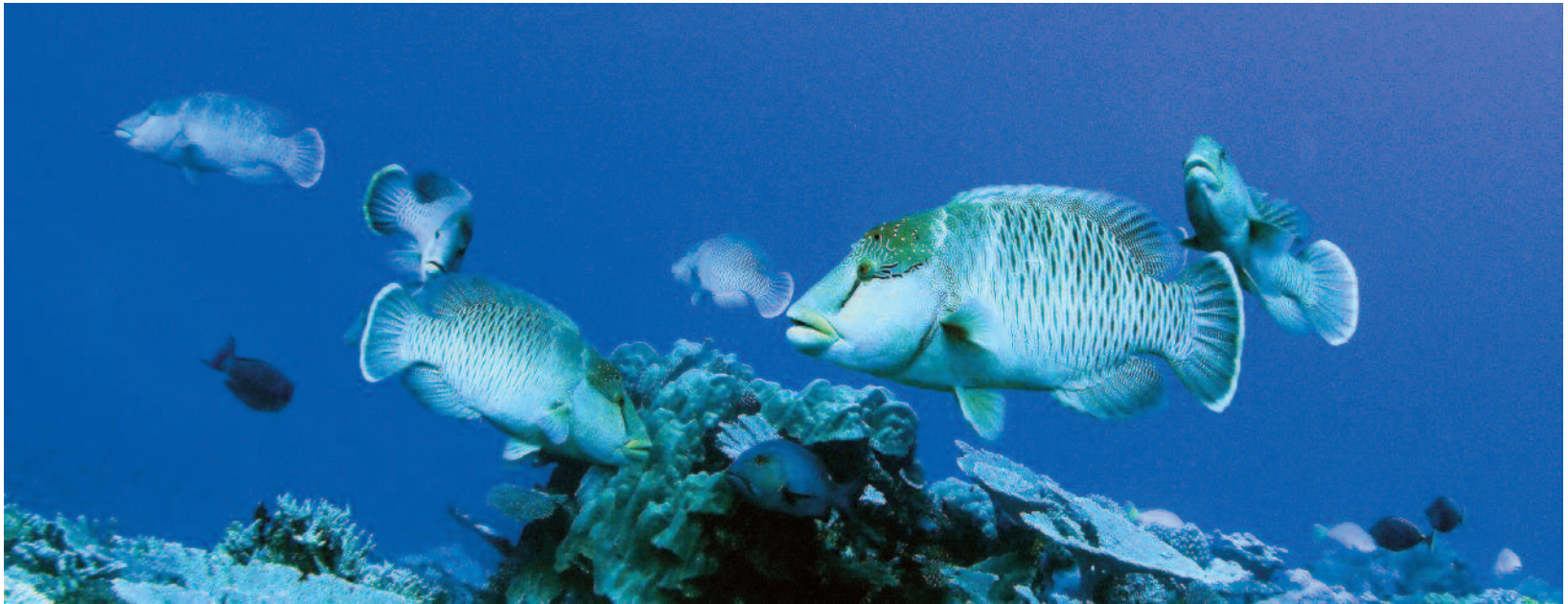


Towards planned management of reserves in New Caledonia

Laurent Wantiez, Emmanuel Coutures, Maël Imirizaldu, Michel Kulbicki and Laurent Vigliola



Juvenile Napoleon fish (*Cheilinus undulatus*). This species, classified as endangered by the IUCN, is found in protected sites. © IRD/S. Andréfouët

Coral reefs are one of the most threatened ecosystems on the planet. They are confronted with the combined effects of global climate change (warming, sea level rise, ocean acidification) and local environmental changes linked to local human activities (growing demographics, fishing, pollution, habitat degradation). These pressures add to natural disturbances (tropical cyclones, acanthaster outbreaks, etc.), whose destructive dynamics are amplified by the environmental changes induced by human populations. The conservation of this ecosystem and the preservation of the resources and services it provides have therefore become major challenges, which often involve controlling the exploitation of resources (species, their size, fishing gear and harvesting season) or establishing marine protected areas (MPAs).

New Caledonia hosts the world's largest lagoon around the main island, Grande Terre (19,385 km²), the second largest barrier reef (1,600 km long) after the Australian Great Barrier Reef, and one third of the world's most isolated and preserved reefs. Therefore, their environmental protection is fundamental at both local and global levels.

In New Caledonia, the implementation of protective measures has been gradual and pragmatic. It was carried out concomitantly to the increase in anthropogenic pressures and the observation of the first impacts, particularly the decline in resources (fishing) and the direct or indirect degradation of the reef and lagoon environments (from mining and urbanization). The implementation of the first protective measures

in the 1970s followed a "wise pragmatism" approach, responding to a determination for action despite the lack of knowledge. The New Caledonian coral ecosystems would probably not be as healthy today if this pragmatism had not triggered and fueled local conservation policies. With time and the acquisition of new knowledge on the dynamics of systems, these policies gradually evolved towards a truly planned management strategy.

The natural protected area is one of the most commonly used protection tools in New Caledonia. It complements resource regulations through the protection of biodiversity within its environment. This type of protection is familiar to the New Caledonian people because it involves the use of various historical forms of "customary/traditional reserves", which are common in Oceania. These customary reserves are now being gradually integrated into "contemporary" marine protected areas. The success of this tool lies in the relative simplicity of its management and its proven effect on protected resources, particularly on harvested species.

The "reserve" tool in New Caledonia

The first protective measures were implemented by confronting the conservation objective (the reserve as a "larder") with expert analysis.

The first significant action was the creation of the Merlet Reserve in 1970 (box. 30). This initiative can be commended for several reasons. First, it was established at a time when the conservation of New Caledonian reefs was not a priority. Second, it is large (173 km²) and benefits from the maximum level of protection (strict nature reserve). Lastly, its protection level has been maintained until today with increased surveillance facilities and regular monitoring of its health status.

The second milestone was the creation of the reserves of the "Grand Nouméa Park" ("Parc du Grand Nouméa"), formerly known as the "South Lagoon Park" ("Parc du lagoon sud"). These protected areas are regulated marine reserves where access is permitted, but any harvesting is prohibited. The origin of this awareness was the

impact of fishing on coral reef resources near Nouméa, where the density of users and the resulting boating pressure are the highest. The initiative involved two phases. The Amédée lighthouse and Maître Islet have been protected since 1981 and four other islets since 1989 (Bailly, Canard, Larégnère and Signal). The year 1990 marked the real beginning of conservation programs with the launch of the first surveillance vessel, the Isabelle. At the same time, and since 1994, regular monitoring (every four years) of the evolution of these reefs has been undertaken to quantify the success of these actions. Their status then evolved into Sustainable Resource Management Areas (SRMAs) or nature reserves, according to the uses and possible economic activities that developed there. Seasonal reserves were also set up to protect fish aggregation sites for spawning, such as the Dumbéa Pass or Grand Port in Prony Bay. However, some inefficient initiatives were discontinued, including the rotating reserve of the three barrier reefs facing Nouméa (Mbéré, Aboré and Kué), where each reef was successively protected for three years.

Although the first regulatory tools for the protection of natural areas were set up around the capital, this type of protection has always been employed by indigenous populations in their so-called "customary reserves" (box. 29). The creation of these protected community areas is linked to the original perception of the clans of the sea that the lagoon is their property. Their main vocation is to protect "their own" resources, particularly so that they are available during major customary ceremonies or special community events. This is probably why the Northern Lagoon (Grand Lagon Nord) is one of the most exceptional reef formations in the territory today. Over the last decade, this customary protection, which also has a subsistence objective (food and artisanal fisheries), has evolved towards an acceptance of the need to adapt and integrate into the rules of common law (regulated protection). The associated objectives have evolved from the protection of resources ("larder") to the conservation of ecosystems for economic valorization (ecotourism). This evolution has led to the creation of the Pweevo and Hyehen reserves on the northeast coast and discussions are under way on the creation of a reserve around Ouvéa Island (Uvea/laai).



The Merlet Reserve, the jewel of the South Province

Emmanuel Coutures

Located between the Sarcelle and Havannah passes, the strict nature reserve, Yves Merlet, created in 1970, is a sanctuary for both the terrestrial and marine flora and fauna of the Southern Lagoon. This maritime space of 17,200 ha, which includes the islets of Améré and Kié, was already covered by customary management when it was formalized by a palaver transcript between the Goro chiefdom and the territorial office of the merchant marine.

Now integrated into the provincial marine park of the Grand Lagon Sud (part of the property inscribed on UNESCO's World Heritage List), the "Merlet Reserve" aims at maintaining the wild state of a reef and lagoon area with a minimum of anthropogenic activity.

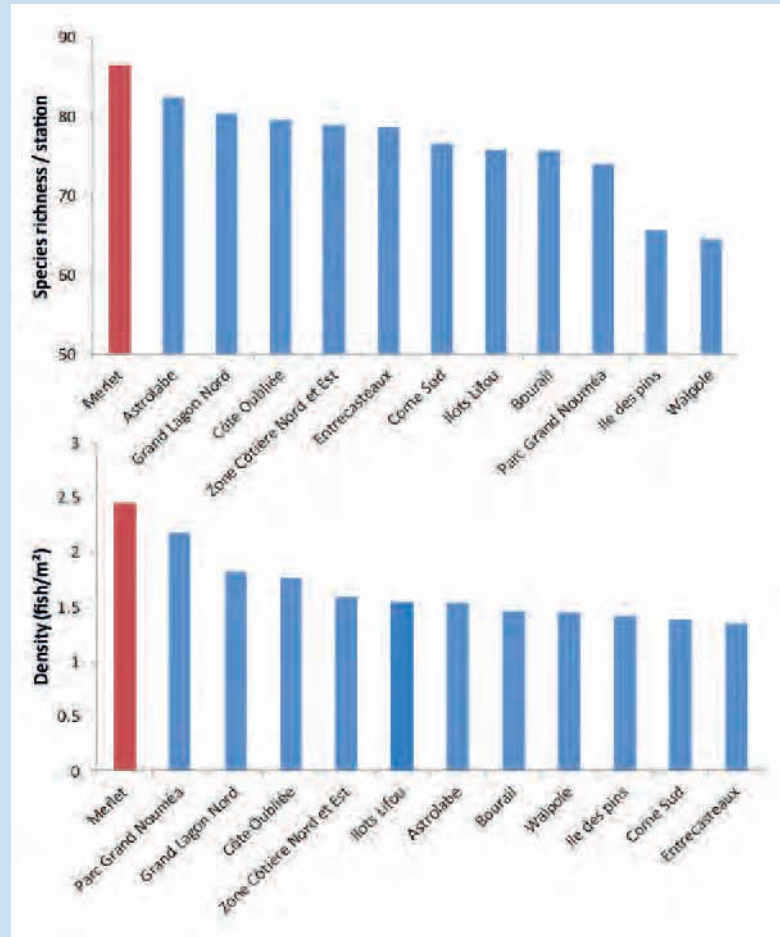
The level of protection of this sanctuary has increased over time: the derogations for the organization of customary fisheries (*mikwaa* or milkfish *Chanos chanos* and green sea turtles), which are still provided for in the South Province Environmental Code, have not been implemented for nearly 10 years.

The reserve is subject to specific management measures. Authorizations to enter the Merlet Reserve for scientific purposes (collection of samples) are increasingly rare and constrained.

Due to its status and the diversity of its coral communities, the Merlet Reserve was chosen as a site for monitoring the Grand Lagon Sud Marine Park. Between 2008 (initial state) and 2013, the monitoring revealed a very healthy ecosystem with no significant anthropogenic impact (WANTIEZ *et al.*, 2013). It hosts the largest diversity (more than 100 species/site) and density (more than 2.3 fish/m²) of reef fish measured as part of the New Caledonia reef monitoring. Giant clams are also very frequently observed (95% of sites) and numerous (4.9 individuals/250 m²), and the trochus are relatively large (9.7 cm on average). Emblematic species are common, including sea turtles and Napoleon fish.

Rangers carry out between one and five inspections of the Merlet Reserve per month, either by day or night, and only record five to six offences per year.

Over time, the Merlet Reserve has become the reference point in discussions relating to the environmental and societal importance of areas with enhanced protection from human pressures. It is both a source of pride for all New Caledonians and a treasure pampered and fiercely protected by the South Province.



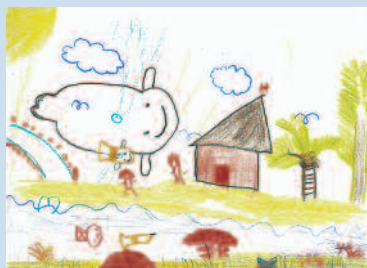
Number of species by site and fish density at major coral sites monitored in New Caledonia between 2012 and 2014. © UNC/L. Wantiez

Reference

WANTIEZ L. *et al.*, 2013 *Communautés biologiques et habitats coralliens de la réserve Merlet. État des lieux 2013. Maintien de l'intégrité du bien*. South Province of New Caledonia, University of New Caledonia, UNC, 86 p.

What is the reef in the eyes of the children of New Caledonia?

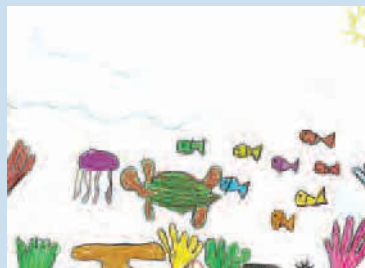
Jocelyne Ferraris, Georgeta Stoica, Catherine Sabinot, Pascale Chabanet,
Stéphanie M. Carrière, Claire Levacher and Marlène Dégremont



Influence of the socio-cultural and environmental context on the perception of coral reefs (after using the MARECO case).

A: Yaté, "Wadiana waterfall". © J.-B. Agourere

B: Nouméa, "The coral reef". © M. Meray



Drawings before (left) and after (right) the use of the MARECO case, "The reef in our hands", by Marie-Louise, eight years old, Isidore Noell school. © M. L. Xowi

In 2016, about 80 children from five primary schools in Nouméa (Boyer, Isidore Noell), the east coast (Thio and Yaté) and the mountain chain (Coula) participated in an interdisciplinary research program on the perception of coral reefs. This program was led by a team of natural and social science researchers. Its aims were to assess the knowledge, practices and perceptions related to coral reefs in children aged between six and eight years old and to develop a method to evaluate the impact of an awareness campaign on reef vulnerability in four French regions (New Caledonia, Mayotte, Reunion Island and Pyrénées-Orientales).

Exploring the coral reef ecosystem is fun!

Coral reef drawings were collected before and after the use of a "The reef in our hands" kit containing three educational games whose objective was to communicate scientific concepts on biodiversity, disturbances, uses and management methods of the coral reef ecosystem. A total of 1,300 drawings and interviews conducted in the field, were analyzed using a grid listing and coding of the depicted elements, in order to compare the coral reef perceptions of the 20 primary school classes involved in the program.

When science meets education

The analysis reveals a great diversity of perceptions among children according to socio-cultural profiles, but also between urban, rural and coastal environments. This emphasizes that relationships with nature or the environment vary from one school to another, depending on direct and indirect experiences of the reef. Using the MARECO case results in an improved understanding of reef biodiversity. The immersion of scientists in the school environment also improves understandings of academic and empirical knowledge and their plasticity in different contexts, as well as how they are transferred, in order to maintain, disseminate and improve them.

Modernity is marked by the gradual transition from the "wise pragmatism" of the beginnings to planned management, including the adoption of an Environmental Code by all provinces. Two major initiatives also reflect the growing and recent awareness of protection and the stakes involved in conservation: the inscription of the "Lagoons of New Caledonia" on the World Heritage List in 2008 (15,743 km²; chap. 46) and the creation of the Natural Park of the Coral Sea in 2014 (1,291,000 km²; box. 5). These two major initiatives commit New Caledonia to long-term responsibility for conservation. They will only be successful if they are supported by a strong and well-established management policy, as well as the implementation of appropriate resources and coherent governance.

The success of pragmatic management

The success of the pragmatic use of the "reserve" tool in New Caledonia is based on a series of decision-making processes:

- setting realistic objectives;
- the choice of a suitable strategy and tool based on available knowledge;
- regular assessment of the outcomes to enable informed decision making and regular adaptation of management strategies and objectives.

It is now recognized that well positioned and monitored marine reserves have many positive effects on protected communities. These effects have been checked and demonstrated on numerous occasions in New Caledonia.

In the reserves of the Grand Nouméa Park, fish communities developed very rapidly after the implementation of monitoring measures and reached spectacular levels in just four years. The number of edible fish species increased by 67%, their density by 160% and biomass by 246% (WANTIEZ *et al.*, 1997) (Fig. 1). At the same time, the number of species and biomass at unprotected sites did not change and the density increase was twice as low. Since 1994, changes in the protected fish populations have been mainly the result of natural causes (Fig. 1). They develop when environmental

conditions are favorable and are particularly affected by disturbances (tropical cyclones). The global oceanographic climate (El Niño/La Niña) also seems to affect these communities.

Another typical example is the lobster populations in the Ouano Reserve. None were observed in the reserve and adjacent monitored unprotected areas before the reserve was created and for seven years after monitoring began. From 2014 onwards, lobsters became frequent in the Ouano Reserve (over 50% of sites) while they are still absent from unprotected areas, although favorable habitats are available (WANTIEZ *et al.*, 2015). Thanks to these protected areas, the emblematic Napoleon fish has also returned.

The protected areas thus allow protected communities to develop. In the long term, they also have an "overflow" effect, with specimens moving from the protected area to adjacent unprotected areas, a phenomenon which was documented in the Grand Nouméa Park for commercial fish species (coral trouts, groupers, parrotfish) (CHATEAU and WANTIEZ, 2009). These effects have probably also occurred in all other protected areas of the territory, for which no pre-protection monitoring data exist.

The limits of New Caledonia's reserves

Marine reserves are an effective tool. However, like any tool, they have their limitations and cannot solve all problems on their own. Marine reserves must evolve with knowledge and adapt to contemporary environmental and societal challenges.

The monitoring of protected reefs in New Caledonia revealed that reserves could do nothing to protect against major meteorological events (e.g., tropical cyclones). These events have an immediate and devastating effect on coral habitats and their associated species. A tropical cyclone can destroy years of protection efforts. For example, in 2003, the tropical cyclone Erica had immediate and significant destructive impacts on the entire ecosystem of the Grand Nouméa Park, resulting in a complete change of community structure. This

was still significant in the medium term (two years) (WANTIEZ *et al.*, 2006) and complete restoration occurred only in the long term (10 years) (WANTIEZ *et al.*, 2014). When the ecosystem is particularly vulnerable, the time required for restoration is dependent on the absence of further disturbance during the process. Hence, reefs recovered in Nouméa, but not in Ouano, where strong westerly swells in 2008 and 2009 destroyed the first signs of coral habitat recovery (WANTIEZ *et al.*, 2015).

In addition, protecting an area leads to the geographical transfer of the fishing effort, which increases in unprotected areas as a result. In New Caledonia, this happens in a context where the pressure exerted on reefs (fishing and non-extractive uses) is increasing. If too many reefs are protected in a densely populated area, the effects on coral reefs, as a whole, may be more negative than positive. It is necessary to optimize the balance between protected and unprotected areas according to the population and to provide the necessary means to control catches. An alternative to this would also be to develop non-extractive economic activities in order to reconcile economic development and environmental protection. However, non-extractive uses also need to be regulated to minimize their environmental impact. For example, a reserve where all harvesting is prohibited but access is allowed, attracts people who come to observe healthy reef communities (e.g., large fish). These areas can then attract a population that exceeds their carrying capacity. This is very obvious on sunny weekends when large numbers of boats aggregate in the reserves of the Grand Nouméa Park.

When properly designed and monitored, marine protected areas are often presented as the ideal tool for conservation. However, despite effective protection, this tool does not allow the coral ecosystem to recover all the characteristics of a system devoid of any negative impact (D'AGATA *et al.*, 2016). This is well illustrated in New Caledonia by the Merlet Reserve, whose results do not reach those of the most remote reefs (d'Entrecasteaux, Astrolabe, Pétrie, Chesterfield, etc.). The most significant differences are in the case of large predators such as sharks (JUHEL *et al.*, 2018), as well as species with high commercial value such as giant clams and sea cucumbers.

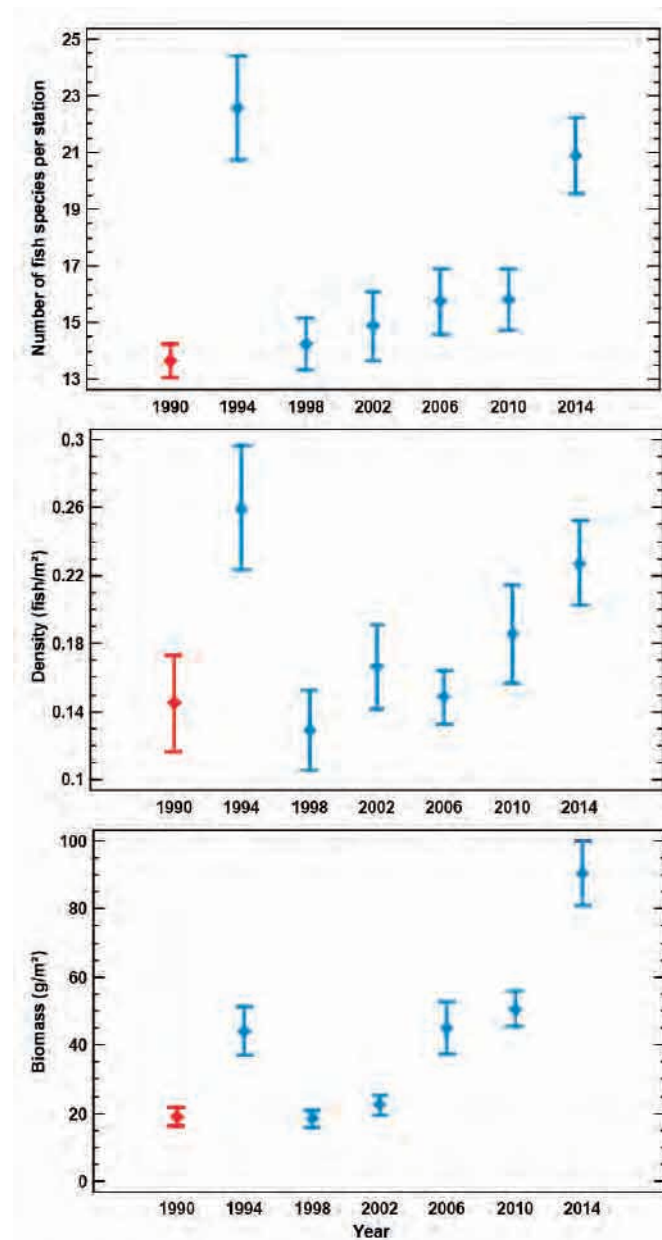
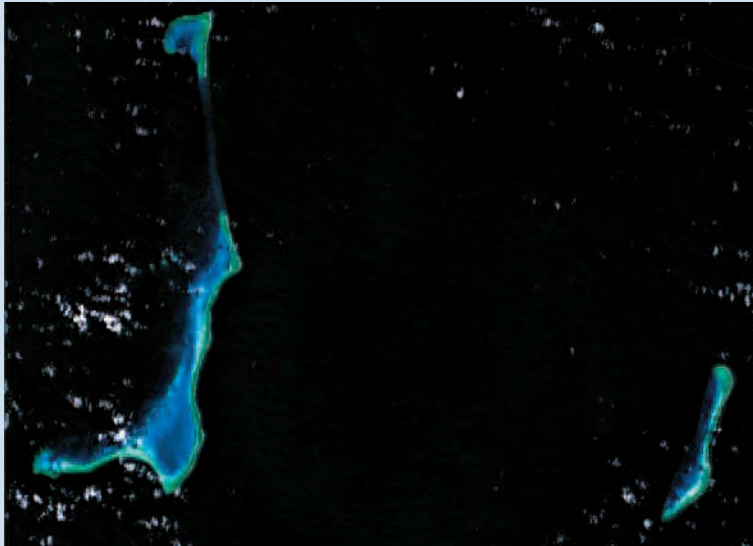


Figure 1: Variations (\pm standard error) in total species richness, site species richness, density and biomass of commercial fish species in the five reserves of the Grand Nouméa Park, before (in red) and after (blue) the implementation of monitoring actions. Adapted from WANTIEZ *et al.*, 2014

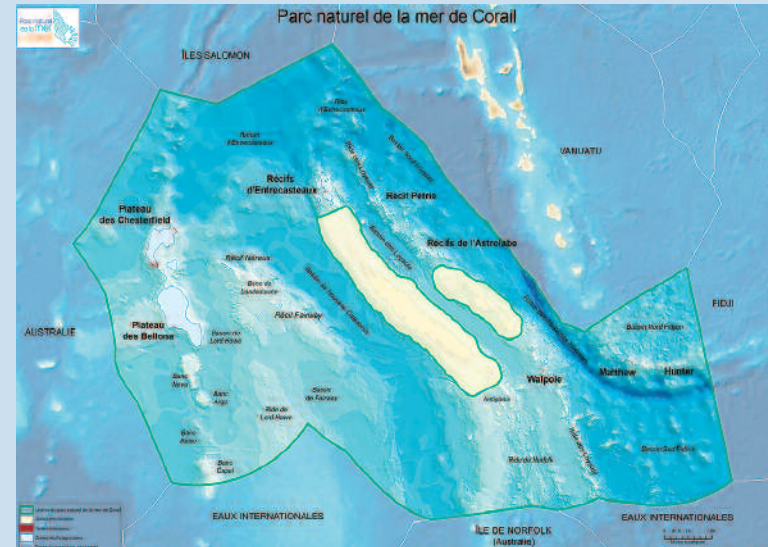
Box 32

Isolated reefs will soon be highly protected

Marie-Hélène Merlini and Julie-Anne Kerandel



Satellite view of Astrolabe reefs (Sentinelle 2 image, march 15th 2018)



Natural Park of the Coral Sea. © Gouvernement de la N.C/DAM-NC/SPE

Only 1.5% of the world's reefs are considered "untouched" by any human impact. The Natural Park of the Coral Sea hosts 30% of these reefs.

Pétrie and Astrolabe: exceptional reefs

The reefs of the natural park that have already been studied are among the richest in the world and described as pristine by the scientific community. The Pétrie and Astrolabe reefs, for example, host one of the highest reef fish biomass in the world and rank higher than the largest marine reserve in the Chagos Islands (Indian Ocean). Chesterfield and d'Entrecasteaux reefs also surpassed Kingman Reef, which used to be the global reference point for

"virgin" sites in the Pacific. These comparative studies ("PRISTINES" and "PRISTINES SEAS" projects), carried out in 2012 and 2013, provided an understanding of the value of regulating access to the most remote areas of ecological interest.

D'Entrecasteaux, a challenge for protecting biodiversity

Since April 23rd 2013, the government of New Caledonia has clearly stated its intention to protect the environmental jewels of its maritime space by establishing a protected area in the atolls of d'Entrecasteaux, the first natural reserve in the waters under its jurisdiction. The Le Leizour Islet and the vegetated part of the

Surprise Islet are classified as a strict nature reserve. All other emerging zones, waters and seabed included within the protected area of the d'Entrecasteaux Atolls are classified as nature reserves. Across the protected area, activities related to professional fishing are prohibited and access to the area is restricted.

Turning isolated reefs into sanctuaries, one of the first management priorities

One year later, on April 23rd 2014, the Natural Park of the Coral Sea was created, confirming the energy for conservation and the protection of all reefs, even those far removed from the New Caledonian maritime space. Although it is recognized that the remoteness of coral reefs forms a natural protection, planning a management strategy is an absolute necessity. In the management plan of the Natural Park of the Coral Sea, the first objective, dedicated to natural and cultural heritage, is to "protect ecosystems and their connectivity", and particularly to "protect remote reefs". This objective requires a high level of protection for remarkable areas (pristine reefs). By mid-2018, all "pristine" reefs (Chesterfield-Bellona and Petrie-Astrolabe) will be protected by the government.

Maintaining the life cycle

A high level of protection would help the conservation of ecosystems. For example, these reefs are used as breeding and feeding grounds by reef and tiger sharks. It is also likely that large predatory sharks use the Chesterfield-Bellona zone as a stopover for annual migrations between New Zealand and the tropical zone. Coral reefs are unique ecosystems essential to the life cycle of species, and to ensure the safety of an abundant and balanced marine life. Establishing regulations and providing the necessary means for their implementation is a visionary and responsible long-term strategy.

Today, conservation measures mainly target coral reefs, which represent the country's emblematic marine ecosystem. This approach has its limitations because it does not take into account the entire reef and lagoon environment, which functions as a connected network of fragmented ecosystems. Reef conservation therefore requires the consideration of wider geographical scales and even the entire seascape. The "informed management" process, which is being gradually adopted in New Caledonia, will have to consider this constraint and significant efforts will have to be dedicated to the protection of mangroves, seagrass meadows and lagoon soft bottoms, which are poorly taken into account today. The situation is similar for seamounts, located at the interface between remote reefs and those closer to Grande Terre, as well as deep and coastal, and pelagic and reef ecosystems.

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