CRISP, 26 mn.

Clua E. (2010). Petit poisson deviendra grand. Film documentaire CRISP, 26 mn.

Comley J., Sadovy Y., Yeeting B., Pascal N. (2010). Reef fisheries management in the Pacific – Success stories. Brochure, CRISP, 4 pp.

David G., Herrenschmidt J.-B., Mirault E., Thomassin A. (2007). Valeur sociale et économique des récifs coralliens du Pacifique insulaire. Flyer, CRISP, 2 p.

Fréling P. (2007). Un ocean, des îles et des Polynésiens. Film documentaire, Merapi Production, 52 mn.

Lagouy E. (2006) Développement du réseau Reef Check Polynésie française. Rapport d'activité 2006, Reef Check, 143 p.

Lagouy E. (2007) Développement du réseau Reef Check Polynésie française. Rapport d'activité 2007, Reef Check, 28 p.

Lagouy E. (2008) Bilan des activités du réseau Reef Check Polynésie française. Rapport d'activité 2008, Reef Check, 29 p.

O'Garra, T. (2007). Combien « rapporte » un récif corallien ? Estimation de la valeur économique totale (VET) de l'aire marine de Navakavu, Viti Levu, Fidji – Etude de cas. Flyer, USP/IRD, 2 p.

South Pacific Regional Environment Programme (2008). Challengecoralreef. Workbook, 30 pp.

Vieux C. (2008). PYOR in Solomon Islands. Activity report, PROE, 19 pp.

Vieux C. (2008). PYOR in Cook Islands. Activity report, PROE, 18 pp.

Staub F., Chhay L. (2010). International Year of the Reef 2008: The year in review. International Coral Reef Initiative, 60 pp.

Wongbusarakum S., Pomeroy B., Loper C., Vieux C., Guilbeaux M. Levine A., Barttlett C. (2008). SEM-Pasifika : Socioeconomic Monitoring Guidelines for Coastal Managers in Pacific Island Countries. Manual, PROE/NOAA, 138 pp.

14. Training and institutional strengthening

Training, capacity building and institutional strengthening were CRISP Programme priorities, especially with regard to making gains sustainable. Three main approaches were followed:

- promoting **exchanges** to enable Pacific Island **students** to receive training at French-speaking institutions, often in mainland France, and to allow French students to study at English-speaking institutions, especially USP;
- offering **technical training** for Pacific Island nationals through **workshops** organised by the programme, using its own funds and co-funding arrangements.

In addition, a major contribution was made to **capacity building for local communities in the field,** concerning some 40 communities, as part of the work to establish and monitor MPA/LMMAs; fishers and other members of the community were trained in monitoring (see relevant section) and their management capacity was strengthened. This was also the case with PCC, reef restoration and the development of integrated management including watersheds (e.g. training on management plans, acquiring management techniques, reforestation) and also as part of reef and resource status monitoring work. This was one of CRISP's outstanding contributions, although it is difficult to know exactly how many beneficiaries there were. Local communities on Efate in Vanuatu (Epau, Emau, Mangarongo and Wiana); Fiji, particularly on Viti Levu (Navakavu, Nakorotubu, Rakiraki, Lami, etc.), but also in Moturiki; Cook islands (Aitutaki, Rarotonga); Kiribati; Solomon Islands; and Tuvalu (see inset p. 129, right) certainly drew benefit from this work.

Training for students

A detailed list of the training provided between 2005 and 2010 can be found in Annex 4 (see pp.165-168). It covers 90 students (including 18 Fijians, 2 Solomon Islanders, 2 Australians and 3 New Caledonians).

Training offered

Some high-level training was also provided, with 2 post-doctoral level students trained as well as 14 theses, requiring at least three years of research, 26 'masters 2' and 18 'masters 1'.

The components dealing with **active marine substances** and **fish ecology and PCC** were the most active in terms of training: 30% of the students were trained in the area of active marine substances, with one post-doctoral student and nine PhD students, and another 24% in the PCC sphere, including two PhDs.

CRISP was keen for these young research students to be able to share their work; it allocated over €40,000 for scholarships using French Pacific Fund resources, to assist them with participation at international meetings, especially the 11th International Coral Reef Symposium (ICRS) and PSI2009.

Research partners

Some 20 students, most of whom were Pacific Islanders, were trained in conjunction with USP, under agreements signed with CRISP partners. The main operators were IRD and EPHE/CNRS, including CRIOBE component coordinators. A framework agreement was signed between the University of the South Pacific and the University of Perpignan (France), which manages the EPHE programme, so that the qualification can be recognised by the two institutions. This EPHE-USP association enabled many French students to carry out master's level studies in partnership with IRD Noumea. Many other research agencies were involved, mainly French.

Sumary of students' trainings in the CRISP program.

Total Studients trained	**88**
Students from Pacific	25 (18 Fiji; 3 New Caledonia; 2 Salomon; 2 Australia)
Post-doc	2
PhD	14
Master degree	26
Associate degree	18
Master Pro	2
Engineers	13
Other	8
Bachelors'degree	3
Post graduate diploma	2
Component 1A	19
Component 2A	35
Component 2C	25
Component 3C	6
Component t 3D	3
PCC	21
Marines' actives' substances	26 (19 chemists; 5 taxonomists, principaly algae; 2 lawyers)
Integrated management	24 (17 GIS; 7 Gov./Eco.)
Knowledge and conservation	15 (dont requins : 2)

For active marine substances:

On substances: the French Institute of Research for Development (IRD), Paul Sabatier University (Toulouse III, UMR 152 IRD–USP, Pharmaco-chemistry of natural substances and redox pharmacophores), CNRS (Natural Substances Chemistry Institute), the Queensland Museum (Brisbane), and the Universities of Nantes, Perpignan, Brest and Naples.

In training: IRD, the Universities of Nantes, Toulouse, 'Bretagne occidentale' (Western Brittany), Montpellier, Aix–Marseille, Paris VI, the French National Higher School of Chemistry in Lille, the French National Museum of Natural History, CNRS, the University of the South Pacific (deeply involved), and the Queensland Museum.

On legal aspects: University of Nantes – CDMO ('Centre for Marine and Ocean Law - EA 1165) and the national government departments of the test countries (Solomon Islands, Fiji, Vanuatu).

For PCC and fish ecology research:

Pierre et Marie Curie University; University of Western Brittany (Bretagne Occidentale)–IUEM; Claude Bernard University in Lyon; University of Liège, Belgium; University of Pau and the Adour; French National School of Agricultural Sciences in Rennes; Lille University of Science and Technology; University of La Rochelle.

In other areas, four other partners are involved: the University of New Caledonia, Griffith University, SUPINFO (Higher Computer Science School), Paris and the Higher Engineering School of Luminy.

Training workshops and institutional strengthening

Whether in terms of training workshops, where participants received academic training or at discussion workshops where specialists exchanged experience and discussed methods and results, CRISP was very active: over the programme period, no less than **54 workshops** were held, an average of some 10 per year, of which 20 were training workshops and 34 were discussion workshops; this makes a total of over **1,600 participants** who benefitted from training or technical support (see Annex 3, pp. 161–164). More than half of these workshops took place in Fiji.

The areas of reef and resource status monitoring, MPAs and integrated watershed/governance were the most dynamic (see relevant sections):

- Reef and resource status monitoring (19 workshops): resource monitoring training (Fiji 2006, Vanuatu 2008); Reef Check training, with over 90 volunteers trained, for GCRMN training coordinators (November 2007); CoReMo training (Samoa, 2009); training in the SEM-Pasifika method; various workshops on ecology and census methods (Fiji 2007, 2008); and training in investigation methods (Moorea 2009). Under "Reefs at risk", the USP Institute of Marine Resources, in cooperation with WRI (World Resources Institute) and ICRAN, and with support from CRISP, organised a workshop on the risks to reefs (www.wri.org/project/reefs-at-risk).

- MPAs (11 workshops): training for Pacific MPA managers (Fiji, 2008); training in participatory management for the French Pacific territories (French Polynesia, 2009); various workshops connected with LMMAs, including a major event for exchanging experience between LMMAs (Fiji, 2008), with more than 100 participants from 16 countries; plus some local community workshops (Kiribati, Cook Islands, Fiji). A university course in MPA management approaches was also held at USP, Fiji.

- In the integrated management area, a workshop on remote-sensing and erosion modelling using a GIS (Noumea, 2008), and various watershed management training modules for local communities (Vanuatu, Fiji) were organised.

Key points

CRISP played a major role in capacity building in the region and in France: many students, managers, officials and local communities received assistance with research and study courses for qualifications, while in the field opportunities were available for improving management and monitoring skills and organising shared management of these territories.

Under the CRISP umbrella, 90 students, including 25 Pacific Islanders, studied for qualifications, mainly in the active substance sphere (30% of students), fish ecology, fisheries management and PCC (24%); of these 90 qualifications, 16 were high level, (doctorate and post-doctoral). Solid ties were established between the main French research partners concerned (EPHE/CRIOBE and IRD) and the University of the South Pacific, which hosted some 20 students: CNRS, two museums, 17 universities, including some of their laboratories, and five scientific faculties are involved. Most are French research bodies but four were either European (3) or Australian (1).

CRISP gave maximum support for the participation of these students at international events, especially the 11th International Coral Reef Symposium (ICRS) and PSI2009.

CRISP was also very active in capacity building work through training and discussion workshops; with 54 workshops held, an average of 10 per year, 20 of which were 'academic' type events and 34 of which were in a discussion format. This amounted to a total of more than 1,600 participants who received training or technical support. More than half of these sessions took place in Fiji. Reef monitoring (37% of workshops) and MPA/LMMA monitoring (22%) were the most popular topics.

Finally, through various components (MPAs, integrated watershed management, reef rehabilitation, reef monitoring), local communities were empowered in an intense but hard-to-measure way. Some 40 communities benefitted from this, in all, some 3,000 people according to our estimations.

Bibliography

Buliruarua L., Fenemor A. (2010). Best-practice Symposium on Community-based Reforestation/Watershed Management, Suva, Fiji, 02–04 Dec. 2009. Workshop report, USP/Landcare Research, 45 pp.

Buliruarua L.-A., Fenemor A. (2010). Best-practice Symposium on Community-based Reforestation/Watershed Management, Jun. 2010. Workshop report, 45 pp.

Chancerelle Y., Gulko D., Lison de Loma T., Planes S. (2009). Coral Reef CSI (Crime Scene Investigation) Workshop – CRIOBE, Moorea, French Polynesia, 26–30 May 2009. Workshop report, 16 pp.

Clua E. (2007). Building capacity and Cooperation for sustainable development of Pacific coastal Resources Forum, Townsville, Australia, 03–07 Sep. 2007. Proceedings, 29 pp.

Clua E. (2008). Séminaire sur le développement des filières postlarves pour le marché de l'aquariophilie, Aquarium de la Porte Dorée, Paris, 02 juil. 2008. Rapport séminaire, 24 p.

Comley J., Vave R., Cakacaka A., Meo S., Tawake A. (2006). Comparison of different UVC methodologies for assessing the effect of MPAs on reef fish abundance in Fiji. CRISP–IRD/ USP Workshop 22 Nov.–02 Dec. Workshop report, 21 pp.

Dumas P. Jimenez H., Léopold M. (2009). Training in community-based monitoring techniques in Emau Island, North Efate, Vanuatu, 40 pp.

Gabrié, C., Cros, A., Chevillon, C., Downer, A., Garrigue, C., Laboute, P., Kulbicki, M., Payri, C., Richer de Forges, B., Spaggiari, J. (2005). Analyse écorégionale marine de Nouvelle-Calédonie, Atelier d'identification des aires de conservation prioritaires-Nouméa, 10–11 août 2005. Rapport d'atelier, 96 p.

Govan H., Rupeni E., Chenet A., Troeng F., Heaps L., Cohen P., Dupré C., Bambridge T., Herrenschnidt J.-B. (eds) (2010). Gouvernance and management issues of marine managed areas, Moorea, French Polynesia, 15–19 Nov. 2009. Report on Workshop Theme 1, AAMP, 14 pp.

Beneficiary countries and sites/communities from CRISP activities

Fiji
Moturiki
Rotuma
Viti levu : Navakavu; Raki raki; Nakorotubu; Navutulevu; Muaivoso; Tavua, Yaqara

Vanuatu
Aneityum
Efate : Paonangisu Marou, Sama,
Takara, Siviri;
Emua Epau
Mystery island

Solomon
Marau
Langa Langa
Gela (Sandfly)

Tuvalu
Funafuti (Lofeagai)
Nanumea
Nukufetau

Samoa
Alepata
Safata

Kiribati
Tarawa
Betio
Bonriki
Phoenix

Micronesia
Ponhpei

Cook islands
Mitiaro
Muri Lagoon
Aitutaki
Muri lagoon (Avana)

PNG
Sunalailai

Wallis et Futuna
Wallis
Futuna
Alofi

French Polynesia
Tahiti
Moorea
Rangiroa
Tikehau
Bora-Bora

New Caledonia
Hienghène
Pouébo
Yves Merlet

Guilbeaux, M., Parras, T., Tan, W.(2008). The Locally-Managed Marine Area Network Indo-Pacific regional meeting : sharing lessons learned in community marine management accrss the Pacific. Workshop report, 112 pp.

Kaur, D., Emmanuelli, E. (2006). Using indicators to assess coral reefs ecosystems and fisheries health, 10–14 Apr. 2006. Workshop report, 57 pp.

Lecchini, D., Bala, S. (2008). Coral reef ecology and survey methods, USP, Suva, Fiji, 15–19 Sep. 2008. Workshop report, 21 pp.

Linch, J. Teitelbaum, A. (2008). Proceedings of the sub-regional Workshop on the Marine Ornamental Trade in the Pacific, 02–05 Dec. 2008, Noumea, New Caledonia, 70 pp.

Michael Guilbeaux, M., Parras, T., Tan, W. (2008). The Locally-Managed Marine Area Network Indo-Pacific regional meeting: Sharing lessons learned in community marine management across the Pacific, November 2008. Workshop proceeding, 112 pp.

Pascal, N., Mercier, J-R., Conner, N. (2008). Economics of Marine Managed Areas of the South Pacific (Suva workshop 26th to 30th of May 2008, Fiji). Proceedings, 40 pp.

Reytar, K., Burke, L., Spalding, M., Perry, A., South, R., Morris, C.(2009). Reefs at Risk Revisited: Pacific Regional Workshop – Institute of Applied Science, University of the South Pacific, Suva, Fiji, 16–18 March 2009. Workshop report, 18 pp.

SPC (2010). SPC regional terrestrial and Aquatic Animal Disease reporting Workshop, OIE (World Organisation for Animal Health) 21–25 June 2010. Workshop report, 26 pp.

Swarup, S. (2005). Report on the biodiversity, Phylogeny and Ecology of Porifera Course, 17–30 July 2005, Marseille, France. Training report, 27 pp.

Ubertini, M. (2009). Larval recruitment of the pearl oyster Pinctada Margaritifera: effects of conspecifics, predation and environmental factors, June 2009. Training course report, 41 pp.

Vieux C. (2009). Gestion participative pour les pays et territoires français du Pacifique, Vairao, Polynésie française, 23–26 nov. 2009. Rapport d'atelier, PROE, 56 p.

Vieux, C. (2008). Preliminary socio-economic monitoring (SEM-Pasifika). Assessment of Sinalailai area (Papua New Guinea). Report, 16 pp.

Waqalevu, V. P. (2009). Capture and culture techniques of coral reef fishes larvae (French Polynesia), February 2009. Training course report, 4 pp.

15. Creating stakeholder networks and developing partnerships

At the inception of the project, the first step was to put together the financial partnerships: AFD/FFEM and the United Nations Fund, initially with WWF and subsequently with Conservation International (CI), and also the French Pacific Fund, the French Foreign Affairs Ministry and IFRECOR (see Introduction). With coordination from Dominique Rojat at AFD, these partners brought the programme into existence. At the technical level, many partnerships were set up at the outset (see Introduction), but, in six years of operation, these partnerships and synergies developed substantially under the guidance of the Programme Coordinator, Eric Clua.

The first step was to tighten the ties between scientists. Work in close partnership with, for example, the University of the South Pacific in Fiji and the various French scientific bodies in the region such as IRD and the joint CNRS–EPHE–UPVD 5,244 research unit at CRIOBE is of special importance. The signing of a framework agreement between CRIOBE and USP gives sustainability to the scientific collaboration between these two bodies, which can jointly supervise PhD research work. Many partnerships were established between those organisations that cooperated in various CRISP Programme components and mainland French or local universities (for example IRD and the University of New Caledonia), but also, in addition to USP, with Pacific research agencies such as Landcare Research (New Zealand), the **Marine Environmental Research** Institute of **Pohnpei** (MERIP) and Australian entities. Under CRISP auspices, in December 2006, CRIOBE organised a scientific symposium on tropical island ecosystems in partnership with the University of the Ryukyus in Japan and the GUMP station of the University of California, Berkeley on Moorea. This event provided an opportunity to forge closer ties between French, American and Japanese scientists as well as those from the Pacific Islands, with the participation of USP. On the shark project, in 2010 SPC entered into association with Australian scientific bodies (JCU, CSIRO) and New Zealand agencies (NIWA, DOC) in order to strengthen sub-regional cooperation. Previously, the Townsville workshop in 2007 had already been a major scientific gathering of French and Australian personnel on cooperation for the sustainable development of small Pacific Island states.

While LMMA existed in the Pacific before the programme, CRISP helped it to expand and strengthened the ties between the partners through support for workshops, exchanges between managers and the establishment of new managed and protected marine areas, etc. In particular, CRISP made possible, for the first time, exchanges between marine areas in French overseas territories and the LMMA network, for the mutual benefit of their managers; the managers of the French territories learnt a lot from their LMMA counterparts in terms of methodology, especially as regards participatory assessment and management methods.

French consultants such as 'CAREX Environnement' were able to work with NGOs like SPI Infra of the GINGER group, FSPI (Foundation of the Peoples of the South Pacific International) and private operators (Ecocean, Tropical Fish Tahiti, Aquabiotech and TahitiEcoClam). The involvement of private sector operators is a notable feature of the PCC area, with a number of jointventures emerging between Ecocean and Hawaiian SeaLife Inc (HSL), Oteee Marine and HSL, MERIP and HSL, and also between NGOs (Te Mana O Te Moana) and private companies (BoraEcoFish).

Various international NGOs began to work together, notably WWF and CI, but also the Wildlife Conservation Society and The Nature Conservancy and such links were forged with many local and regional groups: FSPI, Wan Smolbag and FSP Vanuatu and Solomon Islands, ProScience in French Polynesia, PCDF in Fiji and TANGO in Tuvalu.

Partnerships with various government departments became closer: Fisheries Service of French Polynesia, Fisheries Departments of Vanuatu, Fiji, Solomon

Islands, etc. In this regard it should be stressed that CRISP prompted IRD to restore cooperation with Vanuatu and that two IRD scientists have since taken up residence to support the Fisheries Department.

At every opportunity for cooperation, in order to create synergies and avoid useless duplication, CRISP worked with other projects. The most relevant example is the very fruitful cooperation in reef restoration between CRISP and the "Coral Reef Targeted Research & Capacity Building for Management" project of the World Bank, which was working on the same issue; this led to two important worldwide guides on the topic, as joint publications associating expertise and funding. Other examples of leverage effects also deserve a mention: the contribution to the 'Micronesia Challenge', with CRISP involvement in Palau, where this initiative originated; a contribution to the 'Reefs at Risk' research in the Pacific; and promotion in the French Pacific territories of the 'Crime Scene Investigation' method for rationalising legal approaches after cases of damage to the integrity of coral reefs. Neither should it be overlooked that the programme regularly took part in ICRI meetings and thus significantly facilitated these partnership arrangements (see Chapter 12).

The achievement of closer ties between regional and international organisations and the French overseas territories is another high point worth noting, with special reference to SPREP.

CRISP made a significant contribution to forging closer ties between SPC (with its fisheries and reef resource management responsibilities) and SPREP (responsible in the environment and conservation areas). This renewed cooperation is expected to endure through future regional funding, in particular under the 10th EDF (European Development Fund).

CRISP PROGRAMME MAIN PARTNERS

DONORS

AFD (Agence française de Développement; French Development Agency)
FGEF (French Global Environment Facility)
French Pacific Fund (or SPP)
UNF (United Nations Foundation)
CI (Conservation International)
WWF–France, WWF–South Pacific and WWF–International
IFRECOR (Initiative française pour les Récifs coralliens; French Initiative on Coral Reefs)
SPREP (Secretariat of the Pacific Regional Environment Programme)
SPC (Secretariat of the Pacific Community)
WFC (WorldFish Center)
AAMP (Agence des Aires marines protégées; French Marine Protected Areas Agency)

VARIOUS INTERNATIONAL PARTNERS

UNEP (United Nations Environment Programme)
ICRI (International Coral Reef Initiative)
GCRMN (Global Coral Reef Monitoring Network)
ICRAN (International Coral Reef Action Netwrok)
Reef Check
World Bank, CRTR (Coral Reef Targeted & Capacity Buidling for Management)
US Fish & Wildlife Service

RESEARCH INSTITUTES AND ORGANISATIONS

CNRS/EPHE (CRIOBE UMR 5244)
IRD (Institut de Recherche pour le Développement; Research Institute for Development)
USP (University of the South Pacific)
Consortium for the Barcode of Life (The Smithsonian Institution)
CNRS (Centre national de la Recherche scientifique; French National Center for Scientific Research)
ENSAR (Ecole nationale supérieure agronomique de Rennes; National Agronomical School of Rennes)
Ecole nationale supérieure de Chimie de Lille (National Chemistry School of Lille)
Ecole supérieure d'Ingénieurs de Luminy de Marseille (National Engineering School of Luminy – Marseille)
Griffith University
Institut de Chimie des Substances naturelles (Institute of Natural Substances Chemistry)
Landcare Research (New Zealand)
MERIP (Marine and Environmental Research Institute of Pohnpei)
MNHN (Muséum national d'Histoire naturelle de Paris; National Museum of Natural History – Paris)
NIWA (National Institute of Water and Atmospheric Research – New Zealand)
Queensland Museum (Brisbane)
CSIRO (Commonwealth Scientific and Industrial Research Organisation – Australia)
Station marine GUMP (University of California, Berkeley, UCB)
SUPINFO (Ecole supérieure d'Informatique de Paris; Paris Institute of Information Technology)
Université Claude Bernard à Lyon (Claude Bernard University – Lyon)
Université de Bretagne occidentale (UBO) (University of Western Brittany)
Université d'Aix–Marseille (University of Aix-Marseille)
Université de la Rochelle (Universty of La Rochelle)
Université de Liège (University of Liège)
Université de Montpellier (University of Montpellier)
Université de Montréal (University of Montreal)
Université de Nantes – CDMO (Centre de Droit maritime et océanique) (University of Nantes – CDMO (Maritime and Oceanic Law Institute)
Université de Naples (University of Naples)
Université Pierre et Marie Curie Paris VI (UPMC) (Pierre and Marie Curie University – Paris VI)
Université de Pau et des Pays de l'Adour (UPPA) (Universty of Pau and the Adour Lands)

	Université de Perpignan Via Domitia (UPVD) (University of Perpignan Via Domitia) Université des Sciences et Technologies de Lille (University of Sciences and Technologies of Lille) University of the South Pacific (USP) Université Paul Sabatier (UPS) (Paul Sabatier University)
INTERNATIONAL AND REGIONAL NGOs	
	WWF (WWF–France et WWF–South Pacific) Conservation International (CI) Wildlife Conservation Society (WCS) The Nature Conservatory (TNC) FSPI (Foundation of the Peoples of the South Pacific International)
LOCAL NGOs	
France	Moana Initiative (France)
Vanuatu	FSP Vanuatu (Foundation for the Peoples of South Pacific Vanuatu or FSPV) Wan Smolbag Farm Support Association
Tuvalu	Alofa Tuvalu TANGO (Tuvalu Non-Governmental Organizations)
Solomon Islands	Reef Owners Association Tetepare Descendants' Association
CONSULTING AGENCIES	
	ARVAM (Reunion Island) Carex Environnement – Soproner/Ginger (New Caledonia) Ecocean (France) Ibulu (New Caledonia) Job Consulting (New Caledonia) Pae Tai Pae Uta – PTPU (French Polynesia) Te Mana O Te Moana (French Polynesia) Biocenose (New Caledonia)
PCC PRIVATE OPERATORS	
	Hawaiian SeaLife Inc (Hawaii) ORA (USA) BoraEcoFish (French Polynesia) Te Pukarea (Cook Islands) Tropical Fish Tahiti (French Polynesia)

TOURISM PRIVATE OPERATORS	
	Resorts of French Polynesia and Fiji Islands
ADMINISTRATIONS	
Samoa	Ministry of Natural Resources and Environment
French Polynesia	Fisheries and Pearl Oyster Culture Departments
	Ministry in charge of Environment
	Ministry in charge of Sea
New Caledonia	Administrations of the 3 provinces (Northern, Southern and Loyalty Islands)
	DTSI (Direction des Technologies et des Services de l'Information; Information and Technologies Department)
	ADECAL (Agence de Développement économique de Calédonie; New Caledonia Economic Development Agency)
	Service de Géomatique et de Télédétection (Geomatics and Remote sensing Services)
	SMMPM (Service de la Marine marchande et des Pêches maritimes; Merchant Marine and Oceanic Fisheries Services)
Tuvalu	Fisheries Department
Vanuatu	Fisheries Department
	Agriculture Department

CRISP PROGRAMME MAIN PARTNERS BY COMPONENT

MARINE PROTECTED AREAS AND WATERSHED MANAGEMENT (COMPONENT 1A)

Objective: community based management, strategic analysis of marine resource conservation and integrated management - watersheds and coastal - to reinforce sustainable development of coral reefs in the South Pacific.

- Financial partners: AFD, FGEF, French Pacific Fund (SPP), CI, WWF–France, IFRECOR, AAMP, New Zealand Aid Programme.
- Direct technical partners: CI, WWF–France, WWF–South Pacific, SPREP, FSPI, IRD, USP, IFRECOR PF, ASMPA, ProScience.
- Indirect technical partners: Users and local populations, Environment Department (Wallis & Futuna), PTPU, UPF, French Polynesia Government, New Caledonia Provinces, DTSI (NC).

KNOWLEDGE, MANAGEMENT AND USE OF CORAL REEFS ECOSYSTEMS (COMPONENT 2A)

Objective: improve knowledge, monitoring, management capacity and ecosystem resource development to reinforce sustainable development of coral reefs.

- Financial partners: AFD.
- Direct technical partners: EPHE–CNRS, IRD, USP.
- Main collaborators: SPC, Ecocean, ENSAR, French Polynesia Fisheries Department, Te Mana O Te Moana, resorts, users and local populations.

CORAL REEF ECOSYSTEMS REHABILITATION (COMPONENT 2B)

Objective: contribute to coral reef restoration techniques and their dissemination to promote their healthy functioning and sustainable productivity.

- Financial partners: AFD.
- Direct technical partners: GINGER SPI–INFRA, FSPI, PCDF, JOB Consulting, CRTR, IFRECOR, University of Newcastle.
- Main collaborators: Users and local populations.

DEVELOPMENT OF ACTIVE MARINE SUBSTANCES (COMPONENT 2C)

Objective: contribute to the knowledge and use of coral reef ecosystem benthic invertebrates as a source of marine active substances with pharmaceutical potential.

- Financial partners: AFD, IRD.
- Direct technical partners: IRD UMR 152 (Noumea et Toulouse), IRD UMR 7138 (Noumea).
- Main collaborators: USP, Queensland Museum, CNRS–ICSN, University of Nantes–CDMO, University of Perpignan Via Domitia, University of Western Brittany–IUEM–LEBHAM, GUMP Marine Station–UCB, Consortium for the Barcode of Life (Smithsonian Institution), MNHN.

DEVELOPMENT OF REEFBASE PACIFIC (COMPONENT 2D)

Objective: contribute to the knowledge and use of coral reef ecosystem benthic invertebrates as a source of marine active substances with pharmaceutical potential.

- Financial partners: AFD, UNF.
- Direct technical partners: UNEP, WFC.
- Main collaborators: ICRAN, GCRMN, SPC, SPREP, EPHE–CRIOBE, USP, IRD.

INSTITUTIONAL AND TECHNICAL SUPPORT, LESSONS LEARNED AND DISSEMINATION (COMPONENT 3A)

Objective: institutional and technical support for the programme's technical partners, integration, lessons learned and dissemination of the information (data, approaches, methods and know-how) obtained within the programme.

- Financial partners: AFD, UNF.
- Direct technical partners: UNEP, SPREP
- Main collaborators: ICRAN, UICN, SPC, EPHE–CRIOBE, USP, FSPI, LMMA Network, Pacific populations and governements, ARVAM.

COORDINATION, EVALUATION, PROMOTION AND DEVELOPPEMENT OF THE PROGRAMME (COMPONENT 3B)

Objective: Coordination and monitoring-evaluation of all components. Promotion of results and dissemination of outputs. Development of new projects and partnerships.

• Financial partners: AFD, FFEM, MAE, SPP, MEDD,
• Direct technical partners: SPC, SPREP, HSL, New Caledonia Provinces, IRD, CNRS, French Polynesia Government.
• Main collaborators: CI, CRIOBE, Griffith University, NIWA, CSIRO, ICRI, UICN, IDDRI, SCRFA, WFC, Biocenose, HSL, MERIP, Ecocean, BoraEcoFish, TahitiEcoClam, Te Mana O Te Moana, IRD, Aquaterra, ACREM.

Conclusions

Since its inception in 2005, the CRISP Programme's ambition has been to protect the reefs, provide support for more sustainable reef resource management practices, ensure that resource development brings benefits to local communities, and most importantly, to bring people closer together and be a vector for regional integration.

This document reports on six years of scientific and institutional cooperation in the South Pacific, in pursuit of the protection, management and beneficial use of coral reefs.

Six years of activity, total funding of some €15 million, 80 projects, 17 countries, some 40 partners deeply involved, including 20 or so financial partners, out of a total of around 100 partners who were associated with the programme, 400 documents produced: these figures illustrate how active CRISP has been, how diverse the stakeholders were and how rich the results are.

This report reviews those results; it summarises more than 200 scientific publications and 'grey literature' reports and describes the many tools developed under the Programme's auspices.

CRISP pursued a range of objectives:

- improved knowledge on biodiversity and on the status and functioning of reefs;
- ecosystem protection and management;
- beneficial resource development;
- knowledge dissemination;
- capacity building;
- establishment and strengthening of partnerships.

Many successes have been achieved, in particular the following (without minimising the importance of the other achievements):

Research on coral reefs, both basic research and applied research for development, was pursued in the areas of biology and ecology, in which coral reef research is the most intensive, but also in the pharmachemical, legal and social science areas. Major progress was made in our understanding of biodiversity, with 350 new stations explored and several thousand species described, including several hundred that were new for the areas investigated and more than 50 new to science; in pharmachemistry, with the discovery of 30 new active substances offering anti-malarial, anti-inflammatory and neuro-active properties; in ecology, with highly original and innovative results on issues like connectivity, population fragmentation, the sounds produced by fish, the use of taxonomy, etc. These results are of inestimable value as contributions to regional knowledge, especially given that the countries of the region are numerous and scattered, making access to knowledge very difficult. Many areas remain untouched and unexplored; CRISP has contributed to the discovery of some of them.

Considerable assistance was extended to the **protected and managed marine areas** in the region, with more than 50 MPAs of all kinds established and supported. MPAs have many kinds of impact in terms of food security, alternative income-generating activities, environmental and social resilience and local governance, making them an especially effective mode of intervention and investment, particularly in response to the consequences of climate change. They are also spaces for experimentation and integration, with great potential for associating diverse activities, and they made it possible for a number of CRISP components to operate simultaneously. But we know that MPAs do not become fully effective in five or six years, and that it can often take more than 10 years for them to achieve technical and financial autonomy.

Given this, some of the results acquired are fragile and still require external funding.

The approach to **governance** in this region, where the culture is a marine culture, produced totally new experiences, which many countries could refer to for inspiration. CRISP helped reinforce these governance approaches within communities and between communities that share an ecologically homogeneous territory, but also vertically, from communities to governments and vice-versa.

The integrated land-sea approach, from watershed to lagoon, was not, however, implemented as fully as had initially been hoped. This is a major issue for the small island states of the Pacific. The experience of Vanuatu, the only country where some degree of integration has been achieved, should be strengthened and replicated.

Fishery management, even if it did not appear as a full component of this programme, remains central to CRISP's concerns; fishery resources are vital for communities living near coral reefs, especially in this region. The goal is, of course, to protect biodiversity but also to ensure food security by establishing managed and protected areas. In order to more accurately assess the state of resources the effect of MPAs on their sustainability, and to get local communities more actively involved in the management of their vital resources, a major research effort within CRISP focused on the issue of methods. The idea was to develop easy-to-use, low-cost methods, accessible to technicians, with no large-scale scientific teams involved, while still producing reliable and high-quality results. It is a difficult exercise, as is the identification of robust and representative indicators, and these areas of research, which scientists have been exploring for some time, particularly as part of CRISP, are proving slow to provide practical solutions to managers.

Also in the fishery management area, and also in the hope of finding new income sources for local communities, PCC received special attention within the CRISP Programme. Research and development approaches were applied, the private sector was involved and the work was extended to countries where feasibility studies suggested it could be viable. Although the results obtained by CRISP with this fairly novel technique are promising, PCC is witnessing slow adoption in the region. There is still a long way to go in the light of the difficulties stemming from the current cost and the reluctance of many operators to get involved in the area, but CRISP has opened up new prospects for making the activity more profitable. Because of its high promise, this area has obtained extra funding from FFEM, and the projects are continuing.

Economic analysis of MPAs and their role in economic growth and poverty reduction are of great interest to AFD and FFEM. CRISP proved its ability to bring together regional and international skills around these new issues, in which the methods to be used are still under debate, but which are being increasingly seen as contributing to better protection and good management tools for decision-making. The initial results obtained by CRISP provide practical answers to confirm the benefits of investing in MPAs, but need further consolidation. On this topic, as with MPAs, CRISP will be pursuing its work for another two years.

The major **capacity building** effort at every level, involving students, technicians in national government departments, managers, and local communities, and producing scientific and technical potential and management abilities for the region, remains one of the undoubted achievements of CRISP. No less than 90 students, including 25 Pacific Islanders, obtained a qualification, some 1,666 people took part in training or discussion workshops, and some 40 local communities benefitted from field training projects, making a total of 3000 people altogether. Training for young taxonomists today, in a world where taxonomy, as essential as it is, has been downgraded by decision-makers and research managers, is one of CRISP's most valuable achievements. This heritage will endure come what may.

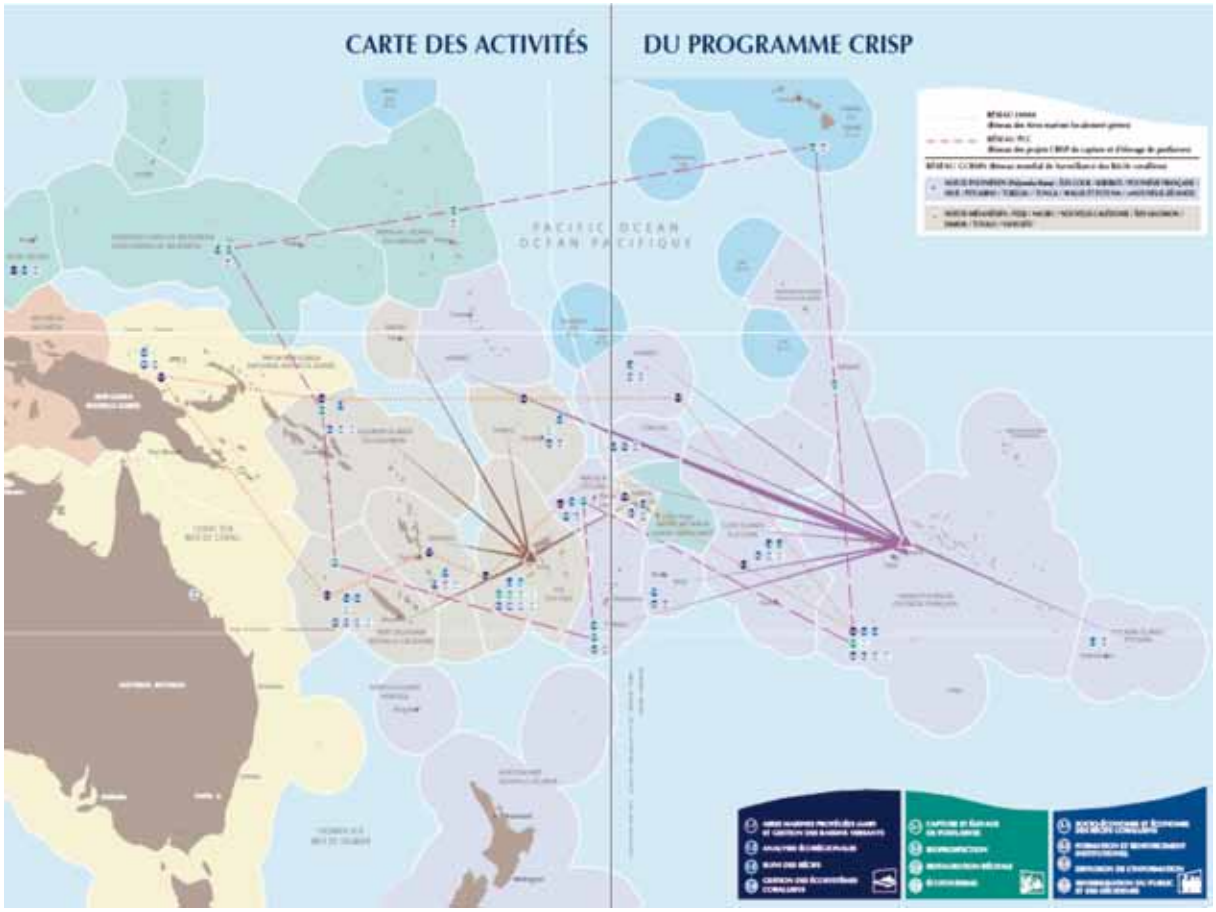
Building or reinforcing networks, establishing partnerships and achieving synergy between stakeholders were among CRISP's main goals and reflected its philosophy. The results speak for themselves; collaboration between NGOs, scientists,

managers, and politicians and cooperation with other international programmes such as ICRI and the World Bank's 'Coral Reef Targeted Research & Capacity Building for Management' were productive; many collaborative relationships were made official and will outlive the programme, as will some bilateral cooperation activities. One of the greatest successes remains strengthening ties between the French-speaking and English-speaking worlds, which were previously somewhat unconnected except for contact between scientists, and better integration of the French Pacific territories in regional programmes.

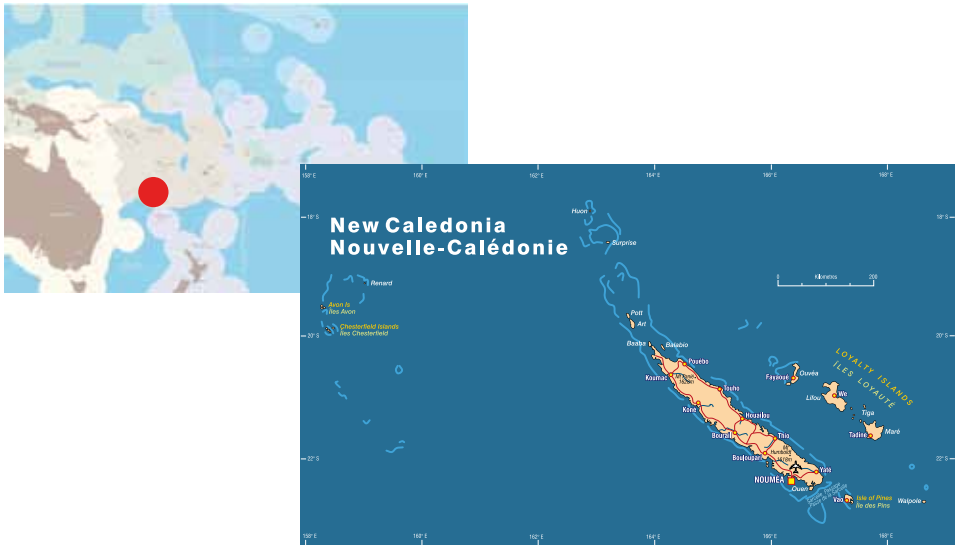
The smaller field-based NGOs, as well as the larger international and scientific NGOs made CRISP what it is; the number of people mobilised on projects in five or six years was remarkable and it is to them that CRISP owes its success.

Because of its involvement at every level, from international lobbying to very practical field work, often in very remote locations, and because it was able to promote multiple-source funding synergy and encourage broad dissemination of results and knowledge in two languages, CRISP will live on for a long time in the region. Through MPAs, PCC, improved governance, expanded capacity and new ties, it is very much present on the ground, and this heritage provides a sound foundation for continuing with current projects and others in the design stage (PICMAC, INTEGRE, various SPC projects).

Country profiles

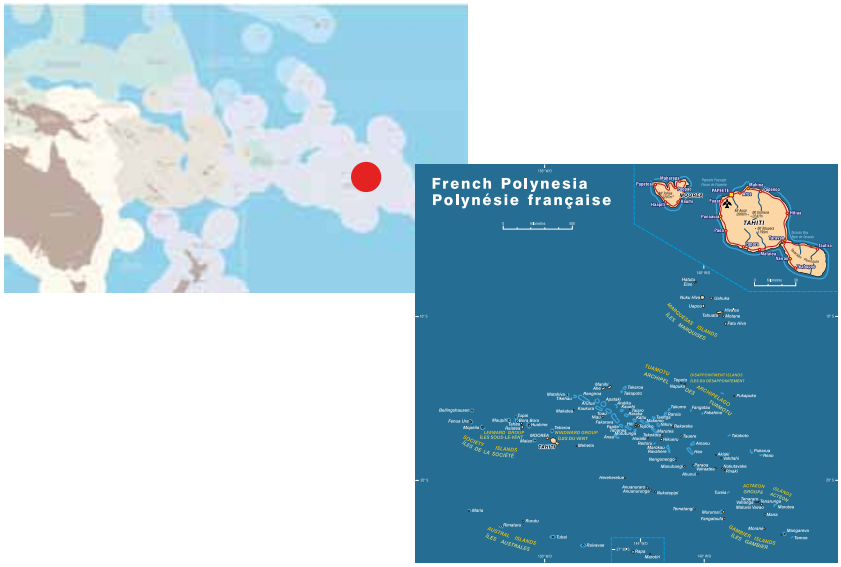


New Caledonia



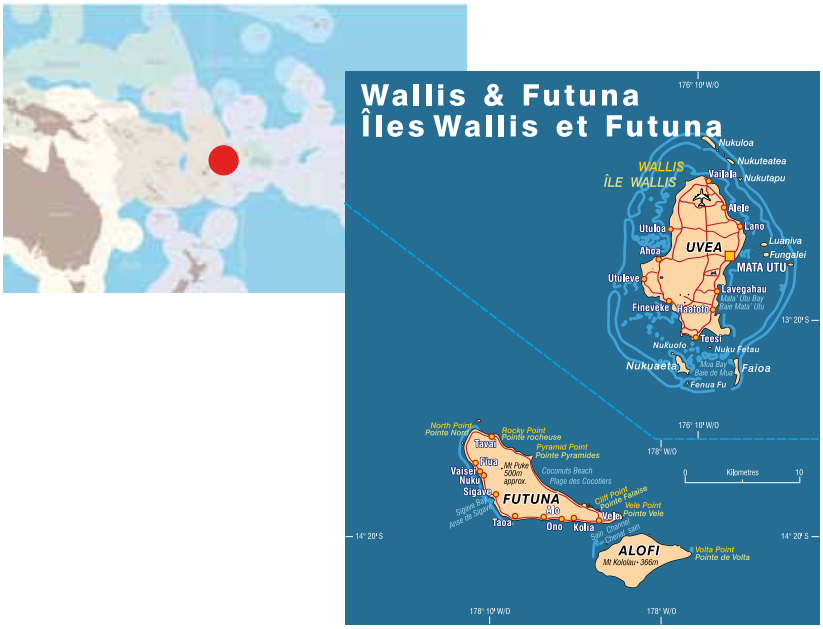
Partners	
Knowledge	Provinces, WWF–France, IRD, CI DTSI, SPC, SOPRONER, Southern Province, Northern Province, Loyalty Islands Province, WWF–France
PCC	IRD
MPA	WWF–France, Northern Province, IRD, DTSI, ADECAL, IFRECOR, UNC
Regional planning	WWF–France, IRD, DTSI, Provinces and many other stakeholders
Main activities	
Knowledge	Many sites explored: Diahot, Poum-Koumac, Great Northern Lagoon, Yambé-Diahoué MPA, Yves Merlet Reserve, Chesterfield. Helped formulate the request to have the New Caledonian reefs placed on UNESCO's List of World Heritage Sites, request granted in 2008. Coral: very rich (401 species), similar to that of the Great Barrier Reef in Australia. Seaweed: rich Sargassum flora (12 taxa). One new red seaweed described. Crustaceans: 176 species of decapods and stomatopods (~ 20% of local fauna), new ones reported. Prepared a preliminary list of land and swallow-water (< à 100 m) stomatopod and decapod crustaceans: 939 species. Great diversity of fish (nearly 3000 species), comparable to that in the Great Barrier Reef in Australia at equal latitudes. Iconic species are abundant, e.g. humphead wrasse, large groupers. Sharks (tiger and bulldog): SharkCal programme. Study of connectivity and study of New Caledonia as a wintering zone for South Pacific white sharks. Humpback whales (about 450 specimens in 2004): wintering in New Caledonia and reproduction in the Southern Lagoon and Isle of Pines. Proposed guideline for managing whale watching
PCC	Production of giant clam larvae (*Tridacna maxima*) to test the collection systems developed by the IRD (DECOVAN project). Validation tests in natural setting. Extension of project planned. 2010: study on developing new tools to catch larvae.
Watersheds	Estimated erosion rates in the Voh-Koné-Pouembout region (137 t/ha/year on average), Preliminary study to develop an integrated analysis method on the impact activities in a watershed (Dumbéa) have on coral reefs.
MPA	3 MPAs created (12,785 ha) : Yambé-Diahoué (MPAYD), Yeega-Hienga (MPAHI) and Dohimen (MPADO), all three included in the area included on UNESCO's World Heritage List. Management plans being developed, accompanied by promotion and educational activities. State zero of the Yves Merlet reserve.
Regional planning	ERA carried out from 2005 to 2007, in close coordination with the process to include New Caledonia's lagoon on UNESCO's World Heritage List. Indentified 19 priority areas for conservation. Analysed uses and pressure: demonstrated the large-scale harmful effects of soil deposits from erosion, discharge of waste water and infrastructures tied to urbanisation, poaching, overexploitation of marine resources. Study of social and traditional organisations in the Diahot and Hienghène zones. Formulated a policy paper: institutional strengthening and MPA management, MPA contribution to resource management and sustainable development, scientific research based on MPAs.
Reef monitoring	Member of the southwest Pacific GCRMN. 10 sites (31 stations) monitored between 2003 and 2007, including 6 sampled since 1997. Coral cover in 2007: 27%.
Resource status monitoring	Developed a rotating video system for fish censuses and 3 video techniques. Study on traditional environmental knowledge to manage community resources on Ouvea with 51 interviews with traditional leaders from different clans. Study on invertebrate communities on soft bottoms in distinctly different sites so as to test various taxonomic levels as descriptors of community trends and changes
TEV	Estimated the total financial value of the services generated by coral reefs and their associated ecosystems as part of IFRECOR.

French Polynesia



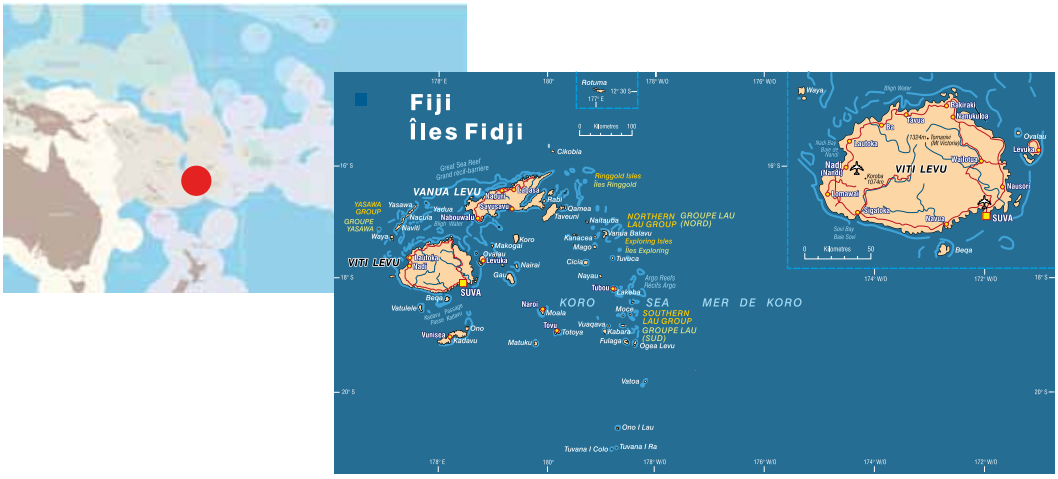
Partners	
PCC	Ministry of the Environment and Tourism, Fisheries Service, IFRECOR, Reef Check, Pae Tai Pae Uta (PTPU), Tropical Fish Tahiti (TFT), BoraEcoFish (BEF), CRIOBE
Integrated management	IRD Noumea, CNRS–EPHE
MPA	UNF, NGO ProScience, IUCN, AMPA
Regional planning	WWF–France, AMPA, Coastal Conservatory, Government
Main activities	
Knowledge	Crustaceans: illustrated guide of the Pacifique. Sharks: studies on the consequences of "shark-feeding" or on the genetic structure of populations. Study on natural and man-made influences on reef fish community diversity. Study on the acoustic behaviour of damselfish. Study on the effect extreme climate events have on ocean productivity and larvae supply in reefs.
PCC	Research on larval recruitment (fish, invertebrates, crustaceans and molluscs, high value species), on fish and crustacean harvest techniques (Bora Bora and Rangiroa,). Published a guide to identify reef fish larvae. Crustacean larvae grow-out on Rangiroa. Evaluation of export potential of ornamental fish postlarvae in the Marquesas. Report on an overall strategy to adapt trade laws.
Watersheds	MPAs and ground truths on Moorea and Tahiti (Tehapuoo): studies on modelling watersheds' vulnerability to erosion and runoff. Evaluation of the risks of water erosion and soil loss. Integrated management programme on Tehapuoo (GERSA): marine and land place names, land management; created a local environmental management committee.
MPA	Supported the Moorea PGEM (Moorea Reef Fisheries Management Plan) (49 sq m) and developed its business plan. Produced a bibliographic review on MPAs. Pacific Regional Conference on Marine Managed Areas (2009), with a session on governance and MPA management. Training in participatory management.
Regional planning	ERA: 2008–2010: expert opinions, analysis of island and reef geomorphology; study on uses and pressure. Topic-based workshops. 60 notable islands and identified Final strategy workshop (2009).
Reef monitoring	Member of GCRMN Polynesia Mana node. Reef Check: launched in 2000, supported by CRISP since 2006: public awareness, information, coral reef monitoring, controlling crown of thorn starfish invasions and communication. In 2007: more than 90 volunteers trained to monitor 61 sites, spread out over 11 islands in the Society, Tuamotu and Austral groups.
Resource monitoring	Developed a protocol to monitor Moorea MPA (with the involvement of volunteers). Study on the relevance of participatory approaches as part of ecosystem monitoring for reef fisheries on Moorea and Tikehau with surveys and fish catch monitoring. The monitoring done indicates overexploitation of resources on Moorea and sustainable fishing on Tikehau. Evaluation of the accuracy of and the bias included in fish consumption estimates during household surveys
TEV	Study on the economic value of lemon sharks on Moorea. Developed a business plan for the Moorea PGEM (Moorea Reef Fisheries Management Plan)
Tourism	Actions to develop eco-tourism: French version of the Fijian guide "Making small hotels and resorts environmentally sustainable: a simple checklist for Fiji operators". Prepared a practical guide on environmentally friendly approaches for tourist service providers and the companies that use them.

Wallis & Futuna



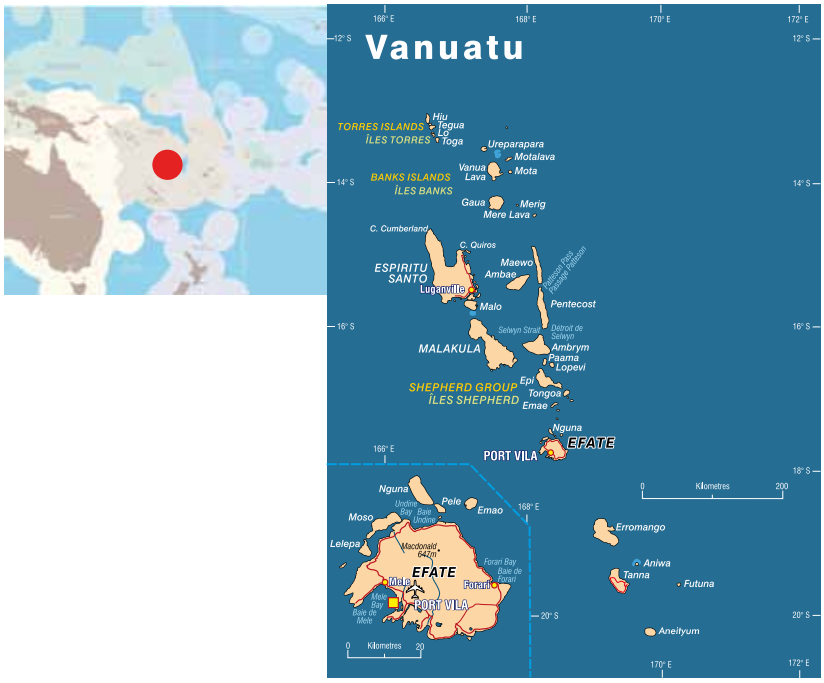
Partners	
MPA	NGO ProScience; Environment Department
Main activities	
Knowledge	Crustacean inventory: on Alofi (9 stations), Futuna (14 stations) and Wallis (8 stations). 127 species identified (provisional report), i.e. probably less than 10% of the cancer-fighting potential for this zone. At least 11 commercially interesting species were identified.
PCC	Work on fish larvae supply in the lagoon. The study showed the effectiveness of catching young stages of fish and invertebrates using fixed nets attached to rubble ridges. Some species of interest for the marine aquarium trade, such as the shrimp *Stenopus hispidus*, accounted for up to 6% of the larvae. Presentation about the techniques to traditional authorities.
MPA	Feasibility studies to develop a PGEM (Maritime Area Management Plan) for Wallis, Futuna and Alofi. The first study in 2007 revealed a serious level of degradation in the reefs of Alofi and Futuna. Recommendations for formulating a specific PGEM for Futuna and Alofi and another for Wallis, given the differences between the islands. Environmental assessments in Wallis and Futuna and Alofi: environmental inventory but, more importantly, a mapped analysis and diagnosis of how the lagoon is used and on induced pressures. Two atlases produced.
Reef monitoring	Member GCRMN Polynesia Mana node.

Fiji



Partners	
PCC	Ecocean, CRIOBE, USP
Reef restoration	CAREX Environnement – SPI Infra (GINGER group), FSPI, PCDF (Partners in Community Development Fiji)
MPA	FSPI, FLMMA WWF–South Pacific
Integrated management	USP, Landcare Research Institute (New Zealand), NGO FSPI, Government
Regional planning	CI, SPREP
Main activities	
Knowledge	Seaweed: 250 species collected (of the 463 listed), some of which were new to science. Sponges: 139 references. Taxonomic studies underway, 18 species that are probably news to science. Fish: Ethno-biodiversity work on fish: list of 226 common fish names in the Navakavu language, for 682 species. 118 species recorded on the Coral Coast. 12 to 43 species of reef fish recorded in Navutulevu.
Active marine substances	69 seaweed and sponge extracts analysed, 81 chemical substances extracted, including 5 new ones. Study on national legislation in the area of conserving marine biodiversity. 6 Fijian students trained.
PCC	Very comprehensive work on postlarval capture, larvae culture and repopulation. Created a grow-out farm. Evaluation of the potential for reseeding reef fish using PCC). Studies on the possibilities of value-adding (aquarium fish trade and luxury hotel industry). Study on legislative framework for aquarium fish trade with proposed adaptations. Numerous training sessions for students, technicians and fishers.
Reef restoration	Work to restore the reefs in Moturiki fishing reserve (2005–2006).
MPA	In the existing MPA in Navakavu: study on the use of fishers' views in participatory resource management and economic assessment of the value of MPAs. Workshops: management capacity building (September 2008), and exchanges of experience between LMMAs (November 2008).
Watersheds	Land cover/ground truths maps. Modelling erosion and sedimentation in northern Viti Levu (Tavua and Yaqara watersheds). Actions to restore and manage watersheds at two sites in northern Viti Levu (Rakiraki; Nakorotubu). Began building a community nursery with collection and planting of seeds from indigenous species and fruit trees. Workshops on participatory watershed management.
Regional planning	Support for ERP (Extinction Resistance Project): determining if the current network of marine management areas is effective in conserving endangered species and related critical habitats: about 100 marine species listed as vulnerable, endangered or threatened with extinction on the IUCN Red List. More than 200 sites or sectors identified as having at least one species this is on the IUCN Red List.
Reef monitoring	Member of the GCRMN – southwest Pacific network. FCRMN (Fiji Coral Reef Monitoring Network): 13 monitoring sites, demonstration of the Fiji reef systems' remarkable resistance capacities. Monitoring temperatures (since 1996). GCRMN Fiji meeting (March 2006) designed to determine the strategies to be implemented in order to gather coral reef monitoring data and effectively coordinate monitoring.
Resource monitoring	Navakavu: compared three reef fish monitoring methods. Used fishers' views to quantify changes in resources from 2002 to 2006. Muaivoso: compared four monitoring methods (workshop on techniques, 2006). Suva: workshop on using indicators to assess the health of reefs and fisheries (2006). Seminar on fish census surveys and estimating fish sizes (2008). Tried to indentify an alternative to UVC, based on CPUE (catch per unit effort).
TEV	Estimated total economic value of the reefs in the Navakavu marine area. Estimated the TEV of traditional fishing sites (Iqoliqolis).
Tourism	CRISP support for developing eco-tourism in the Pacific; Environmentally friendly certification approach. (BlueStar Coral Reef Friendly Initiative).

Vanuatu

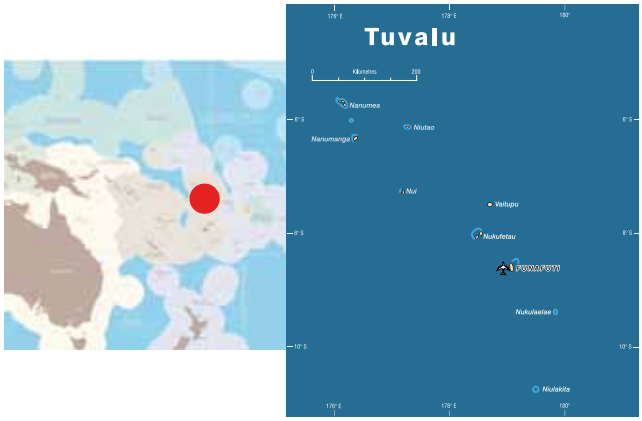


Partners	
PCC	SOPAC, Ministry of the Environment, SPREP IRD
SMA	IRD, French Government
Integrated management	NGO Farm Support Association, Government, Shefa Province Ministry of Forests, FSP Vanuatu (local FSPI representative)
MPA	Department of Fisheries, Wan Smolbag association, FSPV
Main activities	
Knowledge	Seaweed and marine spermatophytes: 284 species identified in the southern part of the island of Espiritu Santo (at least 9 that are new to science). Decapod crustaceans: in the illustrated guide to the Pacific.
Reef monitoring	Member of GCRMN southwest Pacific network. GCRMN: 57 sites (in 11 regions). Mean coral cover for the period 2005–2007: 26%. Training in reef monitoring techniques to provide scientific support to villagers: August 2008.
Resource monitoring	Resource monitoring over one year as part of economic assessment.
PCC	Tests to validate prototypes for harvesting mollusc larvae in situ (DECOVAN project). Extension of tests requested for the period 2011–2012.
Active marine substances	Legal study on existing legislation to protect marine biodiversity in 2007 (Beurier et al., 2008). Conference on legal literacy (Law of the Sea, 2007).
Integrated management	Efate: modelling and spatial distribution of watershed vulnerability to erosion and runoff: increase risk of soil loss on the coast while the central zone of the island (and nearby small islands in the north-west) appears to be healthy. Northern Efate: social and economic survey to strengthen governance. Follow-up to the ELMA (Efate Land Management Area) project: actions to restore and manage watershed on Efate and northern Aneityum. Epau: awareness and participatory diagnosis (2010): mapping resources, watershed and changes to it. Created a committee and a participatory action plan. Set up a nursery (whitewood, sandalwood, *Santalum australcaledonicium*, mahogany, *Canarium indicum*). Aneityum: actions to restore and manage watersheds; awareness campaigns, created 2 nurseries of about 1,000 sq m, and an *Acacia spirorbis* nursery.
MPA	7 village resource management zones created (northern Efate: 6 MPA, Aneityum: 1 MPA), with village management plans. Capacity building with about 25 communities to develop management plans, monitor and evaluate processes. Training in biological monitoring, fisheries monitoring, and turtle monitoring techniques. Set up a national network of VBRMA to build capacities and support the exchange of information between communities: 100 villages involved. For certain sustainable and autonomous sites, an exit strategy is being formulated.
TEV	Large-scale work to assess the socio-economic and ecological impact of MPAs: focus of the impacts on fisheries, estimated net economic benefits of MPAs, study on MPA spill-over effect.

Solomon Islands

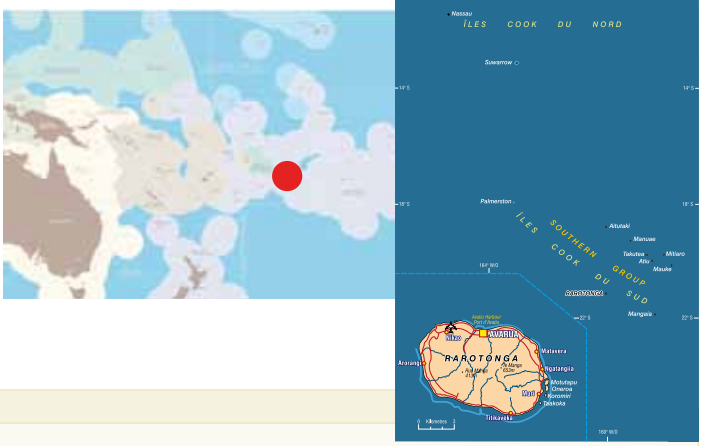
Partners	
Knowledge	Solomon Island Development Trust (SIDT), USP Queensland Museum of Brisbane
PCC	Ministry of Fisheries, WorldFish Center, exporters
SMA	IRD
MPA	NGO FSPI
PYOR	Ministry of the Environment, Conservation and Meteorology
Main activities	
Knowledge	Seaweed and marine spermatophytes: 216 species identified, including 132 new for the zone and 3 new to science. All studies combined, Solomon Islands has 332 species. Sponges: 194 species identified, including 35 new for the region and perhaps for science.
PCC	Developed a sustainable cultural project on ornamental marine products (coral, molluscs), so as to ensure the sustainable development of this activity, diversify the range of products and market them via the Internet. Development of a website (www.solomonseasustainables.com) and an eco-label underway.
AMS	106 extracts studied, using samples from seaweed, sponges and certain tunicates. 177 chemical substances extracted, including 32 new ones. Several new metabolites from sponges showed anti-malarial activity in vitro. Legal study on existing national legislation to protect marine biodiversity. Training for two students from Solomon Islands in the area of AMS. Reported on the results of bioprospecting in 2008.
MPA	Created or maintained MPAs: on Marau (8 MPAs created), LangaLanga (3 MPAs created) and Gela (6 existing MPAs supported). Management awareness and training activities in about 20 communities. Formulated resource management plans for each province. Restoration activities and setting up coral farms. Workshops on connectivity. Major benefit: capacity building in and empowerment of local communities.
Reef monitoring	Member of GCRMN southwest Pacific network. GCRMN: 5 permanent monitoring zones set up in 2004. Mean coral cover: 30%. The earthquake and tsunami in April 2007 damaged the reefs and other coastal habitats.
Awareness	PYOR 2008: awareness campaign on the importance of reefs, implemented through radio programmes. Organised various events (pamphlets and posters for schools and the general public, school contests, distribution of materials, prizes, etc.) Overall, the general public responded well to these information campaigns.

Tuvalu



Partners	
Reef restoration	Ministry of the Environment NGO TANGO (Tuvalu Association of Non Governmental Organisations) GINGER
MPA	NGO TANGO
Main activities	
Knowledge	Synopsis of existing literature on marine biodiversity: 1,453 species listed.
Reef monitoring	Member of GCRMN southwest Pacific network. GCRMN: in 2001 set up 6 monitoring sites on Funafuti. Two monitoring campaigns in 2003, another in late 2007. Mean coral cover in 2007: 65%.
Reef restoration	Reef restoration activities on Lofeagai (Funafuti atoll) : nearly 200 colonies on Acropora branchus transplanted over a 200 sq m zone. Monitored for 18 months after the work was completed in 2007. Involvement of local communities in the project. Communities and administrative staff: training and active participation in restoration work and, for some, in monitoring.
MPA	Developed community MPAs (MMA) in Nanumea and Nukufetau. Strengthened traditional MPAs. Formulated action plans to manage resources and watersheds. Raised awareness in communities about protecting resources in isolated atolls.

Cook Islands

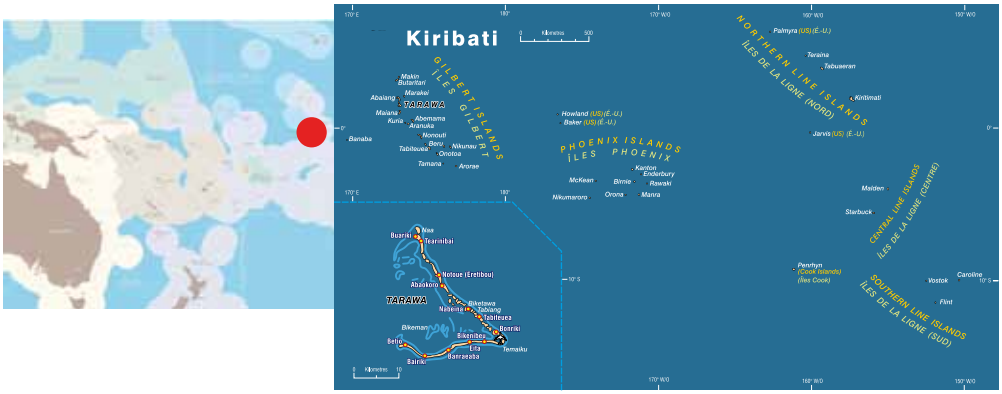


Partners	
ERA	WWF–South Pacific
MPA	WWF–South Pacific, NGO ProScience
PYOR	SPREP, National Environment Service, WWF–Cook Islands, Ministry of Marine Resources, Ministry of Labour, Te pukarea company
Main activities	
ERA	Analysis of the Polynesia-Cook eco-region: conducted by expert opinion during workshops. Identified 50 sites, distributed out over 17 islands. Northern islands given priority due to the still very virgin nature of their sea beds, the large numbers of groupers (*Cheilinus undulatus*) that gather to reproduce or the existence of unique habitats.
MPA	2 MPAs supported by WWF–South Pacific: Mitiaro and Muri Lagoon (0.83 sq km in total). On the 2 sites: community and school meetings, training workshops. Management plans and monitoring programmes formulated (Mitiaro) or revised (Muri Lagoon). Environmental assessment of the island of Aitutaki (ProScience and Pae Tai Pae Uta).
Reefs monitored	GCRMN : Member of GCRMN Polynesia Mana node
Awareness	PYOR 2008: held contests for schools and community groups, public exhibition on coral reefs, showed documentaries, radio programmes. Held a Takitunu Lagoon Day with exhibits and information stands to raise awareness in the community.

Papua New Guinea

Partners	
Knowledge	Ministry of the Environment, JCU, EPHE, SPREP IRD
Main activities	
Knowledge	Produced an atlas of the reefs in PNG as part of Millennium Coral Reef Mapping revealing the very wide diversity of reef formations in the region: 170 Level 5 continental categories covering 16,386 sq km; this is, to date, the highest number of categories observed in one country. Study on connectivity and larval dispersion in the Kimbe Island marine area. Study on the connectivity of the Kimbe Bay reserve network using paternity analysis for clownfish *Amphiprion percula*; local recruitment is estimated at 40% and larval dispersion can occur at distances of up to 35 km, the longest distance ever observed in reef fish. Comparison of two methods (assignation test and paternity analysis) to estimate larval retention rates and the connectivity between the clown fish populations of Bootless Bay, south of Port Moresby and Kimbe Island.
Socio-economic monitoring	Training workshop on socio-economic monitoring in the Pacific region (SEM-Pasifika). Preliminary socio-economic survey of the community of Sunalailai.

Kiribati



Partners	
PCC	Ecocean, Hawaiian SeaLife Inc, SPC, Ministry of Fisheries
MPA	FPSI, CI, Ministry of the Environment, FSPK (Foundation for the Peoples of the South Pacific Kiribati)
Main activities	
Reef monitoring	Member of GCRMN Polynesia Mana node.
PCC	CRISP funding for a project to purchase and sell postlarval products. Live Reef Fish Initiative: signed a contract to provide technical support for developing marine product trade activities which provide relatively significant levels of income for local communities. 2008–2009: pilot capture experiment planned on Christmas Island (Kirimati).
MPA	Created the largest MPA in the world, set up in the Phoenix Island group in 2006 (408,250 sq km, including 30% which is supposed have total protection as a non-fishing zone).

Samoa

Partners	
Regional planning	SPREP, CI, Sinaley Resort
MPA	Ministry of Natural Resources and Environment
Main activities	
Reef monitoring	Member of GCRMN southwest Pacific network. GCRMN: 8 permanent sites. For the period 2006–2007, mean coral cover was 43%. The results of the socio-economic monitoring revealed a decline in fish stocks.
Regional planning	8 land key biodiversity areas, (KBA) and 7 marine KBAs identified as part of a eco-regional analysis including three that are already partially protected by either the government or communities, and two that include small community fishing grounds.
MPA	CRISP support for formulating management plans for the Aleipata and Safata MPAs (created back in the early 2000s), for the period 2008–2010. The two sites benefit from a small trust fund designed to bolster their financial autonomy and cover management costs. In October 2009, the islands were hit by a tsunami. Most of the villages in the area covered by the MPA of Aleipata were destroyed and the reefs were seriously damaged. A CRISP fund was set up to help with reconstruction

Tonga

Partners	
	Ministry of the Environment
Main activities	
Reef monitoring	Member of GCRMN Polynesia Mana node.
Resource monitoring	Study on the effects fishing has on 81 reef fish species. The density of resilient species, which increase in line with fishing pressure, could be used as an indicator of the overexploitation of reef fish communities, as part of reef fisheries management.

Niue

Partners	
	Ministry of the Environment
Main activities	
Reef monitoring	GCRMN: Carried out a technical support mission to integrate the country in the Polynesia Mana reef monitoring network (C2A3).

Palau

Partners	
	CI, TNC, SCRFA (Society for Conservation of Reef Fish Aggregations)
Main activities	
Regional planning	Support for CI's PAN (Protected Area Network) in partnership with The Nature Conservancy as part of the Micronesian Challenge. Support for work on fish aggregation (SCRFA).

Tokelau

Partners	
	Ministry of the Environment
Main activities	
Reef monitoring	GCRMN: Carried out a technical support mission to integrate the country in the Polynesia Mana reef monitoring network (C2A3).

ANNEXES

Annex 1: CONTRIBUTION TO CONGRESS AND SYMPOSIA

Tahiti Aquaculture Papeete (French Polynesia) 06/12/2010 – 11/12/2010	PPT	Le CRISP et l'aquaculture	Clua E.
	Poster	Preliminary results on the potential use of eels for aquaculture in French Polynesia	Sasal P.
	PPT	Developing efficiency of capture methods of coral reef fish larvae in the South Pacific	Clua E., Lecchini D., Galzin R.
	PPT	Development of mantis shrimps (*Lysiosquillina maculate* and *L. Sulcata*): sustainable exploitation from capture and culture of post-larvae	Santos R., Brié C., Chevalier F., Remoissenet G., Lecchini D.
	PPT	Scientific knowledge on postlarvae capture and culture	Galzin R.
ICRI General Meeting Apia (Samoa) 08/11/2010 – 12/11/2010	PPT	CRISP 2005–2010: Lessons learned and next steps	Clua E.
	PPT	Pacific institutions involved in Reef conservation & management: A brief overview	Clua E.
	PPT	Reef Fisheries Session: Report and Agenda	Clua E.
International Institute for Fisheries Economics and Trade (IIFET) Montpellier (France) 13/07/2010 – 16/07/2010	PPT	Effects of MPA on small scale reef fisheries and communities: evidence from Vanuatu (South Pacific).	Pascal N., Clua E., Govan H.
Sharks International Conference (SIC) Cairns (Australia) 06/06/2010 – 11/06/2010	PPT	Business partner or simple prey? The economic value of the sicklefin lemon shark (*Negarpion acutidens*) in French Polynesia	Clua E., Buray N., Mourier J., Planes S.
INTERPRAEVENT International Symposium in Pacific Rim Taipei (Taiwan) 26/04/2010 –30/04/2010	Ext. Abst.	Assessment of soil erosion using USLE model and GIS for integrated watershed and coastal zone management in the South Pacific Islands	Dumas P., Printemps J.
International White Shark Symposium (IWSS) Honolulu (Hawaii) 07/02/2010 –10/02/2010	PPT	Elements of ecology of the Great White Shark (*Carcharodon carcharias*) in New Caledonia(South West Pacific)	Clua E., Seret B.
ICRI General Meeting Monaco (Principauté de Monaco) 12/01/2010 – 15/01/2010	PPT	Reef sharks: Why should they be protected?	Clua E.
Pacific regional Conference on MMAs Moorea (French Polynesia) 15/11/2009 – 19/11/2009	PPT	Past, present and future of MMAs	Clua E.
	PPT	Monitoring in the LMMA network	Comley J.
	PPT	Locally Managed Marine Areas in the Pacific	Govan H., Rupeni E.
	PPT	Presentation of Emua MMA (North Efate) – Sharing experiences	Lango K.
	PPT	Implementation of a marine protected areas network on the North-East coast of New Caledonia	Faninoz S.
	PPT	Initiatives dans le Pacifique	Renoux R., Heaps L.
	PPT	Enhancing MPA Effectiveness how far is Economic Analysis Effective?	Rojat D.
	PPT	Le PGEM de Moorea	Monier C.
	PPT	Les Aires marines protégées de Moorea – Six années de suivi : 2004 – 2009	Kernaleguen L., Chancerelle Y., Galzin R., Lison de Loma T., Planes S.
	PPT	Capacity Enhancement Project for Coral Reef Monitoring: a partnership of Palau International Coral Reef Center (PICRC) and Japan International cooperation Agency (JICA)	Shingo T.
	PPT	Scientific information and tools developed by OFP–SPC to design, monitor and assess oceanic and high seas MPAsin western and central Pacific Ocean	Allain V.
26th Meeting of the European Union of Aquarium curators Valence (Spain) 28/10/2009 – 01/11/2009	PPT	Recherches sur les larves de poissons dans le Pacifique Sud	Galzin R.
World Aquaculture 2009 Veracruz (Mexico) 25/09/2009	PPT	Post-larval marine fish collection technology or how to significantly increase the tank raised marine species list for the marine aquarium trade	Lecaillon G., Vermond S., Galzin R.

GDRI Colloque Inaugural Monaco (Principauté de Monaco) 01/09/2009 – 03/09/2009	PPT	Contribution potentielle du CRISP au GDRI (Groupement de Recherche International « Biodiversité des Récifs Coralliens »)	Clua E.
Fiji Conservation Science Forum Suva (Fiji) 05/08/2009 – 07/08/2009	PPT	Catch per unit effort (CPUE) survey of Fiji: Preliminary results	Comley J.
9th International Phycological Congress Tokyo (Japan) 02/08/2009 – 08/08/2009	PPT	New insights on the classification of the *Sargassum* subgenus *sargassum* (phaeophyceae, fucales) from a three-DNA markers phylogeny and morphological analyses	Mattio L., Payri C., Verlaque M., De Reviers B.
18th IMACS World Congrees MODSIM 09 Cairns (Australia) 13/07/2009 – 17/07/2009		Tools for soil erosion mapping and hazard assessment: application to New Caledonia, SW Pacific	Rouet I., Allenbach M., Selmaoui N., Ausseil A.G., Mangeas M., Maura J., Dumas P., LilleD.
2nd international Marine Protected Areas Congress (IMPAC2) Washington (USA) 19/05/2009 – 24/05/2009	PPT	Relevance of participatory approaches for ecosystemic monitoring of reef fisheries	Brenier A.
	PPT	Culture and updated traditional management tools for serving ownership in locally-managed marine areas.	Clua E.
	WKSP	Contribution of communities to marine conservation in the Pacific	Govan H.
ICRI General Meeting Phuket (Thailand) 20/04/2009 – 23/04/2009	PPT	Fish, food security, climate change	Bell J., Clua E.
Congrès Bourse Clam 2009 Montpellier (France) 28/03/2009 – 29/03/2009	PPT	Comment la PCC peut répondre à la problématique de durabilité de l'aquariologie marine ?	Lecaillon G., Galzin R.
Cooperation In Science and Education in the Pacific (PSI Side-event) Papeete (French Polynesia) 02/03/2009 – 06/03/2009	PPT	Le CRISP et la coopération régionale	Clua E.
	PPT	Information systems to support science and education cooperation in the Pacific	Morris C.
	PPT	Cooperation for Science 2 Action in the Pacific	Martel F.
	PPT	The Foundation of the Peoples of the South Pacific International	Rupeni E.
Governance Workshop (PSI Side-event) Papeete (Polynésie française) 02/03/2009 – 06/03/2009	PPT	Le CRISP et la gestion intégrée	Clua E.
Access and Benefit Sharing (ABS) Workshop (PSI Side-event) Papeete (French Polynesia) 02/03/2009 – 06/03/2009	PPT	Droit de la protection et de l'utilisation durable de la biodiversité marine en Mélanésie – Étude de cas : Fidji, Salomon, Vanuatu	Beurier J.-P.
	PPT	Le CRISP et les substances actives marines	Clua E.
	PPT	Le droit international des biotechnologies et ses relations avec la biodiversité	Guilloux B.
	PPT	Le droit applicable à la bioprospection marine en Mélanésie : l'exemple des Iles Fidji, Salomon et du Vanuatu	Guilloux B.
	PPT	Traditional ecological knowledge and intellectual property – The Pandora box?	Martinez C.
	PPT	Access and Benefit Sharing in non-commercial research	Schindel D.
	PPT	ABS aspects of the Moorea Biocode Project – Case study: French Polynesia	Brels S.
	PPT	Access and Benefit Sharing: Experiences from the Philippines, A megadiverse developing country	Ong P. S.
	PPT	IP issues associated with genetic resources and natural product development	Tom J.
	PPT	Current Issues in International Intellectual Property Law	Uhlir P. F.

11th Pacific Science Inter-Congress (PSI2009) Papeete (French Polynesia) 02/03/2009 – 06/03/2009	Poster	Analyse écorégionale marine de la Nouvelle-Calédonie	Gabrié C., Chevillon C., Bouvet G., Cros A., Downer A. et al.
	Poster	Anti-plasmodial activity and chemotaxonomy of Pacific Dysidea sponges	Chandra M., Lagneau D., Bonnard I., Erpenbeck D. et al.
	Poster	Études comportementales et de vulnérabilité de la population de requins citron (*Negaprion acutidens*) sur le site de « feeding » d'Opunohu à Moorea, Polynésie française	Buray N., Clua E., Mourier J., Planes S.
	Poster	"A cause for optimism": Identification of threats and resiliency on Pacific reefs through establishment of a long term reef monitoring network in Fiji: The Fiji Coral Reef Monitoring Network (FCRMN)	Sykes H., Lovell E.
	Poster	2008 Status of coral reefs in the South West Pacific (Fiji, New Caledonia, Samoa, Solomon Islands, Tuvalu and Vanuatu)	Morris C., Mackay K.
	Poster	Spatio-temporal structure of harvested tropical reef invertebrates: A case study on New Caledonian reef flats	Jimenez H., Dumas P., Ferraris J.
	PPT	Mapping potential soil erosion in the Pacific Islands: A case study of Efate Island (Vanuatu)	Dumas P., Fossey M.
	PPT	Live coral fishery for aquaria in Fiji: Sustainability and management	Lovell E., Morris C.
	PPT	Spatio-temporal structure and functioning of harvested intertidal marine invertebrates: application to New Caledonian reef flats	Jimenez H., Dumas P., Ferraris J.
	PPT	Toward appropriate indicators to assess the impact of coastal fisheries on reef fish communities in New Caledonia	Guillemot N., Le Pape O., Léopold M., Kulbicki M., Jollit I., Chabanet P.
	PPT	Analyzing spatial structure of recreational coastal reef fisheries in New Caledonia for management purposes	Jollit I.
	PPT	Heritage: the New Cultural and Institutional Challenge of Environmental Governance in the Pacific Islands	Herrenschmidt J.-B.
	PPT	Analyse écorégionale marine de Polynésie française	Lagouy E., Gabrié C., Brugneaux S., Clua E., Aubanel A.
	PPT	Reef Check Polynesia Coral reef monitoring network	Lagouy E., Clua E., Aubanel A.
	PPT	High definition video systems for monitoring biodiversity in marine protected areas	Pelletier D., Leleu K., Mou-Tham G., Hervé G., Guillemot N., Chabanet P.
	PPT	Recurrent large-scale disturbances, recovery trajectories, and resilience or coral assemblages on a coral reef in the South-Central Pacific	Adjeroud M., Michonneau F., Edmunds P., Chancerelle Y., Penin L., Vidal-Dupiol J., Salvat B., Galzin R.
	PPT	Behavior and vulnerability of the sicklefin lemon shark, *Negaprion acutidens*, on a shark-feeding site in Moorea, French Polynesia	Buray N., Clua E., Mourier J., Planes S.
	PPT	Sarasinosides of the sponge *Amorphinopsis excavans* from Solomon Islands	Partel K.
Sub-regional Workshop on the Marine Ornamental Trade in the Pacific Noumea (New Caledonia) 02/12/2008 – 05/12/2008	PPT	The development of PCC in the Pacific	Clua E.
11th International Symposium on Natural Product Chemistry (ISNPC) Karachi (Pakistan) 29/10/2008 – 01/11/2008	Poster	Preliminary chemotaxonomic and anti-fungal analyses of the marine sponge, *Dysidea* (Lamellodysidea) *herbacea*	Chandra M., Sotheeswaran S., Ali S., Bonnard I., Banaigs B., Petek S., Debitus C.
7th International Aquarium Congress (IAC) Shanghai (China) 19/10/2008 – 24/10/2008	PPT	Positive effects on the aquatic environment of using PCC as a source of tank-raised MAT products	Lecaillon G., Galzin R.
	PPT	Creation of an economic sector based on the capture and culture of post-larval reef fish and crustaceans for aquarium trade	Rojat D., Vallette P., Henard S., Hirel N.
34th Annual Conference of the International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC) Suva (Fiji) 14/09/2008 – 18/09/2008	PPT	The ReefBase Pacific project and information portal: Delivering information of reef associated livelihoods, fisheries and biodiversity	Cohen P.

11th International Coral Reef Symposium (ICRS) Fort Lauderdale (USA) 07/07/2008 –11/07/2008	Poster	Alpha and functional biodiversity-biomass relationships in coral reef fishes of the South Pacific	Kulbicki M., Vigliola L., Wantiez L., Mou –Tham G.
	Poster	Building regional taxonomic capacity supports marine management and biodiversity conservation efforts	Lovell E., Seeto J., Benito V.
	Poster	Changes in the coral reef populations within a community managed marine protected area in the Fiji Islands 1998–2008	Sykes H., Mackay K.
	Poster	Heavy metal accumulation in Scleractinian corals of Fiji Islands	Shah S., Lovell E.
	Poster	In-situ monitoring of sea temperatures in Fiji – An archipelago-wide monitoring programme	Lovell E., Sykes H., Bonito V., Kahn Z., Quinn N.
	Poster	Larval recruitment as a function of habitat degradation, lunar month and conspecifics	Mills S., Lecchini D., Parmentier E. Dumas P.
	Poster	*Pocillopora verrucosa* and *Pocillopora meandrina* are distinct species: Morphometric evidence	Vidal-Dupiol J., Pichon M.
	Poster	Putative involvement of host/symbiont recognition mechanisms in coral bleaching	Vidal-Dupiol J., Mitta G., Roger E., Allemand D. et al.
	Poster	The risk assessment of soil erosion for better management of coral reefs in the Pacific	Dumas P., Printemps J., Fossey M.
	Poster	Information systems focused on coral reef resources & management	Tan M.-K., Tupper M., Tewfik A., Oliver J. et al.
	PPT	Absence of common geographic barrier across the Indo-Pacific province for coral reef fishes	Planes S., Fauvelot C., Messmer V., Swarup S. et al.
	PPT	Coral reef management in the Pacific Islands: Governance at risk	Herrenschmidt J.-B., Dumas P.
	PPT	Coral reef monitoring in the South West Pacific 2007	Mackay K. T., Whippy-Morris C.
	PPT	Genetic parentage analysis reveals both local retention and large scale connectivity of clownfish in Kimbe Bay	Planes S., Jones G., Thorrold S.
	PPT	Impacts of informal fisheries on reef fish communities: A case study in New Caledonia (Western Pacific)	Guillemot N., Chabanet P., Léopold M., Le Pape O., Cuif M.
	PPT	Importance of post-settlement mortality on Scleractinian population maintenance around Moorea, French Polynesia	Penin L., Michonneau F., Baird A., Connolly S. et al.
	PPT	Lessons learnt from applied restoration projects	Job S.
	PPT	Life-history traits of rare coral reef fishes of the South Pacific region	Kulbicki M., Vigliola L., Wantiez L., Galzin R. et al.
	PPT	Rapid recovery from bleaching events – Fiji Global Coral Reef Monitoring Network (FGCRMN) assessment of hard coral from 1999–2007	Lovell E., Sykes H.
	PPT	Recurrent large-scale disturbances, recovery trajectories, and resilience of coral assemblages on a coral reef in the South-Central Pacific	Adjeroud M., Michonneau F., Edmunds P., Chancerelle Y., Penin L., Vidal-Dupiol J., Salvat B., Galzin R.
	PPT	Some hints about the impacts of watershed management on MPAs in the South Pacific Islands	David G., Dumas P., Mangeas M., Herrenschmidt J.-B.
	PPT	The relevance of traditional ecological knowledge for modern management of coral reef fisheries in the South Pacific	Léopold M., Herrenschmidt J.-B., Thaman R.
	PPT	Overview of the programme CRISP	Clua E.
Séminaire sur le développement de filières postlarves pour le marché de l'Aquariophilie Paris (France) 02/07/2008	PPT	Recherches sur les larves de poissons dans le Pacifique Sud	Galzin R.
	PPT	Socioéconomie de la PCC au travers de l'expérience acquise par Ecocean (Polynésie, Mayotte, Floride, Vietnam, Hawaï, Philippines, Hérault, Fidji, Réunion…)	Lecaillon G.
	PPT	Le CRISP et la PCC (Capture et Culture de Postlarves)	Clua E.
Doctoriales Midi-Pyrénées Toulouse (France) 01/06/2008 – 07/06/2008	PPT	Antimalarial compounds from marine sponges of the Solomon Islands	Mani L.
	PPT	Isolement et identification structurale des métabolites bioactifs d'éponges marines du Pacifique	Patel K.
Economics of marine managed areas of the South Pacific Suva (Fiji) 26/05/2008 – 30/05/2008	PPT	Introduction to CRISP workshop on economics of MPAs	Clua E.
Pacific Island Countries GIS/RS User Conference Suva (Fiji) 04/12/2007 – 07/12/2007	PPT	Habitat mapping of the Coral Coast reefs, Fiji Islands	De Mazieres J.

Modelling & Simulation International Conference (MODSIM) Christchurch (New Zealand) 01/12/2007 – 01/12/2007	PPT	An erosion model for monitoring the impact of mining in New Caledonia	Printemps J., Ausseil A.-G., Dumas P., Mangeas M., Dymond J., Lille D.
	PPT	Assessment of classification methods for soil erosion risks	Gay D., Rouet I., Mangeas M., Dumas P., Selmaoui N.
European Conference on Ecological Modelling Trieste (Italy) 27/11/2007 – 30/11/2007	PPT	Natural and anthropogenic influences on the species richness of reef fish assemblages in the Tuamotu archipelago (French Polynesia)	Mellin C., Ferraris J., Galzin R., Harmelin-Vivien M. et al.
Congrès national des Aires marines protégées Boulogne-sur-Mer (France) 20/11/2007 – 22/11/2007	PPT	Les actions de la coopération française concernant les aires marines protégées	Gauthier C.-A., Rojat D., Calas J.
European MPA Symposium Murcia (Spain) 25/09/2007 – 28/09/2007	Poster	Assessing the initial state of fish assemblages to adapt monitoring protocol for managers in a network of MPAs	Emmanuelli E., Ferraris J., Lison De Loma T., Osenberg C. W., Galzin R.
	PPT	A bioeconomic approach to assess the design and impacts of the creation of small size MPA using the ISIS-Fish model with NPV approach – The case of artisanal fisheries in Garraf (Spain, NW Mediterranean) and Tikehau (French Polynesia)	Pascal N., Maynou F., Pelletier D., Mahevas S., Ferraris J.
	PPT	Video-based observation techniques for monitoring fish assemblages in coral reef MPAs	Pelletier D., Leleu K., Mou-Tham G., Chabanet P. et al.
Vth European conference on marine natural products Naples (Italy) 16/09/2007 – 21/09/2007	Poster	Agelasines J and K from the Solomon Islands Marine Sponge *Agelas* sp.	Appenzeller J., Adeline M.-T., Martin M.-T., Gallard J .-F.
	Poster	Non brominated pyrrole-2 amino-imidazoles alkaloids from the Pacific marine sponge *Agelas* sp	Appenzeller J., Debitus C., Martin M.-T., Gallard J.-F. et al.
	Poster	Pyridoacridine alkaloids within purple morphs of *Cystodytes* spp. (Ascidiacea: Polycitoridae)	Bontemps-Subielos N., Simon-Levert A., Lopez-Legentil S., Banaigs B.
	Poster	Potent antiinflammatory active compounds from marine brown algae (Sargassaceae, Fucales)	Le Lann K., Bourguet-Kondracki M.-L., Longeon A., Ioannou E. et al.
Building Capacity and Cooperation for Sustainable Development of Pacific Coastal Resources Forum Townsville (Australia) 01/09/2007 – 07/09/2007	PPT	Brief overview of the CRISP Programme	Clua E.
	PPT	Building capacity and cooperation for sustainable development of Pacific coastal resources Forum	Wilkinson C.
	PPT	Secretariat of the Pacific Regional Environment Programme (SPREP) Marine and coastal programme	Benzaken D.
	PPT	Benefits and limitations of marine protected areas in fisheries management and biodiversity conservation	Jones G.
	PPT	Case study 3: Larval marking and parentage analysis to estimate retention within and connectivity among MPAs	Jones G., Planes S., Thorrold S., Almany G. et al.
	PPT	WWF–South Pacific Programme: Conserving our hidden gems	Heaps L.
	PPT	Securing community livelihoods through strengthening community based fisheries management and coral reef restoration – Solomon Islands, Tuvalu and Vanuatu	Rupeni E., Khan Z., Govan H., Wale V. et al.
	PPT	Pacific way and status	Veytayaki J.
	PPT	Incorporating resource valuation studies of coral reefs, mangroves and river catchments into decision and policy making processes: a way forward for the Pacific?	Gerbeaux P., Conner N., Vieux C.
	PPT	Three experiences of post larval capture and culture (PCC) in the Indo-Pacific: Technical, ecological and socio-economical observations	Galzin R., Lecaillon G., Lipchitz A., Malpot E. et al.
	PPT	Bioprospecting and capacity building as a short and long term benefit sharing	Debitus C, Hooper J.
	PPT	Technology and community-based management: Dilemna or challenge? – Vanuatu, Fiji, French Polynesia, New Caledonia	Herrenschmidt J.-B.
	PPT	Live rock and live coral trade in Fiji – Culture vs. wild harvest, financial assessment, issues and ways forward.	Vieux C.
Evolution 2007 Conference Christchurch (New Zealand) 16/06/2007 – 20/06/2007	Poster	Phylogenetic relationships of the genus Cribrochalina (Porifera: Demospongiae: Niphatidae van Soest)	Gonelevu M. D., Aalbersberg B., Lockhart P., Hooper J.

21st Pacific Science Congress (PSC21) Okinawa (Japan) 12/06/2007 – 18/06/2007	PPT	More than one decade of fish larvae fishing in French Polynesia	Galzin R, Grignon J., Remoissenet G.
	PPT	Community-based monitoring of coral reef fish resources in two contrasted islands of French Polynesia	Brenier A., Ferraris J., Galzin R.
	PPT	Sensories abilities and habitat selection in coral reef fish larvae/ Effects of alternate coral reef states on the attraction, settlement and subsequent survival of marine invertebrates and fish larvae	Lecchini D., Dumas P., Mills S., Banaigs B., Ponton D.
	PPT	Potential indicators of the status of reef fisheries based on the shifting dominance phenomenon among scarid species submitted to fishing pressure	Clua E., Legendre P.
	PPT	Marine zone management plan (PGEM) : A modern tool for a proactive management plan of islander communities	Egretaud C., Aubanel A., Benet A., Jouvin B., Monier C., Verducci M.
	PPT	Monitoring activities in Kiribati 2005; Comparison of results with 2004	Kirata T., Vieux C., Clua E.
	PPT	Rehabilitation of a lagoonary area under *Stegastes* colonisation	Egretaud C., Jouvin B., Guillemet L., Boudet R., Mathieu F.
	PPT	Recreational Fishing in New Caledonia Developing a Social and Spatial Analysis for Marine Resource Management	Jollit-Boniface I., Ferraris J., Lebigre J. M., Pelletier D., Chabanet P.
	PPT	Reef life and culture under threat: the conservation status of coral reef biodiversity and ethnobiodiversity in the Pacific Islands	Thaman R.
	PPT	The Ecological Importance and Ethnobiodiversity of Parrotfishes (Scaridae): A Pacific Island Perspective	Fong P., Thaman R.
	PPT	Are we measuring the Correct Parameters in Coral Reef Monitoring? Lessons from the Southwest Pacific node of the Global Coral Reef Monitoring Network	Mackay K. T., Whippy-Morris C., Sykes H.
	PPT	Some Hints about the Impacts of Watershed Management on MPAs in the South Pacific Islands	David G., Dumas P., Mangeas M., Herrenschmidt J.-B.
	PPT	Impact of an Expected Anthropogenic Disturbance in New Caledonia (South Pacific): which Methods should be used to Monitor Reef Fish Communities?	Guillemot N., Chabanet P., Pelletier D., Langlois T., Léopold M.
	PPT	Coral reef monitoring in French Polynesia: Objectives, management and results	Salvat B.
	PPT	Assessment of coral reef fisheries by a multidisciplinary panel of indicators: A comparative approach of 12 sites in two Pacific Countries	Ferraris J., Léopold M., Kronen M., Kulbicki M., Labrosse P.
	Poster	Reef Check Polynesia	Lagouy E.
	Poster	PCC (Postlarval Capture and Culture) potential after 14 months of collection in Fiji	Lecaillon G., Lourié S.-M., Grüss A., Vermont S., Galzin R.
BIODEC Symposium Noumea (New Caledonia) 30/10/2006 – 04/11/2006	PPT	The CRISP, a support for marine biodiversity conservation	Clua E.
	PPT	International and national tools for the conservation and management of coral reef biodiversity	Gabrié C., Mabile S.
	Poster	Building the co-management of fisheries in customary marine areas, Ouvea, New Caledonia	Léopold M., Herrenschmidt J.-B.
	Poster	Preliminary results of the eco-regional analysis (ERA) of the marine systems of New Caledonia for the conservation of marine biodiversity	Downer A., Gabrié C.
	Poster	Complex management of a multispecific fishery: the exploitation of coral reef fish larvae	Juncker M.
	Poster	Baited remote underwater video: A tool for the assessment and management of coral reef fish	Langlois T., Anderson M., Cappo M., Chabanet P., Merritt D., Mou-Than G., Harvey E., Pelletier D.
	Poster	Marine RAP survey of the coral reefs of the Mount Panié region, Northern Province, New Caledonia	McKenna S. A., Baillon N., Blaffart H., Cornuet N. et al.
3rd International Tropical Marine Ecosystems Management Symposium (ITMEMS3) Cozumel (Mexico) 16/10/2006 – 20/10/2006	PPT	Coral Reef Monitoring in a Sea of Islands: Lessons from the Southwest Pacific node of the GCRMN	Mackay K.
	PPT	Participative reef Restoration Project, Moturiki Island, Fiji	Job S.
Assises de la Recherche Papeete (French Polynesia) 09/10/2006 – 12/10/2006	PPT	The CRISP, a vector for regional collaboration	Clua E.

GECOREV Saint-Quentin-en-Yvelines (France) 26/06/2006 – 28/06/2006	PPT	Vers une gestion « culturelle » des milieux naturels en Océanie ?	Herrenschmidt J.-B., Clua E.
Asia Pacific Coral Reef Symposium Hong Kong (China) 18/06/2006 – 23/06/2006	PPT	From local knowledge to management of a coral reef ecosytem: Application to a mining development project in New Caledonia (West Pacific)	Chabanet P., Andrefouet, S. Baillo, N., Cornuet N., Ferraris J. et al.
World Maritime Technology Conference (WMTC) Londres (United Kingdom) 06/03/2006 – 10/03/2006	PPT	A specific approach for coral reef conservation and development in SIDS (small island developing states) – the CRISP Programme	Clua E.
SUVA Lagoon Symposium Suva (Fiji) 30/03/2005 – 01/04/2005	Poster	Coral reefs and exploitation of their resources in the South Pacific	Ferraris J., Léopold M., Galzin R., Schrimm M.

Annex 2: SYNTHESIS, GUIDES AND METHODOLOGICAL MANUALS

Author(s)	Year	Language	Title	Publisher	Pages
CORAL REEF REHABILITATION					
Edwards A.J., Gomez E.D.	(2007)	FR, ENG	Reef restoration, concepts and guidelines : Making sensible management choices in the face of uncertainty	Coral Reef Targeted Research & Capacity Building for Management Program: St Lucia, Australia	38
Edwards A.J. et al.	(2010)	ENG	Reef Rehabilitation manual	Coral Reef Targeted Research & Capacity Building for Management Program: St Lucia, Australia	166
PCC (Postlarval Capture and Culture) and IDENTIFICATION GUIDES					
Galzin R., Remoissenet G., Maamaatuaiahutapu M.	(2006)	FR	Guide d'identification des larves de poissons récifaux de Polynésie française	Editions Thétys	104
Juncker M.	(2007)	FR, ENG	Young coral reef fish of Wallis Islands and the Central Pacific identification guide	Service territorial de l'Environnement de Wallis et Futuna, CRISP	170
Poupin J., Juncker M.	(2008)	FR	Crustacés des Îles Wallis et Futuna : inventaire illustré, espèces commercialisables et capture des formes larvaires	CRISP	48
Poupin J., Juncker M.	(2010)	FR, ENG	A guide to the decapods crustaceans of the South Pacific	CRISP, SPC, Noumea, New Caledonia	323
Lecaillon G., Lourié S.-M.	(2007)	FR	La PCC un outil pour la conservation et la valorisation de la biodiversité, applications et perspectives de la collecte et de l'élevage de postlarves marines pour le développement durable	Moana Initiative, Ecocean, CRISP	39
MONITORING OF CORAL REEFS AND RESOURCES					
Wilkinson C. (Ed.)	(2005)	ENG	Status of coral reefs of the world: 2004 Volume 1	Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia	264
Wilkinson C. (Ed.)	(2005)	ENG	Status of coral reefs of the world: 2004 Volume 2	Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia	316
Wilkinson C. (Ed.)	(2008)	ENG	Status of coral reefs of the world : 2008	Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia	304

Sulu R. (Ed.)	(2007)	ENG	Status of coral reefs of the South West Pacific: 2004	IPS Publications, University of the South Pacific, Suva, Fiji	274
Quod J.-P. et al.	(2010)	FR, ENG	CoReMo 3 Coral Reef Monitoring Data Entry System User's manual	ARVAM	66
Pelletier D., Leleu K.	(2008)	FR	Utilisation de techniques vidéo pour l'observation et le suivi des ressources et des écosystèmes récifo-lagonaires	Zoneco, IRD, Ifremer, CRISP	81
Guilpart N., Pelletier D., Leleu K., Mallet D., Hervé G.	(2008)	FR	Guide méthodologique pour la mise en œuvre et l'analyse des stations vidéo rotatives	IFREMER, CRISP	65
Gulko D., Goddard K., Ramírez-Romero P., Brathwaite A., Barnard N.	(2008)	FR	Manuel de police scientifique en milieu corallien, Un guide pour les gestionnaires et enquêteurs en milieu corallien	International Coral Reef Action Network (ICRAN), Cambridge, UK	282
Wongbusarakum S. Pomeroy B.	(2008)	ENG	SEM-Pasifika socioeconomic monitoring guidelines for coastal managers in Pacific island countries	SPREP	138
MISCELLANEOUS					
Cohen P., Dikoila A. Valemei, Govan H.	(2008)		Annotated bibliography on socio-economic and ecological impacts of marine protected areas in Pacific island countries	WorldFish Center	42
David G., Herrenschmidt J.-B., Mirault E., Thomassin A.	(2007)	FR, ENG	Social and economic value of Pacific coral reefs	CRISP	49
Gorchakova E.	(2010)	FR	Mon hôtel devient durable	Te Mana O Te Moana, CRISP	32
Govan, H. et al	(2009)	FR, ENG	Status and potential of locally-managed marine areas in the South Pacific: meeting nature conservation and sustainable livelihood targets through wide-spread implementation of LMMAs	SPREP/WWF/WorldFish Center–ReefBase Pacific/CRISP	95
Petit M.	(2009)	FR	Guide pratique des gestes écoresponsables	Te Mana O Te Moana, CRISP	20
Salvat B., Allemand D.	(2009)	FR, ENG, SP	Acidification and coral reefs	CRISP	32
Beurier J.-P., Guilloux B., Zakovska K.	(2008)	FR, ENG	Marine biodiversity law in Fiji, Solomon and Vanuatu Islands	CRISP	118

Annex 3 : TRAINING WORKSHOPS AND TECHNICAL SEMINARS

Name of the event organizations involved Place	Started	Ended	Number of participants
PROGRAMME MEETINGS			
Inaugural technical workshop of the CRISP Programme AFD/SPP Noumea (New Caledonia)	24/01/2005	28/01/2005	50
Component 2A annual general meeting CRIOBE/EPHE–CNRS/USP/IRD Moorea (French Polynesia)	02/04/2007	05/04/2007	32
GERSA Seminar IRD UR Espace Noumea (New Caledonia)	16/04/2007	19/04/2007	15
Component 2A annual general meeting IRD/EPHE/CNRS/USP Noumea (New Caledonia)	05/02/2008	08/02/2008	45
ECOREGIONAL ANALYSIS (ERA)			
Atelier d'identification des aires de conservation prioritaires – Analyse écorégionale de Nouvelle-Calédonie WWF/IRD/DTSI NC/IFRECOR Noumea (New Caledonia)	10/08/2005	11/08/2005	42
Atelier vision et stratégie WWF/DTSI NC/IFRECOR/IRD Noumea (New Caledonia)	13/11/2007	15/11/2007	150
MARINE PROTECTED AREAS (MPAs) & MANAGEMENT			
Community-Based Coastal Resource Management TANGO/FSPI–FSPK Tarawa (Kiribati)	08/08/2005	12/08/2005	1
Community-Based Coastal Resource Management TANGO/FSPI–FSPK Uvea (Wallis & Futuna)	12/11/2005	16/11/2005	1
PIPA World Heritage workshop GovK/MELAD/PIPA/UNESCO/CI/NEAq Tarawa (Kiribati)	12/12/2007	14/12/2007	22
META-ANALYSIS workshop FLMMA/IAS–USP Suva (Fiji)	26/09/2006	28/09/2006	11
Community Leaders & Monitors Training Workshop FLMMA Ucunivanua (Fiji)	27/05/2007	31/05/2007	37
LMMA Network-Wide Conference LMMA/USP/SPREP/Packard Foundation/MacArthur Foundation/NZAID Suva/Vatuo–Lailai (Fiji)	03/11/2008	07/11/2008	107
Management tools Avana-Muri Workshop WWF/ SPREP/IFRECOR/LMMA Raratonga (Cook Islands)	31/03/2008	02/04/2008	8
Aitutaki Island Ra'ui Community workshop WWF/SPREP/IFRECOR/LMMA Aitutaki (Cook Islands)	03/04/2008	04/04/2008	50

MPA Management Capacity Building Training USP/IOI–OL/USAID/NOAA Suva (Fiji)	08/09/2008	13/09/2008	9
PIMMA-U Course – Academic Training in Pacific Island Marine Managed Areas IAS–USP Suva (Fiji)	08/11/2008	13/11/2008	24
Formation à la gestion participative pour les pays et territoires français du Pacifique SPREP Papeete (French Polynesia)	23/11/2009	26/11/2009	24
WATERSHEDS MANAGEMENT			
RESEM (Remote Sensing and Erosion Modelling) workshop IRD UR Espace Noumea (New Caledonia)	23/06/2008	27/06/2008	6
The Best-practice Symposium on Community-based Reforestation/Watershed Management USP/Landcare Research Suva (Fiji)	02/12/2009	04/12/2009	28
Epau community workshop (COWRIE project) USP/GovV/Shefa Prov/FSPI/FSPV Epau (Vanuatu)	23/02/2010	24/02/2010	42
Epau community workshop: Buffer Zone Restoration and GPS mapping (COWRIE project) USP/GovV/Shefa Prov/FSPI/FSPV Epau (Vanuatu)	03/03/2010	05/03/2010	30
Nakorotubu Watershed Management Awareness Workshop (COWRIE project) USP/GovF Nakorotubu (Fiji)	09/03/2010	11/03/2010	66
Tikina Rakiraki Natural Resource Workshop (COWRIE project) FLMMA/USP Tikina (Fiji)	28/03/2010	31/03/2010	60
Naroko Reforestation Project Training (COWRIE project) USP/Gov F Naroko (Fiji)	01/04/2010	30/04/2010	120
Nakorotubu Watershed Management Planning Workshop (COWRIE project) USP/Gov F Nakorotubu (Fiji)	07/04/2010	08/04/2010	36
Tikina Nakorotubu Nursery Training (COWRIE project) USP/Gov F Nakorotubu (Fiji)	31/05/2010	04/06/2010	35
ACTIVE MARINE SUBSTANCES (AMS)			
Biodiversity, Phylogeny and Ecology of Porifera Course IRD/CNRS/USP Marseille (France)	17/07/2005	30/07/2005	40
MONITORING			
Navakavu Marine Resource Inventory Survey Data Analysis Workshop FLMMA/USP Suva (Fiji)	21/08/2006	22/08/2006	14
GCRMN Review and Planning Meeting USP Suva (Fiji)	06/03/2006	07/03/2006	45
GCRMN South West Pacific Node Report Writing Workshop GCRMN/USP Suva (Fiji)	05/11/2007	09/11/2007	6

GCRMN Training Southwest Pacific Node GCRMN/USP Suva (Fiji)	12/11/2007	16/11/2007	4
Coral Bleaching Rapid Response Communications Meeting WWF Suva (Fiji)	07/03/2006	07/03/2006	45
Using indicators to assess coral reef ecosystem and fisheries health Workshop IRD/USP/EPHE/CNRS Suva (Fiji)	10/04/2006	14/04/2006	32
Comparison of underwater survey techniques of reef fish monitoring Workshop IRD/USP Suva (Fiji)	21/11/2006	02/12/2006	20
Coral Reef Monitoring Training Workshop GCRMN/CRIOBE Moorea (French Polynesia)	26/02/2007	02/03/2007	7
Reef Monitoring Training for Department of Fisheries GCRMN Lami (Fiji)	21/06/2007	21/06/2007	17
Coral Reef Ecology & Survey Methods Workshop USP/WFC/IRD UR CoReUs Suva (Fiji)	15/09/2008	19/09/2008	64
Underwater Biological Monitoring Training IRD/VFisheries/FSPV/Wan Smolbag/SPREP Emau (Vanuatu)	01/08/2008	31/08/2008	10
SEM-Pasifika SocMon in the Pacific NOAA/SPREP Nadave (Fiji)	04/05/2007	05/05/2007	13
SEM-Pasifika Train-the-trainers Workshop SPREP/NOAA Galahi (Papua New Guinea)	29/10/2007	02/11/2007	18
Socioeconomic Monitoring Workshop for Coastal Managers in Pacific Island Countries (SEM Pasifika) NOAA/SPREP Pago Pago (American Samoa)	24/02/2009	05/03/2009	1
Analysis of Multivariate Data from Ecology and Environmental Science using PRIMER v6 WFC Penang (Malaysia)	23/07/2007	27/07/2007	1
Responding to Climate Change: A workshop for Coral Reef Managers NOAA/GBRMPA/TNC Pago Pago (American Samoa)	27/08/2007	30/08/2007	27
Socio-economic Survey Training (GERSA project) IRD UR Espace Efate (Vanuatu)	01/08/2008	31/08/2008	15
CoReMo 3 workshop ARVAM/SPREP/NOAA Apia (Samoa)	09/09/2009	11/09/2009	11
Reefs at risk Pacific Regional workshop WRI/ICRAN/WFC/ReefBase Pacific/USP Suva (Fiji)	16/03/2009	18/03/2009	32
Coral Reef CSI (Crime Scene Investigation) workshop ICRI/ICRAN/US Department of States/NOAA/CRIOBE Moorea (French Polynesia)	26/05/2009	30/05/2009	15

ECONOMIC EVALUATION			
Economics of Marine Managed Areas of the South Pacific SPREP/IUCN Suva (Fiji)	26/05/2008	30/05/2008	30
CRISP Economic workshop – Investing in coral reefs: Is it worth it? SPC/IUCN/SPREP/IRCP Noumea (New Caledonia)	22/11/2010	26/11/2010	40
MISCELLANEOUS			
Tropical Island Ecosystems and Sustainable Development CRIOBE-CNRS-EPHE/COE Ryukyus/UCB Moorea (French Polynesia)	02/12/2006	07/12/2006	60
Hydrology (Soil Conservation Measures) Training on the Field IRD UR Espace Efate (Vanuatu)	15/07/2008	30/07/2008	2
Spawning Aggregation workshop SPC/SCRFA Suva (Fiji)	07/10/2009	10/10/2009	15
OIE World Org. For Animal Health workshop SPC/PIFS-EU/NACA/WSI Inc. Suva (Fiji)	21/06/2010	25/06/2010	30
GIS ArcView training PTPU/ProScience Papeete (French Polynesia)	14/09/2010	25/10/2010	1
TOTAL NUMBER OF PARTICIPANTS			1,666

Annex 4 : STUDENTS TRAINED WITHIN THE CRISP FRAMEWORK

Level	Year	Comp.	Title	Student	Country	Institute or University
ACTIVE MARINE SUBSTANCES (AMS)						
Postdoc	2006	2C4	Taxonomy of algae from Santo Island (Vanuatu)	Antoine N'Yeurt	Fiji	IRD
PhD	2008	2C4	Extraction d'éponges marines du genre *Agelas* et synthèse biomimétique d'alcaloïdes pyrooles-2-aminoimidazoles: vers la synthèse totale de la palau'amine et de ses congénères	Jérôme Appenzeller	France	Univ. Paris XI (ICSN–CNRS)
PhD	2008	2C4	Taxonomie du genre *Sargassum* (Fucales, Phaeophyceae) en Nouvelle-Calédonie et dans le Pacifique Sud - Approches morphologique et moléculaire	Lydiane Mattio	France	Univ. Aix–Marseille (IRD Noumea)
PhD	2009	2CA	Etude de la biodiversité des Sargassaceae (Fucales, Phaeophyceae) en milieu tempéré et tropical : écologie, chimiotaxonomie et source de composés bioactifs	Klervi Le Lann	France	UBO
PhD	2009	2C4	Phylogénie des Corallinales (Rhodophyta) et analyse de leur diversité génétique dans le Pacifique Sud	Lucie Bittner	France	MNHN (IRD Noumea)
PhD	2009	2C4	Phylogénie et biogéographie des morphotypes du genre *Laurencia* (Ceremiales, Rhodomelaceae)	Julie Martin Lescanne	France	MNHN
PhD	2010	2C4	Extraction de métabolites bioactifs d'éponges marines du Pacifique Sud	Kirti Patel	Fiji	MNHN (ICSN–CNRS/IRD)
PhD	2010	2C4	Produits naturels marins antipaludiques des Iles Salomon	Luke Mani	Solomon Islands	UPS Toulouse 3 (IRD)
PhD	2010	2C1	Les aspects juridiques de l'utilisation des ressources biogénétiques marines	Bleuenn Guilloux	France	CDMO–Univ. Nantes
PhD	2011	2C1	La protection de la biodiversité marine en droit international	Karolina Zakovska	France	CDMO–Univ. Nantes
Master 2	2006	2C3	Recherche de nouveaux principes actifs antipaludiques dans les spongiaires des Iles Salomon	Vincent Suau	France	UPS Toulouse 3 (IRD)
Master 2	2006	2C3	Connaissance chimiotaxonomique du genre *Turbinaria* et étude des composés de défense de différentes espèces de Sargassacées des Iles Salomon	Klervi Le Lann	France	UBO–IUEM (LEBHAM)
Master 2	2007	2C3	Recherche et caractérisation de molécules potentiellement anti-inflammatoires chez l'éponge marine Xestospongia testudinaria	Mélanie Roué	France	UPMC (CNRS–MNHN)
Master 2	2009	2C4	Chemosystematics and molecular phylogeny of *Cribrochalina* sponges	Mereoni Degei Gonelevu	Fiji	USP (Queensland Museum)
Master 1	2006	2C4	Variations interspécifiques des composés phénoliques chez des sargasses des Iles Salomon et test de leur activité antibactérienne	Marie Lhuillery	France	UBO–IUEM (LEBHAM)
Master 1	2008	2C4	Etude de la teneur en composés phénoliques et du potentiel antioxydant associé à ces composés, de plusieurs espèces de Sargassaceae du Pacifique Sud	Claire Ferret	France	UBO–IUEM (LEBHAM)
Master 1	2008	2C4	Recherche de molécules anti Phospholipase A2 à partir de l'éponge marine *Rhopaloides odorabile*	Betty Kientz	France	Univ. Montpellier 2 (MNHN)
Master 1	2009	2C4	Secondary metabolites composition and geographical distribution of marine sponges of the genus Dysidea	Mayuri Chandra	Fiji	USP (IRD/UPVD/USP)
Master 1	2009	2C4	Expression of secondary metabolites by the Fiji Islands Ascidia: *Diazona fungia* and *Polyandrocarpa* polypore	Housnat Saldou	France	UPVD–LCBE
Misc.	2005	2A2	Report on the Biodiversity, Phylogeny and Ecology of Porifera Course	Shital Swarup	Fiji	USP (CNRS/IRD)

Misc.	2005	2C4	Pharmacochemical treatment of marine invertebrates	Reuben Sulu	Solomon Islands	Fisheries Department SI (IRD)
Misc.	2007	2C4	Pharmacochemistry and chemotaxonomy of marine sponges of the Dysidea species	Mayuri Chandra	Fiji	USP (IRD–USP)
Misc.	2008	2C4	Etude pharmacochimique et chimiotaxonomique d'éponges du genre *Dysidea*; Isolement de molécules potentiellement actives sur Plasmodium	Delphine Lagneau	France	Ecole nationale supérieure de la Chimie de Lille (IRD Noumea)
Misc.	2008	2C3	Recherche de principes actifs neurotoxiques	Solène Ravily	France	Univ. Nantes (IRD)
Misc.	2008	2C3	Recherche de principes actifs neurotoxiques	Pierre-Yves Juvin	France	Univ. Nantes (IRD)
Bachelor's degree	2008	2C3	Recherche de principes actifs neurotoxiques	Sylvina Meignen	France	Univ. Nantes (IRD)
CAPTURE AND CULTURE OF POSTLARVAE (PCC)						
PhD	2007	2A1	Sélection de l'habitat à l'installation et utilisation de l'habitat postinstallation chez les poissons récifaux-lagonaires de Nouvelle-Calédonie	Camille Mellin	France	UPMC/EPHE(IRD)
PhD	2010	2A1	Capture et Culture des postlarves pour le réensemencement en poissons des récifs coralliens de l'île de Viti Levu aux Fidji	Julien Grignon	France	UPVD /EPHE (USP)
Master 2	2006	2A1	Premiers éléments d'étude de la colonisation larvaire des poissons de récifs coralliens à Suva, Fidji	Thibault Rauby	France	EPHE
Master 2	2007	2A1	Determination of the distribution of coral reef fish larvae versus the distribution of zooplankton in Laucala Bay	Arpana Pratap	Fiji	USP
Master 2	2008	2A1	Etude de la colonisation larvaire des crustacés décapodes et stomatopodes (Rangiroa, Polynésie française)	Raphaël Santos	France	UBO–IUEM (IRD/CRIOBE)
Master 2	2008	2A1	Effet de la dégradation des récifs coralliens sur le succès du recrutement des larves de crustacés et de mollusques (Rangiroa, Polynésie française)	Alexandre Zvara	France	Univ. Claude Bernard Lyon 1 (EPHE–CNRS–UPVD/IRD/Serv. Perliculture Rangiroa PF)
Master 2	2009	2A2	Variation de la production de sons chez *Dascyllus flavicaudus*	Loic Kever	France	Univ. Liège (CRIOBE)
Master 2	2009	2A1	Larval recruitment of the economically important pearl oyster, *Pinctada margaritifera*: effects of conspecifics, predation and environmental factors	Martin Ubertini	France	UPMC Paris VI (Serv. Perliculture de Takapoto PF/EPHE–CNRS-UPVD)
Master 2	2010	3C8	Etude des capacités auditives des poissons au stade larvaire lors des phases de colonisation et d'installation dans les récifs coralliens	Baptiste Bonhomme	France	UPPA (IRD/CRIOBE)
Master 1	2008	2A1	Postlarval fish capture, culture and release in Fiji: Effects of culture conditions on survival in the wild	Shirleen Bala	Fiji	USP–SMS (IRD)
Master 1	2009	2A1	Etude des traits de vie (survie, condition et charge parasitaire) des juvéniles de poissons lors de leur phase d'installation dans les récifs coralliens (Rangiroa, Polynésie française)	Laurent Burgy	France	UPPA (Serv. Perliculture Rangiroa PF/CRIOBE)
Master 1	2010	3C3	Etude du recrutement et des populations des anguilles polynésiennes	Julie Grousseau	France	UPVD
Master 1	2010	3C8	Etude de patron de colonisation larvaire par poissons récifaux	Moana Le Rohellec	France	UPVD (CRIOBE/IRD)
Master 1	2010	3C8	Capture and identification of coral reef fish larvae (French Polynesia)	Lindon Havimana	Fiji	USP (IRD)
Master 1	2010	3C8	Sensory abilities and brain anatomy of coral reef fish at larval stage	Rynae Greta Lanyon	Fiji	USP (IRD)
Master 1	2010	3C8	Phase de colonisation larvaire et Prévalence parasitaire des poissons de récifs coralliens	Kévin Peyrusse	France	UBO – IUEM (CRIOBE/IRD)
Master pro	2009	2A1	Capture, identification and culture techniques for coral reef fish larvae	Viliame Pita Waqalevu	Fiji	USP (CRIOBE)
Post-graduate diploma	2009	2A1	Evaluation of CARE net method in reef fish larval capture over a lunar month in Laucala Bay, Fiji	Viliame Pita Waqalevu	Fiji	USP (CRIOBE)
Engineer's degree	2007	2A1	Development of multispecific post-larval fish rearing approach in aquariums	Sophie Vermond	France	ENSAR (Ecocean/USP)

Engineers degree	2007	2A1	Projet de capture et de valorisation des postlarves de poissons récifaux aux Iles Fidji, Pacifique Sud	Arnaud Gruss	France	ENSAR (Ecocean/USP)
Bachelor's degree	2008	2A1	Effet de la dégradation des récifs coralliens sur le succès du recrutement des larves de crustacés et de mollusques (Rangiroa, Polynésie française)	Laurent Burgy	France	UPPA (Serv. Perliculture Rangiroa PF)
ECOLOGY AND MANAGEMENT OF FISH AND INVERTEBRATES						
PhD	2011	2A2	Structure et fonctionnement des populations d'invertébrés benthiques des platiers du Lagon Sud-Ouest de Nouvelle-Calédonie et du nord d'Efate au Vanuatu	Haizea Jimenez	France	IRD
Master 2	2006	2A2	Relation entre diversité fonctionnelle et diversité spécifique dans les écosystèmes coralliens	Anne-Lise Roblin-Brieu	France	IRD Perpignan
Master 2	2006	2A2	La densité et la biomasse sont-elles liées à la richesse spécifique ? Exemple des poissons coralliens dans le Pacifique insulaire	David Beaune	France	IRD Perpignan
Master 2	2007	2A3	Influence de la fragmentation sur la connectivité des populations de *Dascyllus aruanus*	Shital Swarup	Fiji	USP (EPHE–CNRS–UPVD)
Master 2	2008	2A3	Relationship between coral reef fish population and benthic habitats at Navutulevu	William Saladrau	Fiji	USP
Master 2	2008	2A3	Spatial distribution of reef fish communities: An investigation of the Coral Coast, Fiji Islands	Jeanne De Mazières	France	USP –SMS
Master 1	2006	2A2	Apport des systèmes d'information géographique pour une gestion spatialisée des écosystèmes coralliens : Cas de la pêcherie au crabe de palétuvier dans la zone de Voh (Nouvelle-Calédonie)	Jérémy Bailleul	France	Univ. des Sciences et Technologies de Lille (IRD)
Master 1	2007	2A2	Use of fishermen perception in participative resources management: Case study in Navakavu (Fiji)	Antonin Hubert	France	ENSAR (IRD/USP)
Bachelor's degree	2008	2A2	Distribution spatiale des holothuries et étoiles de mer et Détermination de l'infestation des holothuries et des huîtres perlières par les poissons Carapidae	Yoann Thiault	France	Univ. de La Rochelle (Serv. Perliculture Rangiroa PF/TFT)
WATERSHEDS MANAGEMENT						
Master 2	2006	1A4	Spatialisation de l'aléa érosion des sols en Nouvelle-Calédonie – Méthodologie pour les communes de Dumbea, Païta et Boulouparis	Gaëlle Luneau	France	Univ.Toulouse le Mirail/ INP Toulouse–ENSAT (IRD Noumea–UR Espace)
Master 2	2007	1A4	Comparison of classification methods (SPOT images) for land cover mapping in Efate.	Valérie Laurent	France, Nether-lands	Wageningen University (Pays-Bas) (IRD Noumea–UR Espace)
Master 2	2008	1A4	Estimation et spatialisation de l'érosion hydrique des sols en Nouvelle-Calédonie (Voh-Koné-Pouembout)	Julia Printemps	France	Univ. Joseph Fourier Grenoble (IRD Noumea–UR Espace)
Master 2	2008	1A4	Methodological development and spatialisation of water management risk in Efate (Vanuatu)	Maxime Fossey	France	Univ. de Rennes 1 (IRD Noumea–UR Espace)
Master 1	2010	1A4	Digitalisation de l'occupation des sols au Nord Viti Levu (Fidji)	Jonathan Gony	New Caledonia	Univ. Denis Diderot–Paris VII (IRD Noumea–UR Espace)
Post-graduate diploma	2007	2A3	Integrating Traditional Knowledge and High Tech Geographical Information System GS450 (en attente du fichier par William via James)	William Saladrau	Fiji	USP
Engineer's degree	2008	1A4	Traitement d'images satellites selon l'approche objet pour la caractérisation de l'occupation des sols en milieu insulaire du Pacifique	Maëlle Aubert	France	BRGM (IRD Noumea–UR Espace)
Engineer's degree	2008	1A4	Approche prospective pour l'analyse des impacts naturels et anthropiques du bassin versant sur le milieu récifo-lagonaire	Sylvain Cedat	France	SupAgro Montpellier (IRD Noumea–UR Espace)
Engineer's degree	2008	1A4	Hydrologie et sédimentation : développement d'outils d'évaluation de la sédimentation découlant des bassins versants à Efate	Romain Gueyte	New Caledonia	SupAgro (IRD Noumea–UR Espace)
Engineer's degree	2008	1A4	Interopérabilité des systèmes d'informations géographiques et des métadonnées associées	Nicolas Hans	France	INP Toulouse–ENSEEIHT (IRD Noumea–UR Espace)

Engineer's degree	2010	1A4	Détection de changements sur une série d'images satellites haute résolution : comparaison de méthodologies	Glenn Judeau	France	Institut supérieur de l'Electronique et du Numérique (IRD Noumea–UR Espace)
Engineer's degree	2010	1A4	Développement sous logiciel libre (R) d'outils génériques d'estimation et de spatialisation de l'érosion hydrique des sols	Loïc Bellon	France	INP Toulouse- ENSEEIHT (IRD Noumea – UR Espace)
Engineer's degree	2010	1A4	Mise en place d'un module de modélisation hydrologique sous un logiciel SIG libre	Clément Berlon	France	Ecole nationale des Géomètres et Topographes (IRD Noumea–UR Espace)
Engineer's degree	2010	1A4	SVM algorythm and Voronoi tessellation	Mickael Barotin	France	INP Toulouse–ENSEEIHT (IRD Noumea–UR Espace)
MONITORING OF CORAL REEFS AND RESOURCES						
PhD	2010	1A4	Développement méthodologique en matière de perception et de représentation de la valeur totale de l'environnement (cas d'étude dans la zone de VKP)	Matthias Kowasch	Germany	Univ. Heidelberg–Univ. Montpellier II (IRD Noumea–UR Espace)
PhD	2009	2A2	The relevance of participatory approaches in ecosystem-based reef fishery monitoring	Ambroise Brenier	France	UPMC–Univ. Tulear (IRD/ EPHE–CNRS–UPVD/CRIOBE)
Master 2	2007	2A3	Long Term Monitoring of Sea Surface Temperatures	Zhaidy Afrin Nisa Khan	Fiji	USP
Master 1	2006	2A3	Suivi des aires marines protégées de Moorea : mise en place d'un protocole de suivi impliquant des volontaires	Esther Emmanuelli	France	UPVD/Universy of South Florida (CRIOBE)
Engineer's degree	2009	2A2	Guide méthodologique pour la mise en oeuvre et l'analyse des stations vidéo rotatives	Nicolas Guilpart	France	IRD (IFREMER)
Misc.	2010	1A4	Saisie et pré-traitement d'une enquête socioéconomique dans le nord d'Efate (Vanuatu)	Malcom Xenie	New Caledonia	UNC (IRD Noumea–UR Espace)
CONSERVATION, MARINE PROTECTED AREAS (MPAs)						
Master 2	2006	2A3	Rotuma Coral Reef Conservation Project III	Teri Tuxson	Fiji	USP
Master 2	2010	2A2	Quantifying the gross financial effect of having Marine Protected Areas (MPAs) in three qoliqolis that use Locally-Managed Marine Area (LMMA) Network management tools	Rusiate Ratuniata	Fiji	USP
DIVERS						
Post doc	2010	3D1	Connectivity of tiger (*Galeocerdo cuvier*) and other large shark species in the South Pacific: A focus on inter-connectedness of Great Barrier Reef Marine	Jonathan Werry	Australia	Griffith University (SPC/ CRIOBE)
Master 2	2008	1A4	Governance and integrated coastal management	Vincent Vacelet	France	Univ. La Rochelle (IRD Noumea–UR Espace)
Master 2	2008	1A4	Développer une méthodologie d'intégration des facteurs sociaux contraignant la gestion de l'environnement littoral dans le système d'information géographique EFATIS	Laurie Castel	France	SupAgro Montpellier (IRD Noumea–UR Espace)
Master 2	2010	1A4	Outil d'aide à la gestion des littoraux récifaux dans le Pacifique – Cas de la Presqu'île de Tahiti	Arnaud Campaner	France	Univ. Strasbourg (IRD Noumea–UR Espace)
Master 1	2010	3D1	Mark-recapture of Tiger shark (*Galeocerdo cuvier*) in New Caledonia: A photo-identifi cation approach	Tyffen Read	New Caledonia/ Australia	Griffith University (SPC)
Master 1	2008	2A2	Study of Heavy Metal Accumulation in Scleractinian Corals of Viti Levu, Fiji Islands	Sofia Banu Shah	Fiji	USP
Master pro	2007	2A5	Impact of anthropogenic CO_2 on corals	Anne-Cécile Naudan	France	UPVD–BDSI
Engineer's degree	2008	2A4	Elaboration d'un système d'information sur les récifs coralliens accessible sur Internet	Julie Bargetto	France	SUPINFO Paris- (IRD UR CoReUs)
Engineer's degree	2009	1A4	SIE (Système d'information environnemental) Vanuatu	Alban Diguer	France	Ecole supérieure d'Ingénieurs de Luminy (IRD UR Espace)
Misc.	2010	3D1	La microflore dans des coraux présentant différents types de lésions ou maladies (Lagon néocalédonien)	Pauline Pannetier	France	IUT de Brest–UBO (IRD–UR Camelia)

CRISP

Coral Reef InitiativeS for the Pacific
Initiatives Corail pour le Pacifique

The CRISP Coordinating Unit (CCU) was integrated into the Secretariat of the Pacific Community in April 2008 to insure maximum coordination and synergy in work relating to coral reef management in the region.

SPREP/PROE

The CRISP Programme is implemented as part of the policy developed by the Secretariat of the Pacific Regional Environment Programme to contribute to the conservation and sustainable development of coral reefs in the Pacific.

The Initiative for the Protection and Management of Coral Reefs in the Pacific (CRISP), sponsored by France and established by the French Development Agency (AFD), is part of an inter-ministerial project that began in 2002. CRISP aims to develop a vision for the future of these unique ecosystems and the communities that depend on them and to introduce strategies and projects to conserve their biodiversity, while developing the economic and environmental services that they provide both locally and globally. CRISP also, has a role in fostering greater integration in this area between developed countries (Australia, New Zealand, Japan, USA), French overseas territories and Pacific Island developing countries.

The initiative follows a specific approach designed to:
- associate networking activities and fieldwork projects;
- bring together research, management and development endeavours;
- combine the contributions of a range of scientific disciplines, including biology, ecology, economics, law and social sciences;
- address the various land and marine factors affecting coral reefs (including watershed rehabilitation and management);
- avoid setting up any new body but supply financial resources to already operational partners wishing to develop their activities in a spirit of regional cooperation. This is why the initiative was established on the basis of a call for proposals to all institutions and networks.

CRISP Coordinating Unit (CCU)
Programme Manager: Eric CLUA
SPC - PO Box D5
98848 Noumea Cedex
New Caledonia
Tel./Fax: (687) 26 54 71
E-mail: ericc@spc.int
www.crisponline.net

This approach is articulated through a series of thematic objectives:
Objective 1: Improved knowledge of the biodiversity, status and functioning of coral ecosystems.
Objective 2: Protection and management of coral ecosystems on a significant scale.
Objective 3: Development of the economic potential represented by the use values and biodiversity of coral ecosystems.
Objective 4: Dissemination of information and know-ledge; and capacitybuilding and leadership with local, national and international networks.

The CRISP Programme comprises three major components:
Component 1A: Integrated coastal management and watershed management
- 1A1: Marine biodiversity conservation planning
- 1A2: Marine Protected Areas
- 1A3: Institutional strengthening and networking
- 1A4: Integrated coastal reef zone and watershed management

Component 2: Development of coral ecosystems
- 2A: Knowledge, beneficial use and management of coral ecosytems
- 2B: Reef rehabilitation
- 2C: Development of active marine substances
- 2D: Development of regional data base (ReefBase Pacific)

Component 3: Programme coordination and development
- 3A: Capitalisation, value-adding and extension of CRISP programme activities
- 3B: Coordination, promotion and development of the CRISP programme
- 3C: Support to alternative livelihoods
- 3D: Vulnerability of ecosystems and species
- 3E: Economic task force

CRISP is funded by the following partners:

AFD Agence Française de Développement · FFEM · Liberté • Égalité • Fraternité République Française Fonds Pacifique · Conservation International · WWF · United Nations Foundation · IFRECOR