HEALTH STATUS OF CORAL REEFS, SEAGRASS BEDS AND MANGROVES OF THE FRENCH OVERSEAS TERRITORIES

IFRECOR

INITIATIVE FRANÇAISE
POUR LES RÉCIFS CORALLIENS

Summary for policymakers

IFRECOR, 2021 / Summary 2020

GOUVERNEMENT
Liberté
Égalité
Fraternité

OVERSEAS TERRITORIES

IFRECOR, launched in March 1999 on the Prime Minister's decision, is a national initiative that aims to promote the protection and sustainable management of the coral reefs, seagrass beds of marine seed plants and mangroves. It includes all overseas reefs.

The IFRECOR action is in keeping with the policies followed by France in favour of coral reef preservation. The law for the reconquest of biodiversity, nature and countrysides (2016), commits the State, "within IFRECOR and based on the assessment of the health status of the coral reefs and associated ecosystems carried out every five years, to making an action plan contributing to protecting 75% of the coral reefs in French overseas by 2021," and 100% by 2025.

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Relying on the strategic framework prepared in 2000, the IFRECOR develops an action plan every five years. In each one of these plans, monitoring the coral reefs and assessing their health appear among the main topics. These assessments also answer France's commitment to the International Coral Reef Initiative (ICRI) and its global monitoring of the coral reefs (Global coral reef monitoring network - GCRMN), in which France has taken part since its creation in 1997.

In addition to the ICRI actions, the Convention on biological diversity (CBD) and in particular objective 10 of Aïchi, provide an international strategic framework for protection of the coral reefs. In this context, the global perspectives show that the corals' risk of extinction increases most quickly among all the evaluated groups, that the coral cover considerably decreased in certain regions and that the development tends towards coral species less adapted to maintaining the diversity of reef habitats (IPBES, 2019 and IPC, 2019).

The 2020 report on the health status of the coral reefs, seagrass beds and mangroves of French overseas followed up on the preceding national reports of 2000, 2008 and 2015; it is the first national assessment since the law of 2016.

78% The 11 coral territories of French overseas account for 78% of the maritime territory of France, second in the world to the United States of America (territorial seas and EEZ, January 2021, national maritime limits portal).

Overseas Coral Territories

SCATTERED ISLANDS TAAF

Island type: Coral
Land surface (km²): 42.35
Territorial sea + EEZ (km²): 634 835
Total reef-lagoon area (km²): 794
Linear reefs (km): -
No. level 5 class: 16
Seagrass (km²):> 38
Mangroves (ha): 626.23
Pop density. (inhab/km²): 0
Status of the territory: "sui generis" collectivity

MAYOTTE

Type of island: Volcanic
Land surface (km²): 374
Territorial sea + EEZ (km²): 68,492
Total reef-lagoon area (km²): 1,406
Linear reefs (km): 197
No. of level 5 class: 42
Seagrass (km²): 7.6
Mangroves (ha): 623
Pop density. (inhab/km²): 690
Status of the territory:
Unique Collectivity (DOM and ROM)

REUNION

Island type: Volcanic
Land surface (km²): 2,512
Territorial sea + EEZ (km²): 319 840
Total reef-lagoon area (km²): 18.6
Linear reefs (km): 25
No. of level 5 class: 4
Seagrass (km²): <0.01
Mangroves (ha): 0
Pop density. (inhab/km²): 341
Status of the territory: DOM and ROM

NEW CALEDONIA

Island type: Continental, volcanic and coral
Land surface (km²): 19,000
Territorial sea + EEZ (km²): 1,341,044
Total reef-lagoon area (km²): 35,873
Linear reefs (km):> 2000
No. of level 5 class: 161
Seagrass (km²): 939.7
Mangroves (ha): 28 173
Pop density. (inhab/km²): 14.6
Status of the territory: "sui generis" Collectivity with wide scope of intervention

WALLIS AND FUTUNA

Type of island: Volcanic
Land surface (km²): 140
Territorial sea + EEZ (km²): 262 416
Total reef-lagoon area (km²): 932
Linear reefs (km): 50
No. of level 5 class: 25
Seagrass (km²): 24
Mangroves (ha): 36.2
Pop density. (inha./km²): 83
Status of the territory: TOM with legal personality and administratively and financially independent

FRENCH POLYNESIA

Type of islands: Volcanic and coral
Land surface (km²): 3726
Territorial sea + EEZ (km²): 4 782 456
Total reef-lagoon area (km²): 16,200
Linear reefs (km):> 2000
No. of level 5 class: 66
Seagrass (km²): 28.7
Mangroves (ha): 41.1
Pop density. (inhab/km²): 76
Status of the territory: OCT

CLIPPERTON

Island type: Coral
Land surface (km²): 1.7
Territorial sea + EEZ (km²): 435,600
Total reef-lagoon surface (km²): 12
Linear reefs (km): 12
No. of level 5 class: 6
Seagrass (km²): -
Mangroves (ha): -
Pop density. (inhab/km²): 0
Status of the territory: Public domain of State

SAINT-MARTIN

Type of islands: Volcanic and sedimentary
Land surface (km²): 53
Territorial Sea + EEZ (Saint-Martin and Saint-Barthélemy - km²): 5,098
Total reef-lagoon area (km²):> 19.4
Linear reefs (km): -
Seagrass (km²): 61.5
Mangroves (ha): 24.2
Pop density. (inhab/km²): 654
Territory status: COM

SAINT-BARTHÉLEMY

Type of islands: Volcanic and sedimentary
Land surface (km²): 24
Territorial Sea + EEZ (Saint-Martin and Saint-Barthélemy - km²): 5,098
Total reef-lagoon area (km²): 14.24
Linear reefs (km): 9
Seagrass (km²): 3.7
Mangroves (ha): 4.1
Pop density. (inhab/km²): 466
Status of the territory: OCT

GUADELOUPE

Island type: Volcanic and coral
Land surface (km²): 1705
Territorial sea + EEZ (km²): 90,000
Total reef-lagoon area (km²): 865
Linear reefs (km): 200
No. of level 5 reef class: 33 (for Guadeloupe, St Martin, St Barth.)
Seagrass (km²): 101.93
Mangroves (ha): 3306
Pop density. (inhab/km²): 229
Status of the territory: DOM and TOM

MARTINIQUE

Island type: Volcanic
Land surface (km²): 1128
Territorial sea + EEZ (km²): 48900
Total reef-lagoon area (km²): 55.87
Linear reefs (km): 70
No. of level 5 class: 22
Seagrass (km²): 49.7
Mangroves (ha): 1856
Pop density. (inhab/km²): 330
Status of the territory: DOM and ROM

DOM: Overseas Department, ROM: Overseas Region, TOM: Overseas Territory, OCT: Overseas Country & Territory, COM: Overseas Collectivities

THE CORAL REEFS, SEAGRASS BEDS AND MANGROVES

The coral reefs

10%
of the reef surface worldwide

With nearly 60,000 km² of coral reefs and lagoons in its overseas territories; i.e., 10% of the world surface, France is fourth worldwide in terms of reef area.

This area is very unequally distributed among the territories, New Caledonia and French Polynesia accounting for nearly 90% of the total area of French reefs and lagoons.

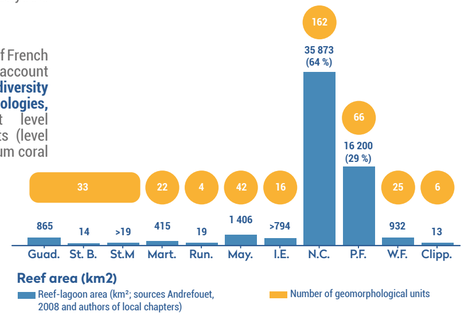
30%
of the world geomorphological diversity

Additionally, the reefs of French overseas territories account for **30% of the world diversity of the reef geomorphologies,** in the 800 finest level geomorphological units (level 5) counted by Millennium coral reef mapping.

25%
of the world diversity in marine species

The coral reefs cover less than 1% of the ocean area but, with more than 25% of the global marine life, they are among **the most diversified ecosystems of the planet:** approximately 4,000 fish species and 800 species of corals that build reefs have been described to date; the surveys are far from complete, in particular for species of small size. The Atlantic territories count less than 4,000 reef species, while New Caledonia (14,337) and French Polynesia (7,025) are richest.

With four times more fish and three times more mollusks, French overseas territories boast richer marine biodiversity than that of metropolitan waters.



The great range of the reefs and lagoons, the exceptional diversity of the reef geomorphologies and these reefs' global geographical distribution in the three oceans, make France, thanks to its overseas regions, **one of the planet's top coral countries.**

The seagrass beds

0.4%
of the world seagrass beds area

On the scale of ultramarine territories, the areas of seagrass beds are estimated at 1255 km², **accounting for 0.4% of world area.** The number of species of marine seed plants present in the scale of overseas lies between 16 and 19 species representing nearly a quarter of all species listed in the world.

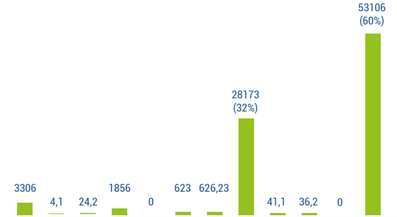
With nearly 940 km², New Caledonia accounts for 75% of the total area of the overseas seagrass beds, followed by Guadeloupe (101.93 km²).

The mangroves

0.7%
of the mangrove area worldwide

The mangroves are present in ten territories, where they occupy **87,796 ha; i.e., 0.67% of the mangroves of the world.** Located in three large oceanic basins, they are located on the two big biogeographic masses (Eastern and Western). This dispersion is at the origin of a significant specific and structural diversity of the mangrove population. These forests are unequally distributed with more than 90% of area between Guyana (60%) and New Caledonia (32%).

The mangroves are structurally rich and diversified. While small insular territories mainly include bay or lagoon mangroves protected from the swell by the reef barriers, the vaster or continental territories, having a significant hydrographic network, also shelter vast estuarine, riverbank or oceanic mangroves as in Guyana, or deltaic mangroves as in New Caledonia.



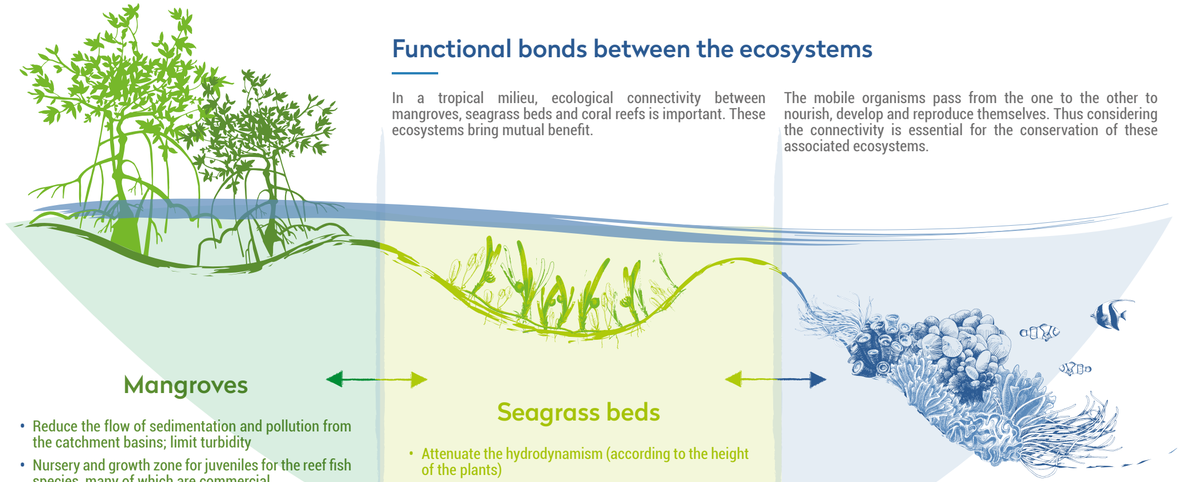
Areas of the mangroves of the ultramarine territories (ha)

France counts 27 species of "true" mangroves, i.e. developing exclusively in the mangrove swamps, with significant differences between the territories; Wallis has two species, and there are up to 19 in New Caledonia.

Functional bonds between the ecosystems

In a tropical milieu, ecological connectivity between mangroves, seagrass beds and coral reefs is important. These ecosystems bring mutual benefit.

The mobile organisms pass from the one to the other to nourish, develop and reproduce themselves. Thus considering the connectivity is essential for the conservation of these associated ecosystems.



Mangroves

- Reduce the flow of sedimentation and pollution from the catchment basins; limit turbidity
- Nursery and growth zone for juveniles for the reef fish species, many of which are commercial
- Nutrient production

Seagrass beds

- Attenuate the hydrodynamism (according to the height of the plants)
- Fix the sediments
- Important zones of food for fish of the mangroves and reefs, as well as for the emblematic species, tortoises and dugongs
- Nursery zone and spawning ground
- Reduce the abundance of certain potentially pathogenic bacteria, in particular in corals, where disease rates are lower near seagrass beds
- Production of carbon and nitrogen: certain coral species could profit from the presence of the seagrass by assimilating the dissolved matter resulting from the seagrass or by buffering the oceans' acidification on a small scale

Coral reefs

- Deaden the energy of the waves and thus protect seagrass beds and mangroves, guaranteeing them calm conditions to develop. The limestone debris torn off from the reef by the waves and bioerosion provide a movable substrate for the development of the seagrass beds
- Many habitats favourable to the life, reproduction and nutrition of various species
- The biological activity of fish, sea urchins, and perforating sponges is a source of sediments transported in the back-reef, colonized by the seagrass beds and mangroves

THE VALUE OF THE ECOSYSTEMS

1.3 billion €
Annual total value of the services rendered by the reefs in overseas territories

Protection of the coasts, food safety, tourism, regulation of the climate, carbon sequestration by the seagrass beds and mangroves, etc. The services provided by the reefs and associated ecosystems are vital for overseas and beyond.

Services provided by overseas mangroves *

The monetary value of the services provided by mangroves in the French overseas territories is estimated at 1.6 billion euros on average per year, including:

- CO_2 **60 %** for carbon sequestration
- **7 %** for water purification
- **28 %** for coastal protection
- **6 %** for the production of halieutic biomass

The different values between those of mangroves and the global values for French overseas territories can be explained by different calculation methods.

Trégarot et al., 2020

VALUES FOR THE FRENCH OVER-SEAS

Coastal protection

595,000,000 €

The coral ecosystems absorb a big part of the energy of the swell. By reducing the damage on littoral installations during extreme floods and other weather events, they are a source of significant savings.

Fishing & aquaculture

215,000,000 €

Fishing is related to the production of biomass by the coral ecosystems. In addition to commercial fishing, we have food and leisure fishing which represent an additional income and important protein source for certain households.

Tourism

315,000,000 €

The service of "blue" tourism related to the scenic beauty and the presence of emblematic species allows an economic activity based on the entertaining uses of the reefs in various forms: discovery excursions, deep-sea diving, pleasure, beach day, etc.

CO_2 Sequestration

175,000,000 €

The mangroves and seagrass beds are carbon sinks able to sequester CO_2. The estimate of the value of this service is based on the prices of the voluntary carbon credit market.

Source: Pascal et al., 2016

PROTECTION AND MANAGEMENT

Coral reefs

67% 67% of the reef geomorphologies included in the perimeter of a Marine Protected Area (MPA) and thus likely to be subject to protection measures.

27% 27% of reef habitats, at the scale of French waters, concerned with a strong statute of protection (heart of national park, national reserve, decree of biotope protection).

0% 0% of protection at Wallis and Futuna and 0% of strong protection in certain territories (Martinique, French Polynesia) or minimally, given the magnitude of the areas of existing protected areas (Guadeloupe, Mayotte).

Mangroves

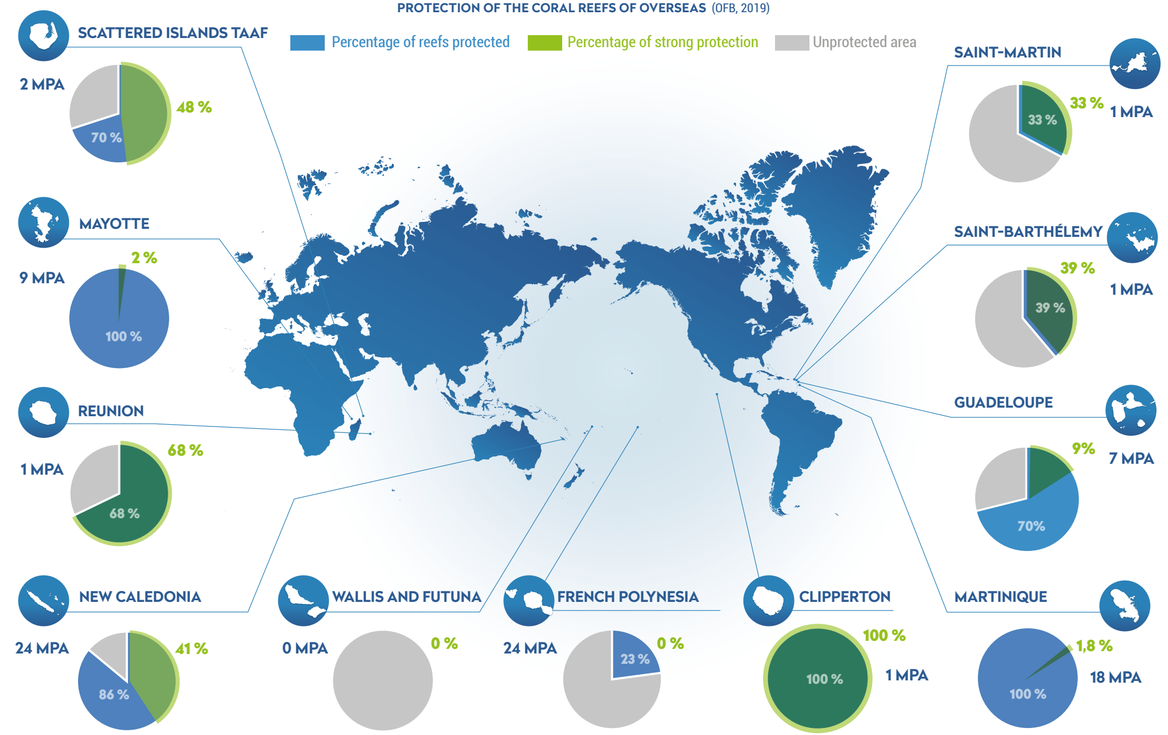
71% 71% of the national area of mangroves are protected and 25% regarded as "managed" or "being the subject of conservation measures" according to Nature France (2018 data), i.e. actually equipped with human and operational resources to reduce the threats.

More than 10,000 ha of mangroves are located within natural reserves or marine parks. In the Pacific territories, some mangroves are also the subject of customary management by the tribes or chefferies.

Seagrass beds

According to the last world report of the United Nations environment program, the seagrass beds appear among the least protected coastal habitats: only 26% are located in marine protected zones.

PROTECTION OF THE CORAL REEFS OF OVERSEAS (OFB, 2019)



Strong protections: heart of marine national natural parks and reserves; for New Caledonia: integral natural reserves, including seasonal ones, and natural reserves; Clipperton: biotope protection area

© Matt Curnock

STATE OF THE REEFS

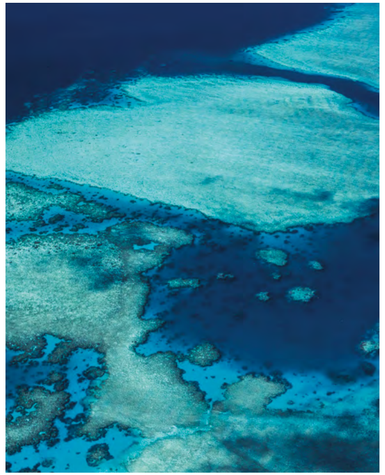
Dynamics of the coral reefs in the world

The natural dynamics of the coral communities is closely related to the environmental conditions under which they develop. These conditions are influenced:

- by the anthropogenic pressures (pollution, fishing, installations) which, in a long-term, chronic way induce modifications of water quality leading to slow but continuous transformations of the communities;
- by extreme events (abnormal rise in temperature, cyclones, strong swells), and other disturbances (infestations of *Acanthaster planci*, exotic species invasions, coral diseases), often much more sudden, which lead to abrupt reductions of the coral cover, affecting certain types of corals more.

This is the case of the branchy corals, which are particularly sensitive; contrary to the more massive corals, they offer many habitats and their disappearance impacts the reef fauna that finds refuge there.

Reduction of coral cover is often accompanied by an increase in algal cover ("coral-algal phase shifts"), the development being supported by the enriched pollutants and nutrients in the medium and by the reduction of the herbivore populations that ensure their regulation, such as the sea urchins in the Antilles or the parrotfish in Reunion.



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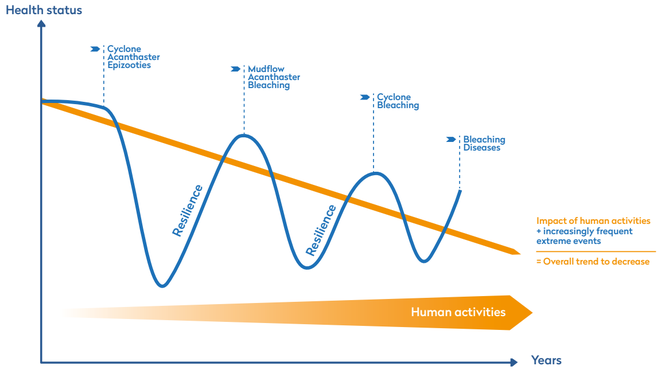
Dynamics of the coral reefs' evolution over time



Dynamics of the coral reefs' development over time, in particular of coral coverage, under the cumulative impacts of human activities and extreme events

The algae with fast growth compete for space with the corals, limiting their expansion.

They also prevent coral larvae from establishing themselves, since they can only attach themselves to the naked substrates.

Abrupt degradation episodes can be followed by a resumption of more or less fast coral cover depending on the reef's initial condition, the pressures to which it is subjected, and thus its capacity of resilience to disturbances.

However, these increasingly frequent episodes gradually weaken the reefs, which do not have time to recover between two events, leading to different ecological states.

While the degradation of the coral communities is immediately visible, the effect on the biological populations that they shelter (fish, invertebrates) can occur later (months, even years).

In the long term, all of these disturbances lead, by cascading effects, to in-depth modifications of the reef landscapes.

International reports on the future of the reefs on a worldwide scale:

Reports of the Intergovernmental Platform on Biodiversity and Ecosystemic Services (IPBES, 2019) and of the Intergovernmental Panel on the Climate Change (IPCC, 2019).

- Nearly a third of the corals which constitute the reefs are currently threatened.
- The coral reefs are particularly vulnerable to climate change (warming waters; acidification), but the frequency of extreme warming events is predicted to increase, with a shorter recovery time between two events.
- A large part of the tropical coral reefs will undergo a notable retreat of their coral cover and will suffer local extinctions following massive bleaching episodes: decline of 70 to 90% if the warming is of 1.5°C, and of more than 99% if it is of 2°C.
- The reefs formed by the remaining corals should be different from the current reefs by their composition and their diversity.
- The decline of the reefs will strongly compromise the services which they provide for the human societies, such as the contribution of food, the protection of the coasts and tourism.
- The increased risks which weigh on food security related to sea products, combined with the drop in fishing resources, will increasingly endanger the nutritional health of certain populations strongly dependent on the marine resources, for example in the small developing Island states.

State of the reefs of the French overseas

The state of the coral reefs has been evaluated according to three time scales:

- the current state (based on the most recent data, generally 2019);
- the development of this state since the last health status assessment of 2015;
- the long term development of coral and algal coverings and the reef fish populations since the beginning of monitoring in the territories.

The ecological/health status of the French reefs has been evaluated in four classes. According to the collectivities, the criteria employed to evaluate the health status differ, but for each territory, these classes characterize the following conditions (see detailed table in appendix):

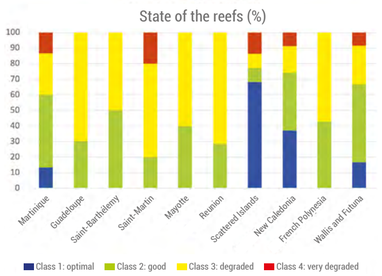
4 Very degraded state · 3 Degraded state · 2 Good state · 1 Optimal state

- class 1: optimal conditions, with rates of coral cove generally high and reefs in very good health;
- class 2: good conditions, with light impacts, for example some signs of necrotic coral, a weak presence of macroalgae and good rates of coral cover;
- class 3: degraded conditions, with a milieu of moderate to high impact, with many dead corals, a predominance of macroalgae and/or a strong silting and reduced rates of coral cover;
- class 4: very degraded conditions, with a milieu of medium to very high impact, a majority of dead corals and sea floors covered with macroalgae and/or entirely silted, with very weak rates of coral cover.

The dynamics of the overseas territories' reefs generally follows the traditional development trends of the reefs in the world (see preceding page diagram): stability - mortality after disturbance - variable regeneration according to resilience.

However, the reefs' health strongly varies among regions, territories, and within the same territory. Subject to the methodological limits (see box), global distinctions are:

- some extended territories, with weak or uninhabited demography, with coastal zones subjected to low or moderated pressures, where the reefs are rather preserved: in the Pacific (New Caledonia, Wallis and Futuna, French Polynesia - except Society archipelago) and in the Scattered islands (Europa, Tromelin);
- some more reduced territories, subjected to a strong demographic and very anthropised pressure, where the majority of the reefs are rather degraded: in the French West Indies and the Indian Ocean (Mayotte, Reunion).



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Limits of the exercise

- **The representativeness of the results** is partly (but not only) a function of the number of stations monitored compared to the area and to the diversity of the reefs' situation. It is quite variable: with, for example, 14 stations for 16,200 km ² of reefs and 120 islands in French Polynesia, against 14 stations for 18.2 km ² of reefs in Reunion, the variations are very significant.
- **The state of reference**, with which the current situation and its development are compared, is variable according to the overseas territories.
- **Objectives** differ between the monitoring networks.
- **The disparities**, between the territories, methods, duration of the time series, or still of indicators of reef status, make it difficult to establish an overall diagnosis.

The results are thus representative only of the sampling of the surveyed stations, depending on a state of reference specific to each region, or even territory.

Class of state of health	French West Indies	Mayotte and Reunion	Scattered Islands	New Caledonia and Wallis and Futuna	French Polynesia
1	The corals practically do not present signs of necroses and the plant population is constituted by an algal grass	Natural conditions out of impact	Pristine conditions Rate of coral coverage ranging between 41 and 100%	Good state: the values reached by all the variables indicating the health of the reefs are optimal with respect to the type of inventoried reef.	Coral cover = 76 - 100%
2	The corals have few signs of necroses, some macroalgae develops and/or some discrete signs of silting of the sea floors appear	Close to the natural conditions, very light impact	Close to the pristine conditions Rate of coral coverage ranging between 31 and 40%	Satisfactory State: one of the variables indicating the health of the reefs is not optimal with respect to the type of inventoried reef.	Coral cover = 31 - 75%
3	Many corals are more or less necrotic, the algal population is dominated by macroalgae and/or a significant silting of the sea floors is observable.	Moderate to highly impacted environment	Environment moderately degraded Rate of coral coverage ranging between 21 and 30%	Medium state: two of the variables indicating the health of the reefs is not optimal with respect to the type of inventoried reef.	Coral cover = 11 - 30%
4	The majority of the corals are dead and they, as well as the remainder of the sea floors, are invaded by macroalgae and/or entirely silted.	Environment very strongly impacted, or situation nearly irreversible in the medium term	Strongly degraded environment Rate of coral coverage ranging between 0 and 20%	Bad state: the values reached by all the variables indicating the reef health are not optimal with respect to the type of inventoried reef.	Coral cover = 0 - 10%

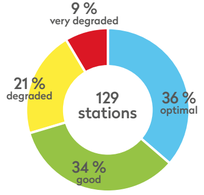
THE PACIFIC AND SCATTERED ISLANDS: GENERALLY GOOD CONDITIONS

In 2020, the majority (70%) of the reefs inventoried on the whole of these territories are in good condition (classes 1 or 2).

In the majority of the Scattered islands (except Juan de Nova), the rates of coral cover are good, sometimes very high in particular on the external slopes (more than 80% at Europa). In New Caledonia, 75% of the studied zones are in a "good to satisfactory" state according to the classification used in this territory (class 1 or class 2), 50% in Polynesia. In Wallis and Futuna, the sectors sheltered from the cyclones are preserved. In these territories, the ichthyologic populations maintain themselves with sometimes exceptional biomass and diversity. However, the situations can be very contrasted, within the same territory, with locally some very degraded reefs, in class 4.

This is the case, for example, with Juan de Nova, where coral cover reached only 9% in 2019, because of episodes of bleaching or sectors under the influence of the cyclones at Wallis.

Current state of the reefs (Pacific and Scattered Islands)



Percentages of stations by health status class

© Y. Bouchon Navaro

Since 2015

Since the last coral reef health assessment (in 2015), the trend is towards stable health status in these territories. In New Caledonia and French Polynesia (in the archipelagos other than Society), 69% of the inventoried reefs are stable, 16% show an improvement and 15% are degraded. In the archipelago of the Society islands, the trend towards the overall increase in coral cover over the period 2015-2019 was followed by a break between 2019 and 2020 due to massive bleaching having affected all the sites of this archipelago during 2019.
The change in the health status since the last assessment could not be evaluated for the Scattered islands (data not available) and Wallis and Futuna (monitoring too recent).

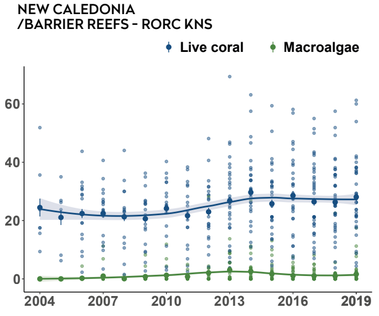
Since the last assessment in 2015:

- **16%** stations show an improvement
- **69%** remained stable
- **15%** are degraded

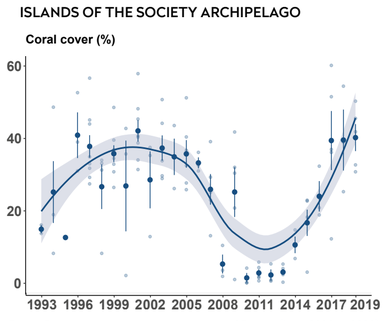
Long-term trends

In the long term also, the reefs of these territories are overall stable and show for the moment a good regeneration after extreme events.

- **New Caledonia:** in spite of the localised degradation of certain Grande-Terre reefs, particularly the coastal ones of the East coast, reef health generally tends towards stability, with good resilience. The reef fish populations are rather stable and locally exceptional.
- **French Polynesia:** considering the particularly important extent of Polynesia in latitude and longitude, the state of the reefs is naturally variable according to archipelagos. The long term developments are thus variable also, and very strongly dependent on events. The reefs of the Society islands over the 15 last years show some very strong variations following disturbances (Acanthaster, bleaching, sometimes cyclone), with strong degradations followed by a remarkable resilience. But the composition of the coral communities has changed a lot (strong decline of *Acropora*). In the islands of the other archipelagos, the coral populations, which did not undergo a major disturbance in the last 10 years, are in relative stability.



New Caledonia: time data of coral cover (in%) all barrier reefs put together.



French Polynesia: average developments over 25 years (from 1993 to 2019), of live coral cover (Society Archipelago).

The total fish biomass, on the other hand, decreases over the last 10 years.

- **In Wallis and Futuna,** the trends are variable according to the exposure to the cyclones and dominant winds. The exposed reefs have undergone significant coral losses, while the sheltered reefs are either stable (Futuna), or in clear progression over time (Alofi and Wallis).
- **Scattered islands:** for the moment, the current good health means good resilience of the reefs, although the increase in the frequency of bleaching in the islands north of the Mozambique Channel suggests a potentially declining trajectory. The development of the fish biomasses is generally increasing in the external slopes, stable or in reduction at Juan de Nova and at the Glorieuses.

FRENCH WEST INDIES AND INDIAN OCEAN (EXCEPT SCATTERED ISLANDS): MORE ALARMING SITUATIONS

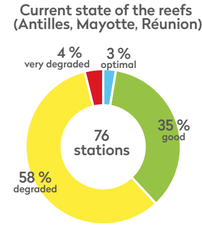
In 2020, the majority (62%) of the reefs inventoried in these territories are degraded (classes 3 or 4).

According to the territories and classification used, these reefs are characterized by environments of moderate to high impact (Indian Ocean classification), with corals more or less necrotic, algal populations dominated by macroalgae and/or silted sea floors (West Indies classification).

In Mayotte and Reunion, coral covers are about 20 to 30%, even if they can locally reach 70% at Mayotte for example. In the West Indies, they are also relatively low to medium, with 20 to 45% in Guadeloupe and Martinique (locally reaching up to 57%, which is exceptional for the area); they are naturally lower (10-20%) in the northern islands (Saint-Martin and Saint-Barthélemy). Everywhere, coverage in macroalgae or algal assemblies is significant.

In these territories, the abundance and biomass of the fish populations associated with the reefs are generally low; we see in particular a worrying reduction in the richness specific to Mayotte, probable consequence of the last episode of major bleaching in 2016.

A particular vigilance must be given to these reefs, which could still be regenerated if measures are taken to reverse the trend, or could continue to be degraded in the contrary case.



Percentages of stations by health status class

Since 2015

Since the last assessment (in 2015), the trend is towards stability in these territories. Although some sites show an improvement (10%), the majority of the inventoried reefs remained stable (57%) or are degraded (33%) since the last assessment.

Since the last assessment in 2015:

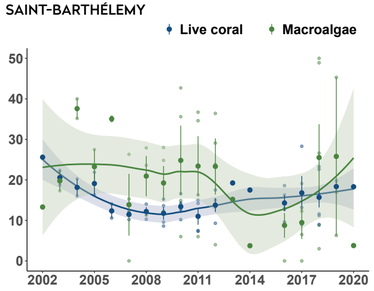
- **10%** stations show an improvement
- **57%** remained stable
- **33%** are degraded

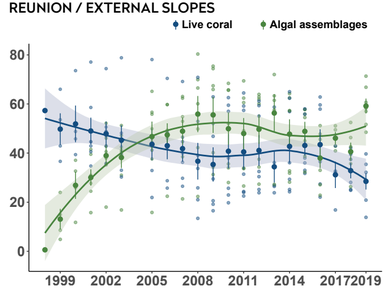
Long-term trends

The long term trajectories of these reefs go, as a whole, in the direction of degradation.

- **French West Indies:** we observe a significant degradation of the reefs of the region from the 1970s (diseases, over-fishing, bleaching), with a progressive replacement of the corals by macroalgae. This trend has continued until today, in spite of local disparities and some sites that still show exceptional characteristics for the region, like Caye d'Olbian, located in the south of Martinique (57% of coral cover in 2019). The fish populations have been subjected to strong fishing pressure and the classes of sizes are reduced, with relatively low abundance and biomass. We observe in particular a significant decline in the bay of Grand Cul-de-sac Marin, in Guadeloupe. However, in Saint Martin and St. Barthelemy, the marine natural reserves have a positive effect on herbivorous fish.
- **Reunion:** we observe a loss of coral cover, in favour of the algal grasses which compete with the corals and limit the possibilities of their regrowth. Since 2002, the reduction in the total fish biomass is of 80%. It maintains at an overall low level, with an imbalance of the high level trophic categories.
- **Mayotte:** in spite of zones still quite alive and resilient in the internal and barrier reefs, the coral cover is overall in decrease. The general levels of the fish populations (diversity, density and total biomass) have decreased since the beginning of monitoring.

Saint-Martin © Laurent Juhel





Average trends of live coral (blue) and algal (green) covers over 20 years. St-Barthelemy: GCRMN monitoring, Reef Check, AMP. Reunion: GCRMN monitoring, external slope.

REMARKABLE RESILIENCE

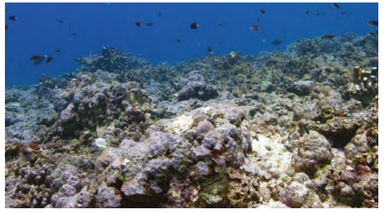
Many examples of resilience[1] of the reefs were observed, with a coral cover recovered at the end of a few years, following a massive destruction.

New Caledonia and cyclone Erica (2003)
In March 2003, the passage of cyclone Erica affected many reefs. Today, the three historical monitoring networks considered in this report show a recovery of the coral population in one decade: for the KNS lagoon and barrier reefs, for the lagoon reefs of Grand Nouméa, and for the reefs of the RORC Grande-Terre.

The monitoring of the Grand Nouméa lagoon indicates that the ichthyofauna, macrobenthos and the habitat had found since 2014 a state comparable with the one preceding cyclone Erica (2003).

New Caledonia and mining impacts
Although by exposing the ground, the mining activity contributes to the dynamics of the sedimentary deposits to the lagoon, the monitoring implemented by the miners does not highlight acute impacts of the activity. It is possible that the corals of the reefs under the impact of these mines got themselves adapted and have a certain resilience in a context of chronic terrigenous influence.

French Polynesia, Acanthasters and cyclone Oli
In 2010, the Society islands were affected by an explosion of Acanthaster, followed cyclone Oli, reducing drastically the coral cover; in Tahiti and Moorea, the coral covers of the followed reefs strongly dropped, passing from 30-40% to less than 5%. In 2019 (before bleaching), almost 10 years after, the live coral coverage showed values among the highest ever reached since the beginning of monitoring (1992).



State of the Moorea (Tiahura) reef in 2010 after infestation of Acanthaster and cyclone Oli © Chancerelle Y./CRIOBE/SNO Coral

State of the Moorea (Tiahura) reef in 2015 in resilience phase
© Chancerelle Y./CRIOBE/SNO Coral

State of the Moorea (Tiahura) reef in 2019 during bleaching
© Chancerelle Y./CRIOBE/SNO Coral

1- Resilience: capacity of the reef to be regenerated after a destruction. This regeneration can be more or less fast according to the environmental conditions, reef type, disturbances in progress, etc.

Mayotte and successive coral bleaching: eight years after the bleaching of 2010 which had led to a strong mortality, the reefs of the S pass again show good health; they also resisted the bleaching of 2016 well. The Surprise reef has also been very affected by the bleaching of 2016, but this reef always showed strong capacities of regeneration following past mortalities. It is also true for the fish populations: 10 years after the planetary episode of bleaching of 1998, the populations had found levels of abundance and biomass similar to those of pre-event.

SOME PROVEN RESERVE EFFECTS

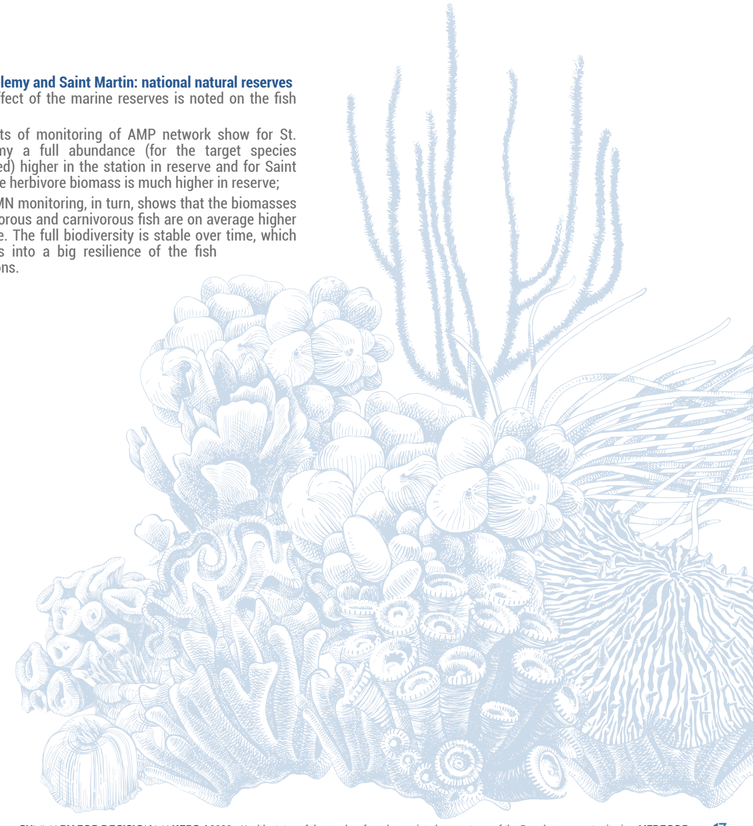
New Caledonia: lagoon of Grand Nouméa
The effects of the AMP of the Grand Nouméa lagoon, set up since 1990, could be shown by levels of commercial fish populations (richness, density and biomass) higher in their centre than those of the non-protected zones, particularly for the two species most targeted by fishing: the dawa (*Naso unicornis*) and the common coral trout (*Plectropomus leopardus*).

Reunion: National Marine Natural Reserve (RNMR)
The reserve effect is not felt on the benthic communities (except locally in the external slope of La Saline sanctuary), but for fish, the impact of protection is proven:

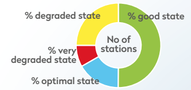
- **in the external slopes** of the sanctuaries, in particular in the reefs of the La Saline and Saint-Leu, with an increase in the biomass of the species of commercial interest (67%) and in particular of the lyretail *Variola Louti*;
- **in the reef flats,** in unfished zones, with a significant increase in densities and biomass for the rockcod *Epinephelus merra*, with a potential spillover effect.

Saint-Barthelemy and Saint Martin: national natural reserves
A positive effect of the marine reserves is noted on the fish populations:

- the results of monitoring of AMP network show for St. Barthelemy a full abundance (for the target species considered) higher in the station in reserve and for Saint Martin the herbivore biomass is much higher in reserve;
- the GCRMN monitoring, in turn, shows that the biomasses of herbivorous and carnivorous fish are on average higher in reserve. The full biodiversity is stable over time, which translates into a big resilience of the fish populations.



Legend



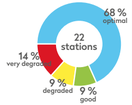
Current State
State assessed based on the latest available data (2018-2020, depending on the areas). Percentage of station by class of health state (except for SI: percentage by class of coral cover)

Since 2015
Percentage of health state development since 2015
- % improving
- % stable
- % degrading

Long-term trends
- Trends of coral and algal cover since the start of monitoring
- Trends of reef fish populations since the start of monitoring

SCATTERED ISLANDS (TAAF) - Reef surface: >794 km²

Curent state



Since 2015
- - %
- - %
- - %

(data not available)

Long-term trends: stability
- Variable conditions depending on the islands
- Safe from direct anthropic pressure, so-called "pristine" state: for Europa, several areas in Glorieuses and Tromelin. Juan de Nova, most affected, health status average to degraded. Average live coral cover: 40 to 60% (up to 80% in Europa)
- Relative stability in terms of species richness
- Generally stable fish biomasses on external slopes, depleting in Juan de Nova and Glorieuses
- Exceptional total biomass locally (Europa)

MAYOTTE - Reef surface: 1 406 km²

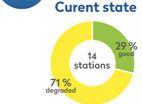
Curent state

Since 2015
- 14%
- 43%
- 43%

Long-term trends: degradation
- Great variation depending on the areas
- Coral dynamics mostly driven by regional phenomena: Sudden reef degradation (for example, 25% coral mortality after 2016 bleaching), followed by variable recovery
- Global depletion of fish population after the beginning of monitoring
- Signs of high pressure on specific commercial species
- Coral bleaching strong impact on species richness of fish

REUNION - Reef surface: 19 km²

Curent state

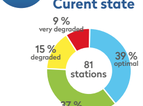


Since 2015
- 8%
- 69%
- 23%

Long-term trends: degradation
- Average reduction in coral cover of 17% on reef-flats and 43% on slopes
- External slopes: change in the community composition, very fast loss of species richness and habitat opportunities for the fauna
- Increase in algal cover
- Reef-flat: reduction in herbivore biomass (Naso spp.); weakness (density and biomass) in carnivores-piscivores
- External slopes: 80% reduction in global biomass on external slopes; imbalance in high trophic levels

NEW CALEDONIA - Reef surface: 35 873 km²

Curent state

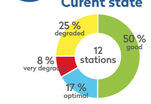


Since 2015
- 7%
- 75%
- 18%

Long-term trends: stability
- General trend to stability, especially for reefs of the Grande-Terre under oceanic influence and Loyalty islands
- Severe and localised degradations since 2012, only in Grande- Terre
- Regeneration of some reefs under way
- Good resilience, globally
- Results of miners' and world heritage monitoring:
- Stability at local scale, functional patterning of preserved species
- Local disruption along with habitat disruption
- Locally exceptional populations

WALLIS AND FUTUNA - Reef surface: 932 km²

Curent state



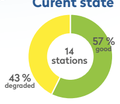
Since 2015
- - %
- - %
- - %

(no data in 2015)

Long-term trends: variable depending on exposition
- Coral cover dynamics of external slopes mainly driven by the cyclone: sheltered coasts shelter more live coral, stable (Futuna) or in progress (Alofi and Wallis)
- Irregular monitoring does not allow to draw conclusions on the development of fish communities
- Varying populations, more dense and larger in size in Wallis than in Futuna and Alofi
- Signs of pressure on fish stocks (lack of commercial fish and large predators)

FRENCH POLYNESIA - Reef surface: 16 200 km²

Curent state

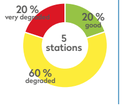


Since 2015
- 69%
- 31%
- 0%

Long-term trends: strong variation depending on events
- Spatial (among archipelagos) and temporal heterogeneity
- On external slopes, alternating phases of fast decline and regeneration, mostly related with natural events (Acanthaster, bleaching)
- Severe change in coral community patterns since the reduction of branchy forms after the destruction of Society reefs in 2010
- Decrease in total fish biomasses

SAINT-MARTIN - Reef surface: > 19 km²

Curent state

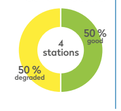


Since 2015
- 0%
- 50%
- 50%

Long-term trends: degradation
- Reef degradation after the beginning of the monitoring (Decline in coral cover and recruitment). Since 2015, slow progress in coral cover
- Reserve effect, with higher average herbivore biomass in reserve

SAINT-BARTHÉLEMY - Reef surface: 14 km²

Curent state

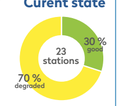


Since 2015
- 0%
- 25%
- 75%

Long-term trends: stability
- Alternating coral cover decline/reprise phases, higher in reserve
- Relative stability of GCRMN Networks' coral populations
- No abundance trend for target species but upward biomass trend since 2012. Reserve effect with higher biomasses in reserve (up to 4 times more)

GUADELOUPE - Reef surface: 865 km²

Curent state

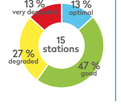


Since 2015
- 4%
- 52%
- 43%

Long-term trends: degradation
- Decrease in coral cover, except for the lee shore, where cover is stable
- Macroalgae cover: stable, but high in the Grand cul-de-sac Marin bay; increasing in the lee shore
- Increase in abundance and biomass of target species in the lee shore
- No decline trend in other sectors

MARTINIQUE - Reef surface: 415 km²

Curent state



Since 2015
- 20%
- 80%
- 0%

Long-term trends: degradation
- Regressing reef habitat on the long term, but recent relative stability
- Fluctuating populations, but relatively stable average trend
- Weak biomass and abundance values
- Small size classes

Seagrass beds

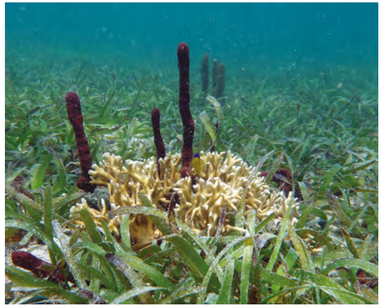
© Fanny Kerninon

STATE OF THE SEAGRASS BEDS

Worldwide, one in five species of marine seed plants is now indexed as in danger, vulnerable, being almost threatened or presenting an increased risk of extinction on the UICN red list. Nearly 30% of the world's seagrass beds earth have now disappeared since the end of the 19th century.

Among the marine seed plant species inventoried in the ultramarine territories, two are registered in the "vulnerable" category of the UICN Red list of species threatened by extinction and show overall decline trends (*Halophila bailonni* and *Zostera capensis*).

Site in bad state © Fanny Kerninon



Site in good state © Fanny Kerninon

Evolutionary trends, still difficult to establish because of a great heterogeneity of the network of stations and indicators used, are variable according to territories:

- **The Pacific:** stability of seagrass beds in spite of some disturbances close to the urban centres.
- **The West Indies:** progressive modification of the seagrass beds' specific composition and decline in density, in particular *Thalassia testudinum* seagrass beds with high functional potential; invasion by the marine seed plant *Halophila stipulacea*.
- **Indian Ocean:** except for the Scattered islands where they are stable, they decline in Reunion, but especially in Mayotte, where the fast disappearance of the large dense seagrass beds of *Thalassodendron ciliatum* is alarming.

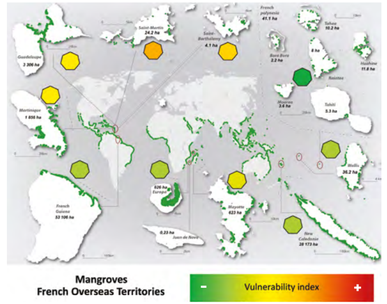
Mangroves

© Florent Bignon

STATE OF THE MANGROVES

The French mangroves' health varies by territory:

- good health for the mangroves of Guyana, Europa, Juan de Nova and Wallis, and most of the mangroves of New Caledonia;
- some pressures which affect their health for the mangroves of Martinique and Guadeloupe and some mangroves of New Caledonia (mainly in the outskirts of Nouméa);
- some degraded conditions for the mangroves of Mayotte, Saint Martin and St. Barthelemy;
- in French Polynesia, the mangrove was introduced; there is no question of deciding on its health.



Overall state of the mangroves in the territory scale

● = Very bad state
●● = Bad state
●●● = Average state
●●●● = Good state
●●●●● = Very good state

Saint-Martin	●●
Saint-Barthélemy	●●
Guadeloupe	●●●●
Martinique	●●●
French Guiana	●●●●●
Europa	●●●●●
Juan de Nova	●●●●●
Mayotte	●●
New Caledonia	●●●●
Wallis	●●●●

© P. Dumas / IRD

THE PRESSURES

The marine ecosystems of the ultramarine territories are subjected to local and regional pressures.

ON A LOCAL SCALE

The local pressures are related to human activities on the catchment basins (agriculture, mines, urbanization, etc.) and in coastal zones (coastal installations), or the marine environment (pleasure, maritime transport, etc.).

The practices' intensity has evolved a great deal with population increases and lifestyle changes. The coastal zones are the world's most densely populated regions and demographic pressure is strong in several territories (Mayotte, Reunion, West Indies).

The pressures induced by these activities have an impact more or less marked on the coastal ecosystems, according to the sensitivity of the habitats, their distance from the source of the pressure, the intensity and frequency of the pressure.

The littoral urbanization, which waterproofs the grounds and supports the streaming, agricultural developments, mines, sometimes devastating fires, which erode the grounds, have led to an increase in the addition of sediments, nutrients and pollutants in coastal water. These additions deteriorated the environmental conditions of the adjacent marine ecosystems considerably, in particular in the densely populated territories. In the least populated islands, these pressures are generally more localised.

The types and severity of the induced effects are variable: destruction of habitats, loss of functionality of the ecosystems, reduction of the calcification of the reefs (thus of their growth), modification of the structure of the communities, reduction of the richness in species, etc. The impacts affect the reproduction, regrowth and survival of the species, in particular at the larval stage, particularly fragile.

ON THE GLOBAL AND REGIONAL SCALE

The pressures on a global scale are induced by natural events (cyclones, increase in the temperature of the oceans), accentuated by climate change (increase in the frequency and intensity of these events, acidification, modification of the mode of precipitations, rise of the sea level) (GIEC, 2013).

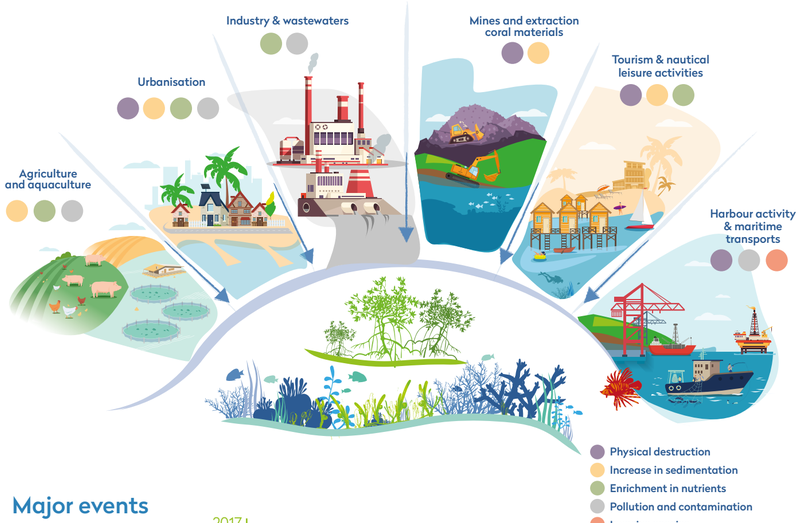
Other pressures are added, probably reinforced at the same time by climate change and by the local human activities: explosions of populations of Acanthasters and of *Drupella* (predators of the corals), coral diseases, invading exotic species like the fish-lion, or beaching in pelagic sargassos in the Caribbean.

These five last years, between 2015 and 2020, several episodes of bleaching have affected the Pacific (two episodes) and the Indian Ocean (three episodes), including one particularly significant in 2016; nine cyclones in addition crossed the overseas territories. The islands of the north of the West Indies were strongly affected by the hurricane Irma, of category 5, in 2017, and the whole of the French West Indies saw the emergence of the Stony Coral Tissue Loss Disease (SCTLD) in 2020. These episodes, increasingly frequent, impact the reefs durably.

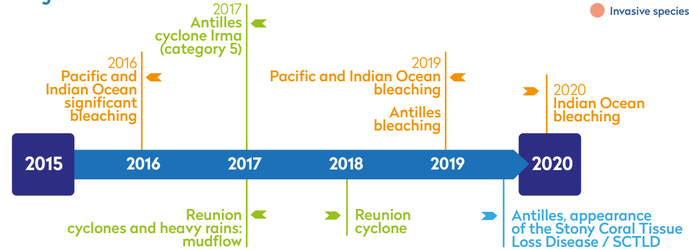
The pressures act on two scales: the chronic pressures of low intensity (wastewaters for example) but have long term effects; they impact the reefs durably. Pressures of abrupt intensity have a strong immediate impact (cyclone, brutal sediment discharge, large littoral installation).

These various pressures interact, making analysis of the impacts difficult, especially because not all the components of the ecosystems react in a similar way to pollution.

With a density of population of almost 500 to 700 res/km² in Mayotte, Saint Martin and St. Barthelemy, the requirements in infrastructure for millions of tourists in the West Indies, significant clearings (in particular of mangroves), forest fires and illegal slash-and-burn at Mayotte (approximately 230 ha between 2004 to 2012, but 150 ha in 2013), or in New Caledonia (27,000 ha of vegetation burnt each year), the dysfunctions of sanitation system in almost all the territories, the coral reefs, seagrass beds and ultramarine mangroves are exposed chronically to a quality of water deteriorated by the suspended matter, pollutants and waste.



Major events



On the seagrass beds

In the majority of the territories, as on a worldwide scale, the main threats on the seagrass beds are related to the deterioration of the quality of water (increase of the load in nutrients, pollutants, turbidity and silting) and to the physical disturbances (fill, trampling, damage caused by boat anchors).

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© Nathaniel Cornuet

On the mangroves

The main pressures which affect the mangroves of French overseas are the urbanization (conversion of mangroves into buildable areas), the modification of hydrological continuities (drains, artificialisation of the grounds upstream of the mangrove, deviation of river) and pollution resulting from the catchment basins or the sea.

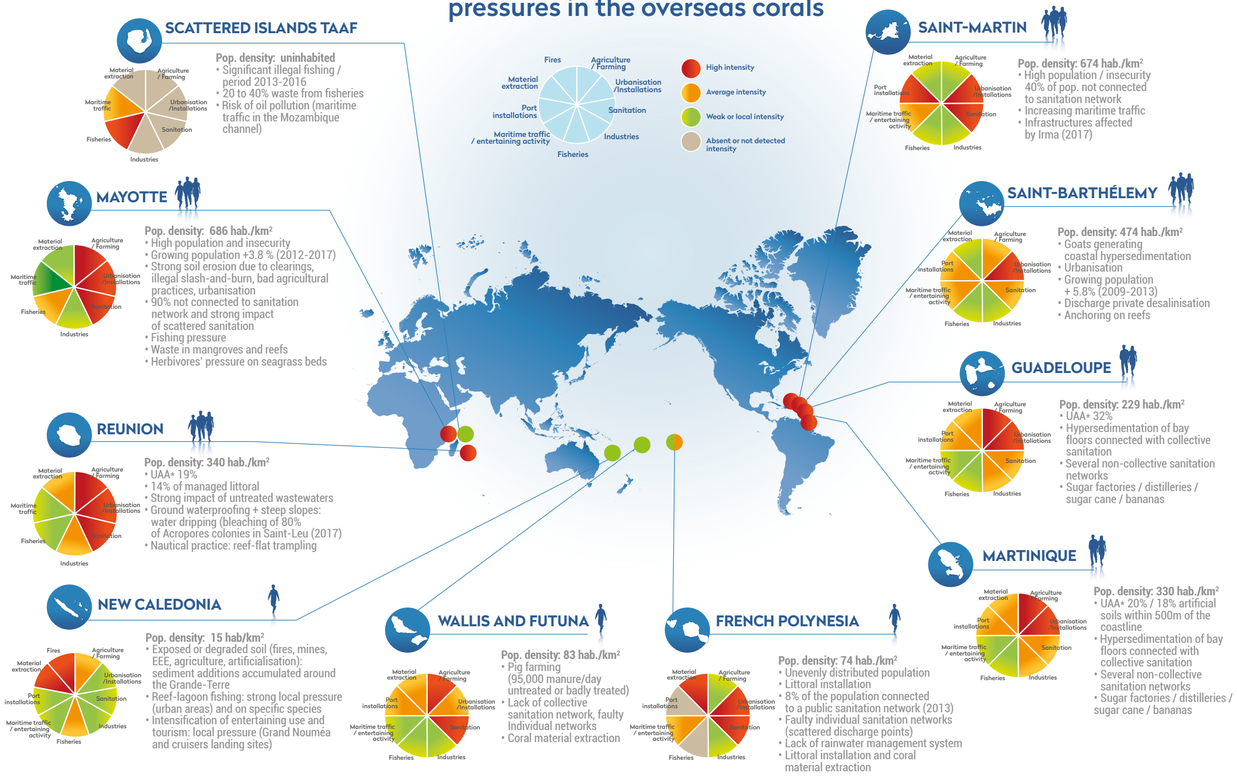
	Main intensity of the pressures		
	Urbanisation	Hydrological continuity	Pollution
Saint-Martin	Strong	Medium	Medium
Saint-Barthélemy	Strong	Strong	Medium
Guadeloupe	Strong	Medium	Medium
Martinique	Strong	Medium	Medium
French Guiana	Low	Low	Low
Europa	Low	Low	Low
Juan de Nova	Low	Low	Low
Mayotte	Strong	Medium	Strong
New Caledonia	Medium	Low	Low
Wallis	Medium	Low	Medium

Mangroves of overseas: main pressures and their intensity

Dead mangroves, Guadeloupe ©PRZHT

Waste in mangroves, Saint Martin ©PRZHT

Intensity of the anthropogenic pressures in the overseas corals



Recommandations

© DR

RECOMMANDATIONS[2]

While the Nature-based Solutions (NbS[3]) are largely proposed to take up the global challenges, the coral reefs, the seagrass beds and mangroves constitute natural solutions to fight against the effects of climate change as long as they remain in good condition.

In the current ecological crisis, marked by an important decline of the biodiversity, the protection of the coral reefs, important places of the world marine biodiversity, is essential.

This assessment 2020 falls under the line of the regional reports and the preceding assessments and confirms the general tendency of the degradation of these ecosystems, in a context of global change, although certain zones are still preserved or show encouraging signs of regeneration.

Against the pressures and threats with which the coral reefs, seagrass beds and mangroves are confronted, one of the main recommendations of this report, relates to the limitation of the direct anthropogenic pressures, to increase the resilience of the ecosystems; echoing the recent recommendations of a collective of international scientists (see. frame). It is only at the price of a strong political will to reduce these pressures that the objective of 100% of protection of the coral reefs in 2025 could be achieved.

For the survival of the coral reefs: the scientists point out that (Kleypas et al, 2021) :

- If nothing is undertaken, the coral ecosystems will continue to decline significantly and globally.
- The attenuation of climate change is an essential but insufficient action to preserve the reefs.
- The corals' adaptation to global warming will be effective only within scenarios of low emissions.
- Protection of the reefs and innovations aiming at increasing the resilience of the corals must develop quickly.
- Protection of the coral reefs requires efforts and financing comparable with those of other great challenges.

The three pillars of the survival of the reefs are: attenuation of climate change, reduction of anthropogenic pressures and innovation allowing to protect the reefs effectively and to reinforce their resilience.

2 - The stakes and recommendations suitable for each territory appear in the local chapters. Only the recommendations of general nature are repeated here.
3 - NbS : Nature-based Solutions are defined by IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits".

Reefs

REDUCING THE PRESSURES

Reinforcing the resilience of the ecosystems by reducing the direct and indirect anthropogenic impacts, go through voluntary and coherent policies as regards the development of the territory, management of water, development of agriculture and fishing.

It is recommended:

- **To improve the networks and infrastructures of wastewaters treatment:** in all the territories, the improvement of the health of the reef ecosystems go through the control of the treatment of the wastewaters and rain water: installation of purification stations, improvement of the effectiveness of the treatments, generalization of the collective networks, stopping the discharges at sea of untreated or badly treated wastewaters, management of rain water loaded with mud, coming from the catchment basins;
- **To support an agriculture respectful of the environment by improving the practices,** in particular by controlling the importation of the phytosanitary products, developing agricultural sectors which are free from the massive use of inputs, and by improving the practices of culture, with a better control of erosion;
- **Ensure better management of development impact risks** in catchment basins and littoral areas, in particular by supporting the appropriation and implementation by the developers and services of instructors of the **ACR, Avoid-Reduce-Compensate sequence** ;
- **To collaborate at the regional level in the fight against the invasive exotic species,** in particular by implementing the regional strategies of regulation and monitoring of these species;
- **To reduce the impact of anchorages** by supporting the use of ecological anchorages, by limiting anchoring to ecologically nonsensitive areas;
- **To regulate frequentation and uses in the marine zones at stake** (higher diversity zones, resilient zones, nurseries, etc.) ;
- Generally, **to make sure of the consideration of the coral reefs, seagrass beds and mangroves in all the public policies** (littoral territory development, fishing, etc.).

PROTECTING

The Marine Protected Areas currently cover 67% of the coral reefs, including 27% in strong protection[3], and their beneficial effects on in particular commercial fish populations, are proven. This tendency can be accentuated by reinforcing this network, in particular by multiplying and by extending the zones of strong protection, by accentuating their monitoring, in particular on the following zones:

- zones of stronger biodiversity;
- zones of stronger resilience to climate change;
- zones of ecological importance for reef fishes (zones of reproduction, nurseries, etc.) ;
- zones allowing to ensure the protection of ecological continuities.

SUPERVISING

The inspection networks are essential to follow the change of the ecosystems and to adapt the policies and management accordingly. The monitoring network of the reefs in overseas is already significant, with more than 700 stations monitored more or less regularly, but nevertheless insufficient in certain overseas territories in comparison with the area of their reefs; the allocated means are in addition often too low to ensure a regular monitoring.

It is recommended:

- **To perpetuate and reinforce the monitoring networks** of the reefs;
- **Improve coherence of the various monitoring networks** in the same territory; if possible pooling monitoring actions;
- identify robust indicators of reef health, reporting of the state of the ecosystem as a whole and to work with the **implementation of an integrated indicator** for each territory, considering their specificities. This indicator must be based, in addition to the benthic compartment, on the ichthyologic compartment, to better capture the time dynamics and interactions among compartments. To do this, we will rely on the program in progress called Score-Reef.
- **To also re-examine a national indicator** of health of the reefs, to inform the national biodiversity observatory regularly;
- To improve **bank access of the monitoring data;**
- **Report the indicators of the global monitoring recommended by the ICRI;**
- **To perpetuate actions in favour of participatory science,** raising awareness among citizens and being able to serve as an alert network, particularly in isolated reefs (Polynesian atolls, for example);
- **To consolidate the observatory of climate change** for ensuring the monitoring of the impacting parameters and their effects;
- **To ensure events that impact coral reefs are monitored** (bleaching, diseases, invasive alien species, etc.) ;
- **To favour the development and use of new technologies** for improving the monitoring systems, in particular in the most isolated reefs (Clipperton, Scattered Islands, certain archipelagos of French Polynesia, etc.).

4 - Strong protections: heart of parks and marine national natural reserves; for New Caledonia: comprehensive natural reserves, including seasonal ones, and natural reserves; Clipperton: biotope protection area (source: OFB, 2019)

REINFORCING KNOWLEDGE

The fast development of ecosystem dynamics under climatic forcing, direct and indirect anthropic forcing, makes a significant development of knowledge on several subjects necessary:

- **The impact of use and their pressures** on the reefs, seagrass beds and mangroves (pressure-state link);
- **The impact of climate changes:** if the corals are the first organisms to being directly affected by the recurring episodes of coral bleaching, the response of the whole of the reef ecosystem, much later, remains still unknown. The question of the impact of the phenomenon about the biodiversity of the main organisms structuring the reefs (fish, algae, Echinodermata, mollusks) remains entirely unanswered to date. A better apprehension of these phenomena will thus provide to the managers of natural environments with the elements to take effective measures of protection of certain target species or taxonomic groups, affected by bleaching and/or involved in the ecological resilience of the reef ecosystem;
- **the dynamics of Acanthaster outbreaks and their impacts on coral reefs and coral mortality** ;
- **The still unknown marine zones,** often remote, and in **mesophotic habitats (deep reefs),** which could be sources of coral resowing;
- the **understanding of the resilience of the ecosystems** and PMAs' roles in this resilience;
- the development of the work in the **national Red Lists** in relation to the ecosystems and endangered species;
- the update of the evaluation of the **socio-economic value of the ecosystemic services** and bringing the results to wider knowledge.
- **the promotion of the innovation dedicated to the reinforcement of the resilience of the ecosystems.**

SENSITIZING-EDUCATING

For a good appropriation of the stakes, for educating and mobilizing all the players, the actions in overseas are already very numerous and of long date. The efforts must continue in:

- favouring **involvement of players and citizens** in the stakes of protection of the coral reefs, seagrass beds and mangroves;
- **communicating and sensitizing** on the importance of the coral reefs, seagrass beds and mangroves for the society;
- **mobilizing the national elected members and all the local councillors,** who play an essential part in the good management of the catchment basins, the littoral and marine zones.

Seagrass beds

This assessment of the ultramarine seagrass beds' health clarifies alarming trends, in particular in the Caribbean and in the Indian Ocean, not a good sign for the future of these ecosystems. These trends, in a context of decline and overall degradation of the seagrass beds' health, are an alert and must become a lever to reinforce the implementation of management measures appropriate to what is at stake. Various recommendations can be established, in coherence with the international recommendations (UNEP, 2020) and the Ifrecor action program:

- **to perpetuate the working groups in the science-management interface** to bring concrete and operational solutions for the management and preservation of the ultramarine seagrass beds in the local, regional, national and international scales;
- **to ensure the recognition of the seagrass beds in the plans of management** of the Marine Protected Areas to prevent their decline and maintain the various ecosystemic services provided;

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- **initiate monitoring** of stations aiming to evaluate the health of the seagrass beds in particular within PMAs and zones at stake (associated heritage fauna) in the territories where they are lacking, **reinforce and perpetuate the actions of seagrass monitoring** in the territories where they are already initiated; adapt the protocols;
- **make mapping of the seagrass beds** precise in the sectors where the data is insufficient or old and implement the automated**cartographic** monitoring when the types of seagrass beds and depth allow it;
- **to reinforce the conservation and concrete preservation of the overseas seagrass beds** to reverse the tendency to decline and to allow the restoration of the associated ecosystemic services, by integrating them more in the overall public policies of conservation and territorial installation applying in the ultramarine territories, in the same way as the reefs and mangroves;
- to support an **integrated implementation of the public policies** applying in overseas territories while working to pool actions according to a principle of complementarity and non-redundancy;
- to reinforce **management according to an earth-sea continuum** and to initiate actions integrating the **connectivity between the coral mangroves, seagrass beds and reefs** within specific action plans;
- to promote the seagrass beds as **Nature-based Solutions** while being based on the ecosystemic services provided;
- **accentuate the attention given to the seagrass beds,** an ecosystem still ignored by publicity campaigns on their interest and the consequences of their decline, to reinforce the collective conscience.

Mangroves

The summary of main pressures, which puts in parallel an overall state of the mangroves with regard to the pressures exerted there, makes it possible to have a first outline of the stakes of preservation for each territory and priorities of actions.
The main recommendations arising from this report and relating to the current pressures on the French overseas territories' mangroves are as follows:

- in the territories where the Littoral Conservatory is present, **continue the work of acquisition of the mangrove lands** and concentrate the efforts on managing them effectively, with the appointed managers, set up measures for conservation of these ecosystems and limit installations (various constructions, airport, port, industrial zones);
- reinforce the actions of training and support to management of the mangroves, including by the means of the Network of Observation and Assistance to management of mangroves of the tropical wetland zone relay-centre;
- **to reinforce the actions of control** on the mangroves, to avoid illegal occupations or uses (in particular wild discharges and dumping of fill);
- **to promote the mangroves as Solutions based on Nature** and to include them as such in the documents of installation, planning and risk management, considering the expected impacts of climate change in particular in their upstream migration;
- **to better consider the stakes relating to the mangroves in the sectoral policies** of development, including within the mechanisms of European (in particular agriculture and aquaculture) and State financing: integration of environmental considerations in the budgets and tax mechanisms (including tax exemption);
- **to continue the awareness campaigns** for local communities, youth and elected officials on mangroves: to make known and to appreciate their ecological, economic and heritage values.

In conclusion

All these recommendations could be implemented only if financial means are at par with stakes that these tropical marine ecosystems represent for the French biodiversity and for the services rendered to the inhabitants and overseas territories.

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STATE OF THE REEFS RESULTS BY REGION

Caribbean region

THE CONTEXT

Located in the Lesser Antilles, between 14°23'N and 18°00'N, the French West Indies include Martinique, the archipelago of the Guadeloupe and the islands of North, Saint Martin and St. Barthelemy. On the whole, these collectivities extend on a maritime space from 151,076 km² and the coral reefs cover more than 1300 km².

Three great types of coral formations are present in the Antilles: the fringing reefs, which border the coast, the barrier reefs (reef belt separated from coast by a lagoon of variable depth) and coral floors that are not bioconstructed. The latter formations constitute communities often richer and more flourishing in the Caribbean coasts (leeward) than in the reef formations of the Atlantic coasts.

The live cover of the corals forming the reefs of the Caribbean has badly decreased since the end of 1970. During this period, many reefs dominated by the bioconstructor coral populations permuted towards the reefs dominated by assemblies of macroalgae, sponges and invertebrates other than the corals. This decline has been linked to fishing, pressures coming from the catchment basins, warming of the oceans and epizooties affecting the corals and sea urchins.

The first ecological studies relating to the reefs of the Caribbean started at the end of the years 1960, less than one decade before a series of acute events act in synergy to quickly transform the coral communities of the region. At the end of the 1970's and at the beginning of the 1980's, the "white band disease" (WBD) decimated more than 80% of the populations of *Acropora palmata* and *Acropora cervicornis*, which formerly dominated the zones of reef fronts or the higher parts of the external slopes (less deep reefs). Then, the massive mortality of the sea urchin *Diadema antillarum* in 1983-1984, due to an unidentified pathogen, almost eradicated this key herbivore of the reefs, already largely deprived of large herbivorous fish because of overfishing. The mortality of the diadem sea urchins exceeded 90%, limiting the regulation of the settlements of macroalgae, whose fast growth was supported by the conditions of coastal eutrophication in the reefs of the Caribbean. These events were followed by episodes of coral bleaching starting from the end of 1980, followed by regional epidemics in the 1990's, involving a new increase in the diseases of the corals and, in certain cases, a new replacement of the corals by macroalgae (Bouchon et al, 2008b; Cramer et al, 2020).

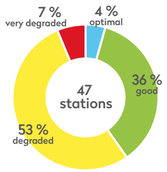
Thus, some major degradations occurred before the start of the monitoring on which this assessment rests (beginning of 2000). The strong anthropisation (229 to 654 inhabitants/km²), the cumulative effect of pressures resulting from human activities (failure of the sanitation networks, littoral installations, agriculture/breeding, etc.), climate events (hurricanes, bleaching) and coral diseases continue to impact the reefs.

The long-term dynamics of the reefs of the French West Indies thus fit in the general tendency of degradation described for the entire Caribbean region since the beginning of the 1980s (Bouchon et al, 2008b; Jackson et al, 2014; Cramer et al, 2020). However, a great ecological variability is observed according to the sites, their geographical location - Atlantic, Caribbean, exposed zones, bay floors.

Overall situation of the coral reefs in the region (Caribbean GCRMN)

In 2014, the Caribbean GCRMN report (Jackson et al, 2014) gave a report on an average coral cover for the Great Caribbean Region ranging between 14.3 and 16.8% (going from 2.8 to 53.1%). In 75% of the sites (88 sites), the coral cover had declined, passing from 34.8% (over the period 1970-1983) to 19.1% (1984-1998) then 16.3% (period 1999-2011), with great disparities between the sites. On the contrary, the cover in macroalgae had increased from 7% to 23.6% between 1984 and 1998.

CURRENT STATUS AND RECENT CHANGES



Percentages of stations by health status class French West Indies

In 2020, on the 47 stations considered in the French West Indies, 60% are degraded (classes 3 or 4) and 40% are in a good state (classes 1 to 2) The majority of the sites present necrosis of corals, algal settlements dominated by the macroalgae and/or a strong silting of the sea floors.

Since the last assessment in 2015:

- **9%** stations show an improvement
- **59%** remained stable
- **33%** are degraded

Locally, the situations are contrasted according to the sector considered (windward coast, leeward coast, bays), the communities meeting and the hydrodynamic conditions and pressures to which they are subjected.

In Martinique, 47% of the sites are in good condition (class 2), 27% are degraded (class 3). The reefs of the windward and leeward coasts are relatively preserved, with coral cover rates from 22 to 45% (windward coast). Very exposed with the currents and the swell, the benthic communities of the Atlantic coast are different from the other sectors of the island, with more encrusting colonies. The fringing reefs of the south of the island are classified as class 4 to class 1, according to a East-West gradient of pressure, starting from the exit of baie du Marin, subjected to significant anthropogenic pressures, up to Diamant, more preserved. The Caye d'Olbian site is characterized by an exceptional coral cover for the Antilles region (57% in 2019) and very stable since it was first monitored (2011). The bays show the most critical situations. The bays are zones of accumulation of anthropogenic pressures, with strong silting in particular. However, the benthic communities survive there; the rates of coral cover are high overall (30-50%) and the sites' situation is mostly stable (80%), since the last assessment, which can mean a good capacity of adaptation.

In Guadeloupe, 70% of the sites are degraded (class 3). Those of the windward coast are affected by the proliferation of macroalgae, which has worsened since 2015, to the detriment of the coral cover. In the bay of Grand Cul-de-sac Marin, the pressure of the macroalgae for the occupation of the sea floors is also strong, but the state of the reefs has remained relatively stable since the last assessment. On the lee shore, the coral communities show the best health status (in majority of class 2), but all the sites show a reduction in their coral cover since the last assessment, a probable consequence of the passage of cyclones Irma and Maria in 2017. Between 2015 and 2020, the health of the coral communities remained stable for 52% of the sites, and 44% of them were degraded. Only the Fajou Nord station shows an improvement.

In St. Barthelemy, the health of the reefs is evaluated on four sites, of which half are in good condition (class 2) and other half degraded (class 3). Coral cover lies between 9 and 23%, with higher values in the stations in reserve, while the macroalgae cover reaches up to 50% in the two Reef Check stations. The total biomass of the fish (60 target species) and those of the herbivores and carnivores are higher in the stations located in reserve (up to 3.7 and 4 times more for the herbivores and carnivores). At the end of 2019, some signs of bleaching were observed in several stations of the lee shore, but induced mortality remained low. The health of the reefs was degraded overall since the last assessment of 2015.

In Saint Martin, three of the five evaluated stations are degraded (class 3), the two others are in class 2 and 4. Average coral cover is around 14% in 2020, declining after the passage of the hurricane Irma, just like regrowth into coral juveniles. The cover in macroalgae, lower than 25% in the stations of the Reef Check and PMA networks, reached 57% in the Chicot station,

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located in reserve. For fish, the biomass of the herbivores and carnivores (target species) show the highest values since the beginning of monitoring. Since the last assessment, two stations present a stable state, and two others are degraded.

TRENDS IN THE LONG TERM

In the long term, coral cover is declining overall, with some particular local situations showing signs of recovery or stability. The tendencies of the fish populations are less marked, but also show a decline in the degraded sites.

In Martinique, the average values of coral cover in 2019 vary from 12% to 57% according to sites, against 21 to 50% at the time of the first monitoring (2001 to 2010 according to stations). **The coral reef habitat is overall in regression compared to the initial monitoring,** although exceptional sites are identified (Caye d'Olbian, Corps de Garde) and some show signs of regeneration (Jardin Tropical).

The fringing reef of the south of Martinique shows a different dynamic with reefs in very good state and stable at the west, and very degraded sites to the east. The sites having undergone strong environmental constraints after 2005 and exposed to chronic pollution are in a very degraded state, reached in 9 years (reduction of 75% of the live coral rate at Pointe Borgnesse between 2001 and 2010). The rate of coral cover in the Atlantic reefs is stable in time, around 30%, with an equivalent rate of macroalgae. The reefs of the Caribbean bays and Atlantic are stable with live coral rates overall high (30 to 50%), except in Marin (10% - bad state). The average coral cover of the communities of the Caribbean rock coasts decrease from almost 50% between 2001 and 2010, then a light increase is observed until 2019.

The fish populations (target species) associated with the reefs of Martinique fluctuate and depend on the geomorphological structure of the sites. The biomass and abundance values of the herbivores are very variable from one site to another and relatively constant since the beginning of monitoring. The biomass of the carnivores 2 and piscivores (which eat mainly benthic invertebrates and fish) is overall low (8360 g/300m^2 in 2019), but among highest in the east Caribbean. It reaches a minimum in 2005, then increases in 2019 towards a value slightly higher than the first monitoring. Their abundance is stable over time. This trend is visible in all the sites, with important fluctuations.

In Guadeloupe, the coral cover regressed in the reefs of the windward coast, from 30% in 2007 to 15% in 2019, while that of the macroalgae increased from 15% to 40% over the same period. This trend is also observed in the bay of Grand Cul-de-sac Marin, with a decrease in coral cover (from 28% in 2002 to 15% in 2019) and regrowth of juvenile corals, while the cover in macroalgae is relatively stable and consistently high, steadily exceeding 30% from 2008. In this sector, the fish populations also declined significantly, whether we consider all 60 target species, or only herbivores or the predators. On the lee shore, on the other hand, the monitored sites do not show a significant long-term trend for benthic communities.

In St. Barthelemy, the coral cover shows an alternation of phases of decline and recovery on the fixed GCRMN network stations, without however reaching the values of the beginning of monitoring (in 2002). In the nonfixed PMA network stations, however, the trend has increased since 2012 (28.3% in 2018).

Some outstanding figures

- **53%** of the stations considered are in degraded state (necrosed corals, macroalgae, silting) in 2019.
- Up to **57%** of cover in macroalgae in the Chicot station, located in the reserve of Saint Martin.
- **50%**: the average coral cover of the reefs of the windward coast of the Guadeloupe decreased by half, going from 30 to 15% between 2007 and 2019. That of the macroalgae has more than doubled in the same time.
- Close to **50%** of reduction of the average coral cover in the Caribbean rock coasts of Martinique between 2001 and 2010. A light recovery is then observed until 2019.

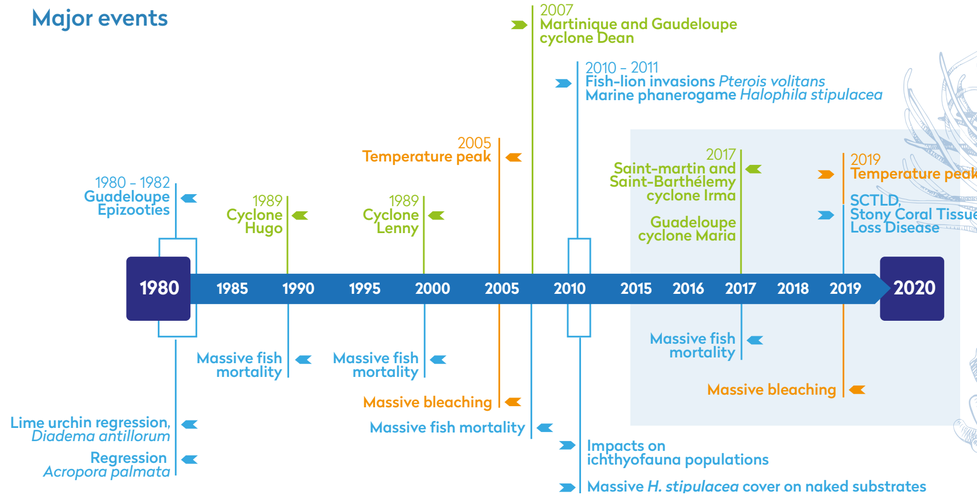
The total biomass of the target species and of the herbivores also tends to increase in the long term in the stations in reserve.

In Saint Martin, the state of the reefs is overall degraded, marked by the reduction in cover of live hard corals and the decline of the coral regrowth. However, the coral cover shows a slow recovery since 2015, without reaching the values of the beginning of monitoring. The target fish species' abundance and biomass do not show a significant trend. However, the biomass of the herbivores shows a regular increase between 2014 and 2017, and a significant peak in 2019. On the long term, a reserve effect is observed for the herbivores.

Major events since 2015

- **2017:** Hurricane Irma (Cat. 5) struck the islands of the north of the Lesser Antilles, causing significant human, material and environmental damage.
- **At the end of 2019:** an episode of coral bleaching struck the Antilles, affecting about half of the coral species. The mortality induced by the phenomenon however was low.
- **2019-2020:** The appearance of a new coral disease (Stony Coral Tissue Loss Disease - SCTLD) worries the local experts: all the territories from now on are affected and the first observations indicate a strong mortality, in particular in the most significant species like *Meandrina meandrites*, *M. Jacksoni* or *Colpophyllia natans* (34 affected species).

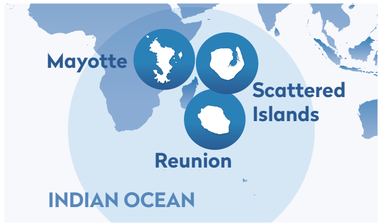
Major events



Western Indian Ocean

THE CONTEXT

Located at the extreme west of the indo-pacific biogeographic province, the Western Indian Ocean region extends 22 million km²; it accounts for 50,000 km² of reef-lagoon formations, including nearly 15,000 km² of built reefs (Millennium Coral Reef Mapping), distributed along the African East coast (Kenya, Tanzania, Mozambique, South Africa) and around the islands (Madagascar, Maurice/Rodrigues, Seychelles and French overseas territories).



The French territories of the Indian Ocean are represented by two departments, Reunion and Mayotte, and a *sui generis* territorial community, the Southern and Antarctic French Lands (TAAF), which counts five islands, extending along the Mozambique channel (Glorieuses, Juan de Nova, Bassas da India and Europa) and to the North-East of Madagascar (Tromelin).

On the whole, on a maritime space of 1 million km², the reefs of these territories extend on 2000 km², (Mayotte around 1406 km², Reunion 18 km² and the Scattered islands 794 km² in total), including 546 km² of built zones. Their geomorphological diversity, which results from their geological history, is important: fringing reefs at Reunion, the youngest island, reef benches and atolls in the Scattered islands; Mayotte, the oldest island, has some fringing reefs and one of the most beautiful barrier reefs of the region, as well as a double barrier. The mangroves are present only in Mayotte (623 ha), Europa (626 ha) and Juan de Nova (0.26 ha) and the seagrass beds are present everywhere, but less developed.

Within this region, **the northern part of the Mozambique channel** constitutes the **second triangle of reef biodiversity** in the world, after the one centred around Indonesia. Mayotte and the Glorieuses are located within this triangle of richness.

The islands are very variously populated: the Scattered islands are uninhabited, thus constituting a reference and an observatory for reefs without direct anthropogenic pressures, Reunion has a density of population of 340 res./km² located in the average of overseas, while Mayotte (686 res./km²) has the highest density of population of all French overseas.

The main pressures which impact the reefs, seagrass beds, mangroves and lead to slow chronic degradations of the reefs in **Reunion and in Mayotte** are related (i) to the soil erosion, linked to the development of the territory, cultivation practices, and (ii) water pollution resulting from the defective treatments of wastewaters and rain water, whose streaming is reinforced by the waterproofing of the urbanized grounds. At Reunion, the narrow and close to the coast reefs are directly under the influence of these pressures; at Mayotte, the socio-economic and geopolitical context is at the origin of a particularly fast increase in the human population and associated pressures.

Scattered islands, on the other hand, are thus subjected very little to the anthropogenic pressures, with exception of sometimes strong illegal fishing (on Juan de Nova for example, until recently) but today almost controlled (reinforced monitoring).

Monitoring of the coral reefs' health started, within the GCRMN, as of the end of 1990s in Mayotte and Reunion, and at the beginning of the 2000s in the Scattered islands. The region today has several inspection networks (GCRMN, Reef Check, PMA, DCE) mobilised very irregularly, in particular in the Scattered islands, considering the difficulties of access to the islands.

During the 2015-2020 period, several climatic episodes impacted the reefs: three episodes of coral bleaching and several cyclones (see the strip in next page).

Overall situation of the coral reefs in the Indian Ocean region

(Obura et al., 2017, Wickel et al, 2013, 2018, 2020, Nicet et al., 2019, 2020)

In 1998, the coral reefs of the Western Indian Ocean crossed a threshold, because of the impact of the greatest bleaching event known globally:

- on average, the coral cover decreased by 25% compared to the initial levels, the cover passing from 40% before 1998 to 30% afterwards;
- the cover in algae was multiplied by 2, going from 15% before 1998 to 30%;
- the structure of the fish communities has been modified; it is now dominated by herbivores and scavenger of small size (which account for approximately 80% of the total biomass).

In 2016, the second greater event of bleaching of the Western Indian Ocean also had a considerable impact:

- 30% of the reefs showed signs of significant or serious bleaching, and the coral cover decreased by 10%;
- while the resistance of the corals to the bleaching of 2016 was significant (2/3 of the bleached corals recovered), the potential of recovery of the reefs will be probably less than in 1998 because of the already reduced coral cover, of the higher algal cover and of the dynamics between herbivorous fish and the algae.

In 2019, the hot season would have been again marked by abnormal rises in the temperature of water giving place to the phenomena of massive coral bleaching, which affected the reefs of the South-west of the Indian Ocean differently:

- in Reunion, a significant bleaching (40% of the coral cover in the external slope and the reef-flats) but a mortality of low to average (15% in the reef-flats and 12% in the external slope);
- in Mayotte, a low bleaching and no notable mortality;
- in the Scattered islands, no bleaching observed during the trip of Marion Dufresnes in April 2019;

The year 2020 was marked by the first proven bleaching in the island of Europa (temperatures higher than 31° over several weeks in February 2020). The investigation of only one GCRMN station in the reef reef-flat showed a coral death rate of around 60%. The most affected families are Pocilloporidae and Milleporidae. But no loss of biodiversity is to be deplored. This report cannot be extrapolated to the whole of the reef for lack of data.

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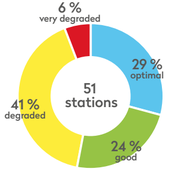
5 - In Reunion and Mayotte only, 2015 data not available for the Scattered islands.

CURRENT STATE AND RECENT CHANGES

In 2020, out of the 51 stations considered in the scale of the region, 29% are in an optimal state (class 1), all located in the Scattered islands; 24% are in good state (class 2) and 41% are degraded (class 3). Lastly, 6% are very degraded (2 stations at Juan de Nova and 1 station at Glorieuses).



Percentages of stations by health status class Indian Ocean

Since the last assessment in 2015[5]:

- **11%** stations show an improvement
- **56%** remained stable
- **33%** are degraded

The situations are always contrasted, with strong spatial heterogeneities both in the coral cover and in fish populations (species richness, abundance, biomass); in Reunion between the reef-flats and external slopes; in the Scattered islands between the islands and reef-flats, lagoon terraces and external slopes, and in Mayotte between fringing reefs, internal reefs and barrier reefs; also, in all the cases, they are contrasted according to the geographical sectors, their exposure, hydrodynamic conditions and rates of sedimentation and/or pollution to which they are subjected.

Coral covers: majority of the reefs **in Reunion** (71% of the stations) and in **Mayotte** (60%), are in a degraded state. The rates of coral cover are 20 to 30% for the lowest and at 70% locally, for the highest.

In the Scattered islands, 77% of the stations are in an optimal or good state (classes 1 to 2), mainly in the stations of external slope in the whole of the islands. But especially in the island of Europa, where the rates of coral covers in the external slope reach up to 80%. In Glorieuses, the results are mitigated and the coral cover very seldom exceeds 50%, because of the particular environmental conditions; while in Juan de Nova, strongly subject to coral bleaching (temperatures sometimes higher than 32°C), the reefs are very degraded in the lagoon terraces and show a low coral cover (9% at the maximum in 2019).

Ichthyologic populations: the species richness of fish is particularly high in the Scattered islands, in particular at Glorieuses (up to 57 species/250m²), located at the centre of the biodiversity triangle, and at Europa 35 to 50 species/250m²; in Mayotte, all species put together, the values fluctuate from 13 to 46 species/250m² in the fringing reefs, the strongest diversity being in the barrier reefs with values ranging between 30 and 52 species/250m².

In Mayotte, the biomass in species of commercial interest is very low in the fringing reefs, except occasionally, but locally high in the barrier reef (up to 6-7 kg/100 m²) and in the passes. **In Reunion**, the biomasses are very low everywhere (1.5 kg/100 m² for the 30 indicating species), at the same time for the apical predators (at the highest of the trophic chains) and the parrot fish, which play a key role in the reefs' resilience by managing the expansion of the algae. In **the scattered islands,** the biomasses are highest (up to more than 100 kg/100m² in the external slopes of Europa).

Developments of the health of the reefs since the last assessment (2015), on the regional scale (Mayotte and Reunion), show that 56% of the stations present a stable state and 33% are degraded.

- We note a great stability in Reunion (69% of stable stations).

In Mayotte, on the other hand, the development goes in the direction of a significant overall reduction in the state of the coral communities (43% of the stations in degradation), with 25% of coral mortality on average following a major impact of bleaching of 2016.

The "original" state in Reunion and Mayotte (end of 1970s)

Reunion: the external slope showed a coral cover of at least 50% (in the 5-15m horizon) with a predominance of *Acropora* and in particular the tabular, submassive and/or branchy forms (which, except in the sector of Saint-Pierre, almost disappeared today in favour of *Pocillopora*, *Astreopora* and *Porites* in particular). On the contrary, the cover in erect algae was lower than today.

Mayotte: the barrier reef had a coral cover of around 60% (East barrier reef) to 70% (West barrier) with a predominance of the Acropore corals (more than 50% of the coral populations), in particular the tabular forms.
The fringing reef showed a cover of more than 60%, with Acropore corals dominant, in particular branchy and tabular Acropore.

TRENDS IN THE LONG TERM

On the long term, **the dynamics of the coral cover** is governed by the diffused anthropogenic pressures to which are added the extreme events, like the infestations of *Acanthaster planci*, impact of the cyclones, and episodes of raised water temperature, inducing the phenomena of coral bleaching, increasingly frequent (1983, 1998, 2010, 2016, 2019, 2020). bleaching is differently impacting according to the episodes, and reef zones; thus, **in Mayotte the fringing reefs seem better to resist and to be more resilient than the barrier reefs.** These events are accompanied locally by abrupt reductions in the coral cover, then by a more or less fast recovery according to the resilience of the followed stations. Thus **in Reunion, coral cover is in continuous reduction since 2000 in the majority of the stations of reef slope** (and coral regrowth is low).

The degradations result in a **local disappearance of the sensitive corals** (*Acropora*) in favour of resistant forms (massive and encrusting), whose habitability for associated fauna is less, and by the **increase in algal cover** (external slopes of Reunion + 32% in 10 years).

In the external slopes of the whole of **Scattered islands**, in general, live coral cover is high and relatively stable in time (averages varying between 40 and 60%).

Red list of corals forming reefs of the French islands of the Indian Ocean

The risk of disappearance of the entirety of the corals forming the reefs of Reunion, Mayotte and the Scattered islands was evaluated within the Red list of the endangered species in France. The inventory shows that 15% of the species are endangered or quasi endangered in Reunion, 12% in Mayotte and 6% in the Scattered islands.

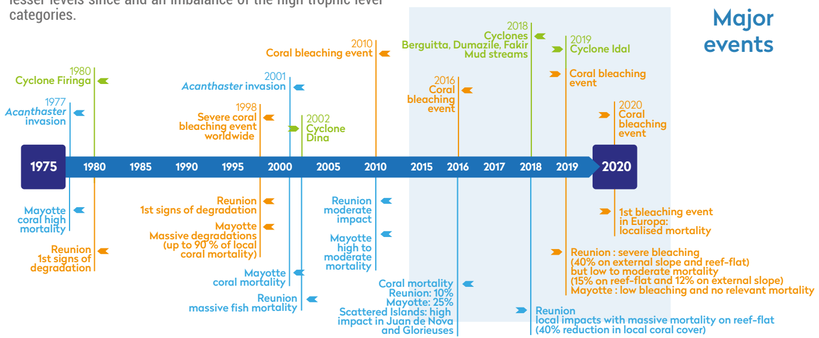
In Mayotte, these degradations of the habitat and the pressure of increasingly higher fishing (35% of the tonnage of the captures relate to ichthyologic populations) result in a worrying reduction in the general parameters of the fish populations (diversity, density and total biomass). The reduction in the resource for 10 years has been illustrated by that of the Saddle grouper (*Plectropomus laevis*), emblematic species very vulnerable to the fishing activities, still common 10 years ago and today rare (87% of reduction between 2008 and today).

In Reunion, the fish populations are also affected by the modification of their habitat which, added to the overexploitation of the fish resources, generates a reduction in the total biomass (80% since 2002), with lesser and lesser levels since and an imbalance of the high trophic level categories.

Some outstanding figures

- Reunion (external slope): reduction in coral cover (from 49 to 28%) between 2000 and 2019 and doubly in algal cover (from 27 to 59% over the same period)
- Mayotte: 87% of reduction in the density of the Saddle grouper (*Plectropomus laevis)* between 2008 and 2019
- Europa (reef reef-flat): reduction in coral cover between 2011 and 2016 (from 40.8% to 17.5%), but increase in 2019.
- Tromelin: reduction in coral cover (from 60 to 16%) in lagoon terrace, but strong increase between 2011 and 2019 in the external slopes
- Juan de Nova: reduction in the coral cover (from 35 to 9%) from 2013 to 2019 in external slope; and reduction in fish biomass of 62% between 2004 and 2019 in lagoon terraces

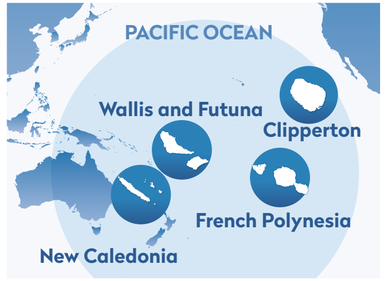
In the Scattered islands, the development of the fish biomass is generally stable in the external slopes, or in reduction in Juan de Nova and in Glorieuses; it decreased in the lagoon terraces of Juan de Nova between 2013 and 2019.



Pacific Region

THE CONTEXT

This region includes the three overseas territories of the Western southern Pacific: New Caledonia, Wallis and Futuna and French Polynesia, including the Clipperton atoll further east. The maritime zone of these territories accounts for 80% of the maritime reef overseas (for 62% of the whole of French maritime space) and for 95% of its reef lagoon area. New Caledonia, as for it, accounts for 64% of French reef area (nearly 35,873 km²).



The diversity of the reef formations is very significant in the region. **New Caledonia** is girdled by a reef barrier of 1,600 km in length, the internal barrier reefs that are overlapping and multiple, the fringing reefs and many lagoon reefs and islets. It also counts atolls, submerged reefs and coral banks.

French Polynesia counts five archipelagos for a reef lagoon area of approximately 16,200 km² distributed in nearly 120 islands, including 85 atolls of great diversity (40% of the number of atolls in the world). **Wallis** is surrounded by a barrier reef (218 km² of lagoons and reefs), **Futuna** and **Alofi** are bordered by a narrow reef-flat of fringing reef ("apron reef") and, in the EEZ, many atolls and submerged banks extend on a total area (680 km²), quite higher than that of the two oceanic islands.

Not only do these territories count the widest reefs, but they are also less populated (fewer than 100 res./km², compared with more than 200 and up to 600 for all the other overseas regions). The human pressures on these territories are thus more reduced and localised (islands and urban zones, agricultural farms, industries and mining).

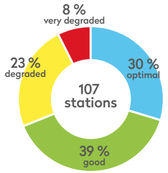
Health monitoring results there are very old (1970 for Moorea, 1990 for New Caledonia, 1999 for Wallis for the first records), and the reefs of Moorea belong to the most studied in the world, with a particularly long-time series, invaluable to understanding the reefs' long-term dynamics and functioning.

Several networks are at work, in particular in Polynesia (12 networks of 3 to 53 stations, meeting various objectives), but also in New Caledonia (several programs being able to be regarded as regular and on broad space scale, of which four could be considered here, i.e., a total of 468 stations for the whole of the networks), and two in Wallis and Futuna, of which one is recent. In Clipperton, the remoteness of the island constrains us to sporadic monitoring.

The total number of reef stations monitored in the region is very high; nearly 650 stations all networks together (468 in New Caledonia, 155 in French Polynesia, 18 in Wallis and Futuna). However this assessment is based only on a small proportion of these stations.

CURRENT STATE AND RECENT CHANGES

During the 2015-2019 period, several events affected the reefs, including two high-temperature events (2016 in New Caledonia; 2016 and 2019 in French Polynesia), resulting in coral bleaching with more or less severe effects and episodes of demographic explosions of Acanthaster. In Wallis and Futuna, the observations were rare over this period, not allowing to determine with precision the causes of recent changes in the reefs.

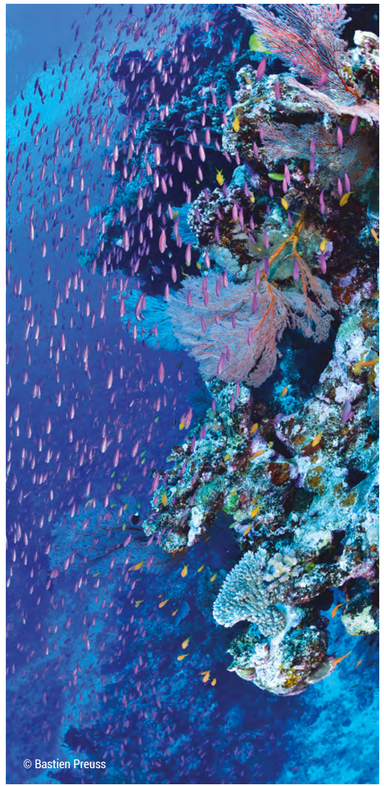


Percentages of stations by health status class Pacific

The reefs monitored in the Pacific region are mainly in good health: 69% are in a good to optimal state.

In 2019, in Wallis and Futuna, 67% of the reefs monitored within the FEO network are in good to satisfactory state (classes 1 or 2). In Wallis, the majority of the reefs monitored are in class 2, sheltering overall high coral covers, but with the wealth and abundance of fish or invertebrates, which could be more significant, considering the reef type. In Futuna and Alofi, the health is medium to good (classes 2 or 3), with rather high rates of coral cover (30 to 50% according to reefs) and the target fish populations fairly varied and abundant.

In French Polynesia, until 2019, the reefs of the Society archipelago showed a relatively high live coral rate of (30-50%), in strong growth since 2010, but with a recent decrease in the wind islands, because of the particularly intense episode of bleaching in 2019, having involved severe coral mortality (up to 50% in the external slopes of Moorea). In the other archipelagos (Tuamotu, Australes and Marquises), the rates of cover are lower (< 30%) but stable, even in increase.



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In New Caledonia, 75% of the reefs monitored within the RORC are still in good to satisfactory health (classes 1 or 2); however the majority of the degradations recorded took place over the five last years. If New Caledonia was spared by the massive bleaching before, the event of 2016 impacted many reefs, with a variable attack, but a strong resilience: off the coast of Nouméa, 70 to 80% of the bleached colonies monitored within project BLANCO had completely recovered their vitality at the end of two years; a similar observation was made for the RORC reefs. The communities of reef fish are preserved overall and, in the sites of the world heritage for example, of an exceptional diversity.

TRENDS IN THE LONG TERM

In the long term, the dynamics of the coral cover developments are mainly controlled by the cyclones in Wallis and Futuna, in New Caledonia (strong impact of cyclone Erica in 2003) and in French Polynesia (less frequent but potentially very destroying impacts like the cyclones of 1982-83 or 2010 for example).

In Wallis and Futuna, the reefs exposed to the cyclones underwent significant coral losses, while the sheltered reefs appear either stable (Futuna), or in clear coral progression over time (Alofi and Wallis). The GCRMN monitorings being less frequent and irregular, it is not possible to conclude precisely the development of the fish populations.

Over the last fifteen years, the state of the coral reefs monitored in **New Caledonia** is characterized by an overall trend toward stability, particularly marked in the reefs under oceanic influence (Grande-Terre and Loyalty islands). This trend should not hide occasional but severe degradations of certain reefs (coastal reefs of the East coast mainly), nor clear increase in the coral cover of a considerable number of inventoried zones. On the RORC scale, overall compensation was measured in coral regressions and growths over the last 15 years.

In French Polynesia, the most destructive events were episodes of coral bleaching and demographic explosions of Acanthaster (very significant in 1979, 1986, and more recently between 2006 and 2010, then 2016 and 2018); these events severely destroyed many reefs in the Society islands and destructured the coral communities (strong reduction of the branchy forms). The developments are thus very variable among:

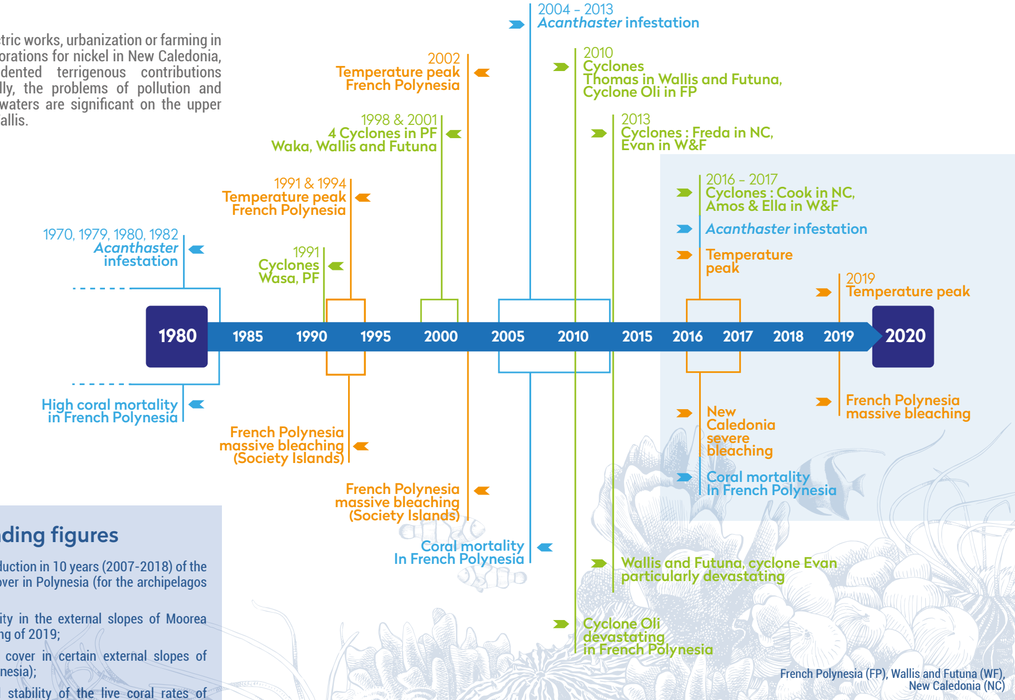
- the reefs of the Society islands, which over the last 15 years show some very strong variations of coral cover over relatively short durations, lower than the decade; this passes indeed from one extreme (cover lower than 10% in 2010-2011, because of a proliferation of Acanthaster and cyclone Oli) to the other (strong resilience with a sometimes spectacular regeneration of coral cover over the 2010-2019 period). In the degraded zones, the branchy coral populations are more affected than the massive corals;
- the reefs of the other archipelagos, which did not undergo a major disturbance in the last 10 years, are relatively stable, with average to good coral cover (external slopes of Tuamotu atolls); except in the Marquises where the natural conditions do not allow the formation of coral reefs and where cover is naturally rather weak (about 5%).

The total fish biomass shows a decrease since 2008-2010, whatever the geographical scale considered, in the Society archipelago and more still in the peripheral archipelagos, with a strong decrease, in particular since 2010. At this stage, it is difficult to give a precise origin to this decrease and we can consider the combination of increased efforts of fishing and an effect of the environment.

However, if the dynamics of abrupt changes coral cover are related to climatic events and other risks, they should not hide the effect of the anthropogenic pressures, sedimentation, pollution, and littoral installations, which have affected the reefs in a more insidious way for many years.

We will point out, for example, that the estimates of the destruction related to the embankments or the extraction of coral materials in the Society islands were evaluated in 2006 at approximately 6% of the cumulative area of the fringing reefs of the islands of Tahiti, Moorea and some Sous-le-Vent islands; the big hydroelectric works, urbanization or farming in Polynesia, or, again, explorations for nickel in New Caledonia, have led to unprecedented terrigenous contributions on the reefs; additionally, the problems of pollution and eutrophication by wastewaters are significant on the upper islands of Polynesia or Wallis.

Major events



Some outstanding figures

- From 40% to 10%: reduction in 10 years (2007-2018) of the rate of gross coral cover in Polynesia (for the archipelagos other than Society);
- 50% of coral mortality in the external slopes of Moorea following the bleaching of 2019;
- 50-60%: good coral cover in certain external slopes of Tuamotu atolls (Polynesia);
- overall trend toward stability of the live coral rates of the Caledonian reefs: degradations and regenerations compensated themselves.

HEALTH STATUS OF CORAL REEFS, SEAGRASS BEDS AND MANGROVES OF THE FRENCH OVERSEAS TERRITORIES

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POUR LES RÉCIFS CORALLIENS

Summary for policymakers

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