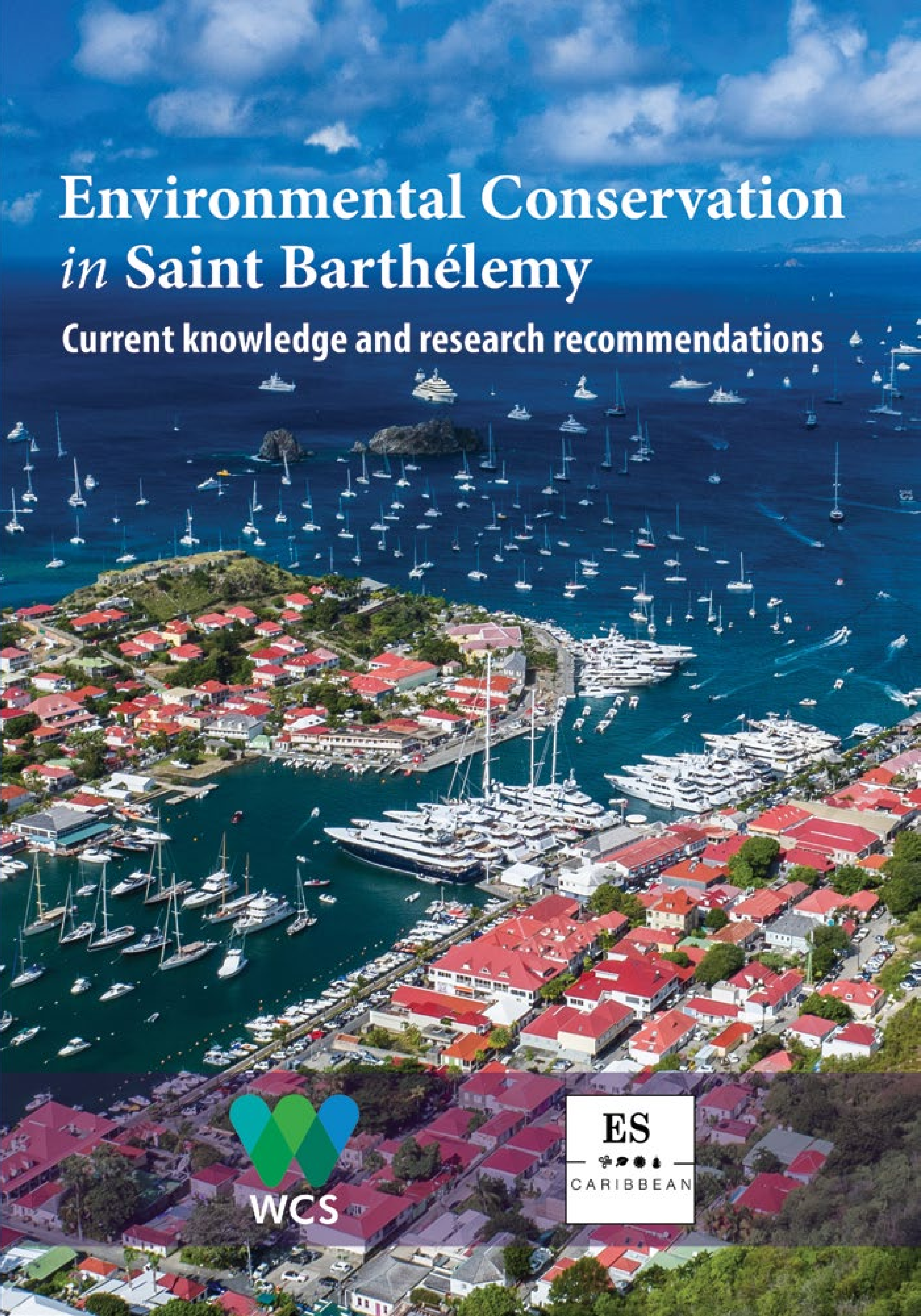
Environmental Conservation *in* Saint Barthélemy

Current knowledge and research recommendations



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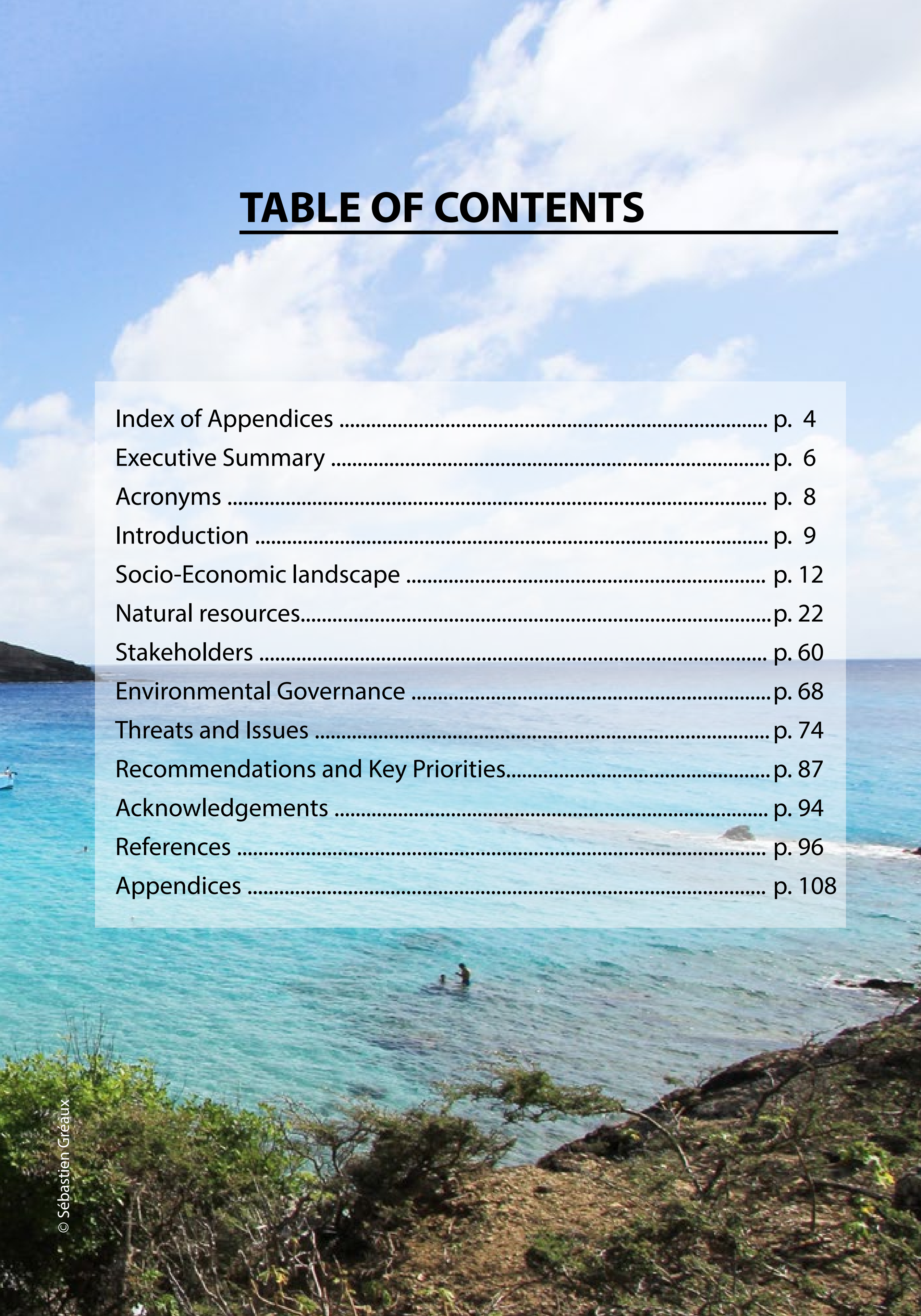

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EXECUTIVE SUMMARY

With a territory of only 25 km^2, the island of Saint Barthélemy is one of the smallest Overseas Countries and Territories (OCT) of the European Union. The island is fortunate to have beautiful landscapes and support rich marine and terrestrial biodiversity. The collectivity of St-Barthélemy has undergone a rapid transition from an isolated island to a luxury tourist destination. This high-end tourism development model has propelled the economy of the island to new heights but has also increased demands on its natural resources. With the increased pressure on its natural resources, we find new opportunities for improved conservation.

St-Barthélemy's government has set their environmental regulations through their Environmental Code (*Code de l'Environnement*), adopted in 2009, and it is governed by a public body, the Territorial Environment Agency (ATE). Since October 2016, the legal framework allows for enforcement by sworn agents. The collectivity has initiated environmental protection measures such as constructing a new sanitation plant for Gustavia, initiating an improved recycling program where household waste is sorted and separated, fueling the desalination plant through thermal energy from incinerated materials and updating its fishing regulations. However, designing effective measures for the conservation of the environment relies on having strong and comprehensive knowledge of the various ecosystems, both marine and terrestrial. Today, our knowledge of St-Barthélemy's ecosystems is fragmented and, in some cases, outdated. The few available indicators reflecting the ecosystems' health pinpoint that the marine system is reaching critical thresholds:

- Reefs around the island are in critical condition,
- Fish populations levels have dropped below the regional benchmark for recovery, inside and outside of the Marine Protected Areas,
- Overall health of the seagrass beds has been categorized as "mediocre",
- The macroalgae cover in the reef systems has increased rapidly and is now over 50%,
- Coastal erosion is severe in several locations around the island and in some areas has led to repetitive beach re-nourishment programs, and
- Invasive species (goats, iguana, lionfish) further threaten the territory's biodiversity.

The lack of information relating to other critical components of the island resources, such as fisheries, hinder the assessment of their health and sustainability.

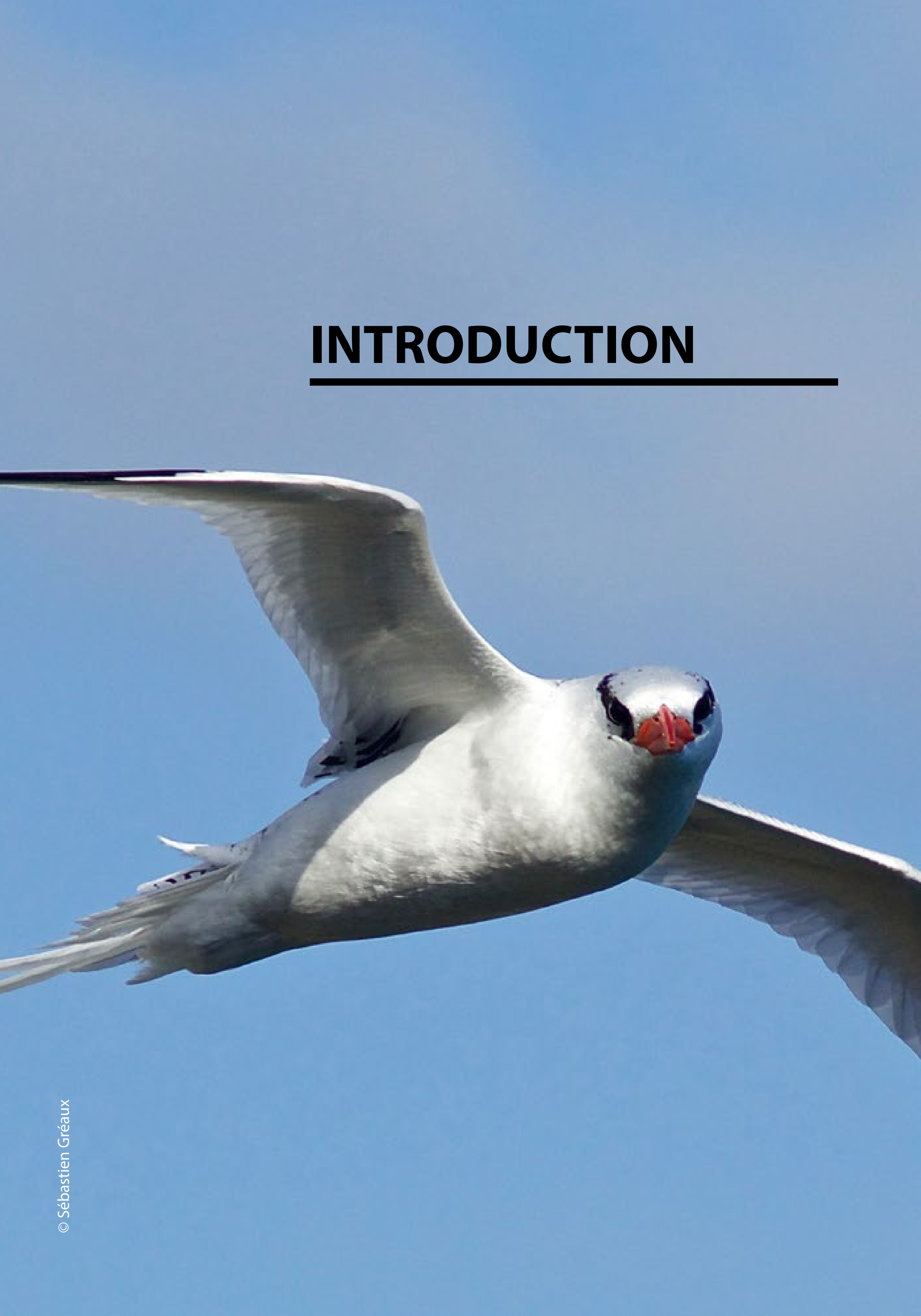
This report compiles current information about St-Barthélemy's environment to help establish the foundation for future potential conservation-related activities. It also incorporates the results of a stakeholders' workshop to identify the primary threats to natural resources of the island. We provide a summary of key stakeholders and review the various legal structures related to the environment of St-Barthélemy. We conclude with recommendations and key priorities for actions to effectively manage and conserve the resources of St-Barthélemy and surrounding islands, such as the development and implementation of an island-wide sustainable development plan, updates to the legal framework, and intensification of collaborations with out-island institutions to close the identified research gaps.

Overall, the environment of St-Barthélemy seems to be degrading rapidly, with major concerns regarding land based pollution, urbanization and overfishing. Some of the regulations in place are well formulated to protect the natural resources of the island, however monitoring and enforcement are sorely lacking. In order to support the livelihood, economy, and wellbeing of St-Barthélemy, conservation efforts must take place through holistic, informed, and coordinated planning.

ACRONYMS

AAPE	Approved Environmental Protection Associations *Associations Agréées de Protection de l'Environnement*
APO	Association for Bird Protection *L'Association pour la Protection des Oiseaux*
ATE	Territorial Environment Agency *L'Agence Territoriale de l'Environnement*
BPS	La Baleine du Pain de Sucre
CCCC	Caribbean Community Climate Change Centre
CESCE	The Economic, Social, Cultural and Environmental Council *Le Conseil Économique, Social, et Environnemental*
CMA-CGM	Maritime Freighting Company - General Maritime Company *Compagnie Maritime d'Affrètement - Compagnie Générale Maritime*
COM	Overseas Collectivity
DEAL	Regional Environment Directorate *Direction de l'environnement, de l'aménagement et du Logement*
EEZ	Exclusive Economic Zone
EU	European Union
FAD	Fish Aggregation Device
FAO	Food and Agriculture Organisation
IBA	Important Bird Area
INRA	French National Institute for Agricultural Research *Institut National de la Recherche Agronomique*;
IUCN	International Union for Conservation of Nature
MPA	Marine Protected Area
OCT	Overseas Countries and Territories
OR	Outermost Region
RMTG	Marine Turtles Network of Guadeloupe *Réseau Tortue Marine de Guadeloupe*
RHI	Reef Health Index
UAG	University of the French West Indies and Guiana
ZNIEFF	Zone of High Natural Interest for the Fauna and the Flora *Zone Naturelle d'Intérêt Ecologique, Faunistique et Floristique*

INTRODUCTION



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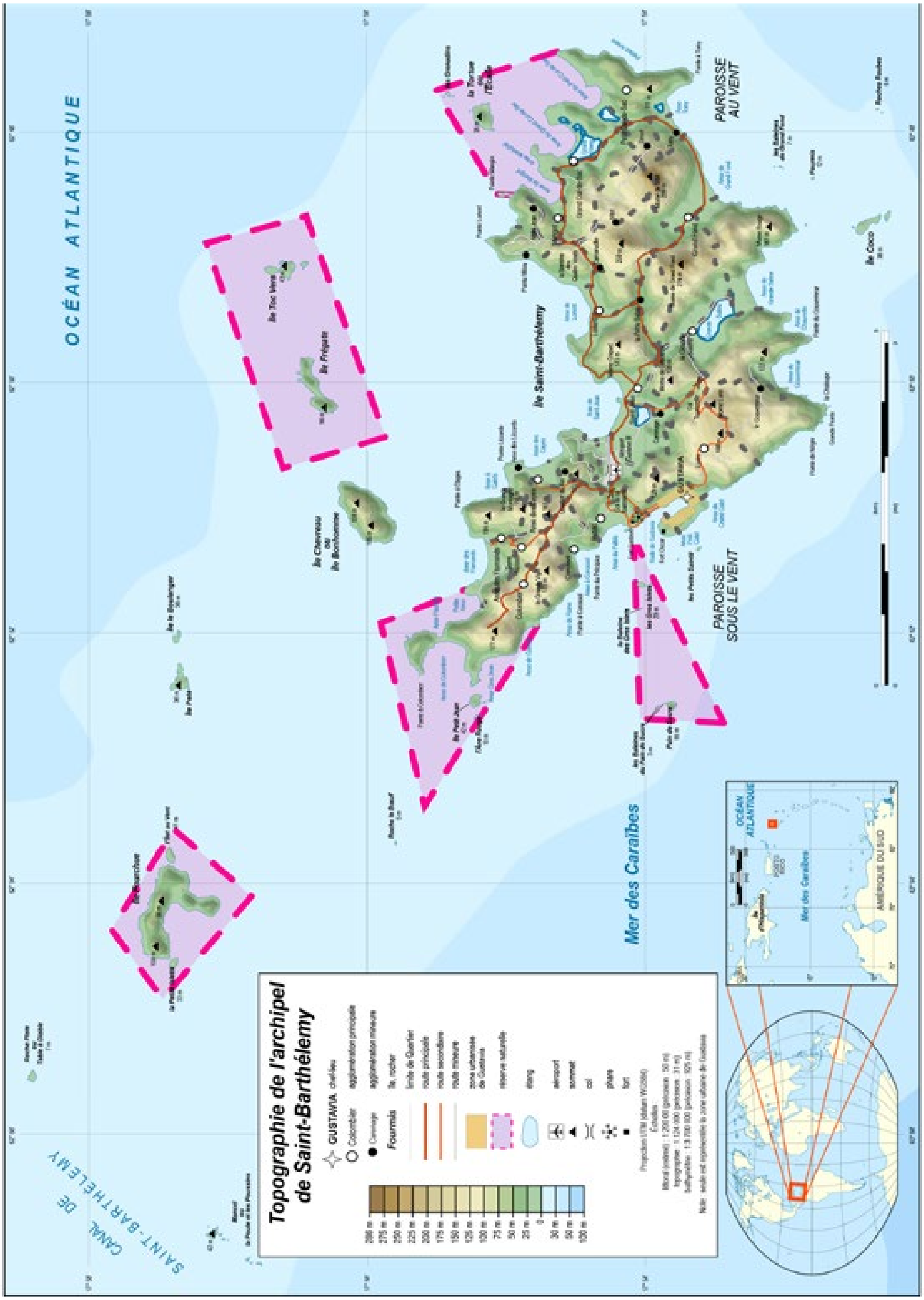

Figure 1. Map of Saint-Barthélemy archipelago (Source: Eric Gaba (Wikimedia Commons user Sting) and OpenStreetMap

Saint-Barthélemy (also known as St Barts, St Barth in French) (18°50' N, 62°49' W) is the smallest island of the French West Indies. The island is 21 km^2 (8.1 sq mi) and is surrounded by 22 satellite islands for a total surface area of 25 km^2 (9.6 sq mi) (Karthala, 1999; Levesque, 2008). The main island and its satellites are located in the northeastern Caribbean in the Lesser Antilles, about 35 km (22 mi) southeast of St Martin and 240 km (150 mi) to the west of Puerto Rico (Figure 1).

Before Columbus "discovered" the island in 1493 and named it after his brother Bartolomeo, the volcanic island was inhabited by Arawak Indians and by the Caribs. The first French settlers came from the nearby island of St Kitts in 1648 but were slaughtered in 1656 by the native populations. The French came back in 1659 and established the first colony in St-Barthélemy which remained under French control until 1784. In 1784, St-Barthélemy was handed over under Louis XVI to Sweden in exchange for access rights to the Swedish port of Gothenburg. After a referendum among the population, the island was officially retroceded to France in 1878. It became administratively attached to the colony of Guadeloupe as one of its 33 municipalities, despite the distance between the two islands (230 km /143 mi). Driven by a desire to recognize the island's geographical, social, and economic uniqueness, the elected representative proposed a statutory change. For over a decade, the island engaged in a process of political evolution. On July 15, 2007 the new Overseas Collectivity (COM) of St-Barthélemy was born (IEDOM, 2008).

In 2010, the island and the surrounding islets took one more step to further their differentiation, becoming a member of France's Overseas Countries and Territories (OCT). OCT's are not fully part of the European Union (EU) but have special relationships with one of the member countries of the EU (IEDOM, 2013; France Diplomacie, 2016).

Under this designation, the COM of St-Barthélemy is able to enact its own laws in certain areas of powers such as urbanism, taxation, environment, and tourism, and in 2009, St-Barthélemy ratified a new environmental code based on its French counterpart: *Code de l'Environnement*. In January 2016, a decree was added to allow criminal prosecution and penalties for non-compliance with the code. The Collectivity has entrusted the Territorial Environment Agency (ATE) with the environmental protection and sustainable development of the island. On June 14, 2016, six members of the ATE took an oath and became the first officers of the Environmental Police.

Recent changes in the legal status of the islands along with the development of their environmental code contributed information on the island's natural environment, albeit quite fragmented. The sustainability of St-Barthélemy's environment will depend upon on a comprehensive knowledge of the various ecosystems, both marine and terrestrial, and the ability to design effective conservation and management plans for them. This report synthesizes the current state of St-Barthélemy's marine and terrestrial ecosystems thereby establishing baselines and recommendations for future monitoring, management, and conservation activities.

This report is based on a review of over 200 references, a stakeholder workshop conducted by WCS in September 2016, and numerous meetings and informational exchanges with local and regional authorities and experts.


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SOCIO-ECONOMIC LANDSCAPE

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Saint Barthélemy economy is based on high-end residential tourism, with real estate and construction dominating the market services sector. The island is characterized by a high rate of activity (86.8 % in 2011) and a very low unemployment rate (4.3% in 2011). The estimated GDP per capita is one of the highest for French regions at EUR 35,700 (IEDOM, 2015).

DEMOGRAPHICS

St-Barthélemy's isolation, lack of large cultivable land, and limited natural resources have impeded human population growth for a long time. The inhabitants lived in relative poverty until the 1970s when St-Barthélemy developed into a luxury destination and the population underwent dramatic changes. These changes have affected both the diversity and density of the population (Benoist, 1966, 1989; Cousin & Chauvin, 2012).

The population remained relatively stable until 1982. By the early 1990s the population increased by 40% mainly due to an influx of immigrants intending to cater to the growing tourism industry. Within the last 50 years, the small island of St-Barthélemy has seen its population increase by 333% and its housing by 633% (Figure 2) (Diaz, 2003; INSEE, 2015). As of today, the island has reached a density of 448 people/km^2; for comparison, France has a density of 118 people/km^2. Currently, the island of St-Barthélemy hosts seven main languages and is inhabited primarily by descendants of the 17th century French settlers, immigrants coming mainly from France and other European countries, and vacationing expats (Maher, 1996; Cousin & Chauvin, 2012). The last census recorded nearly 40 different nationalities (de Bettencourt & Imminga-Berends, 2015). This rapid population growth and urban development has important consequences on the island's environments.

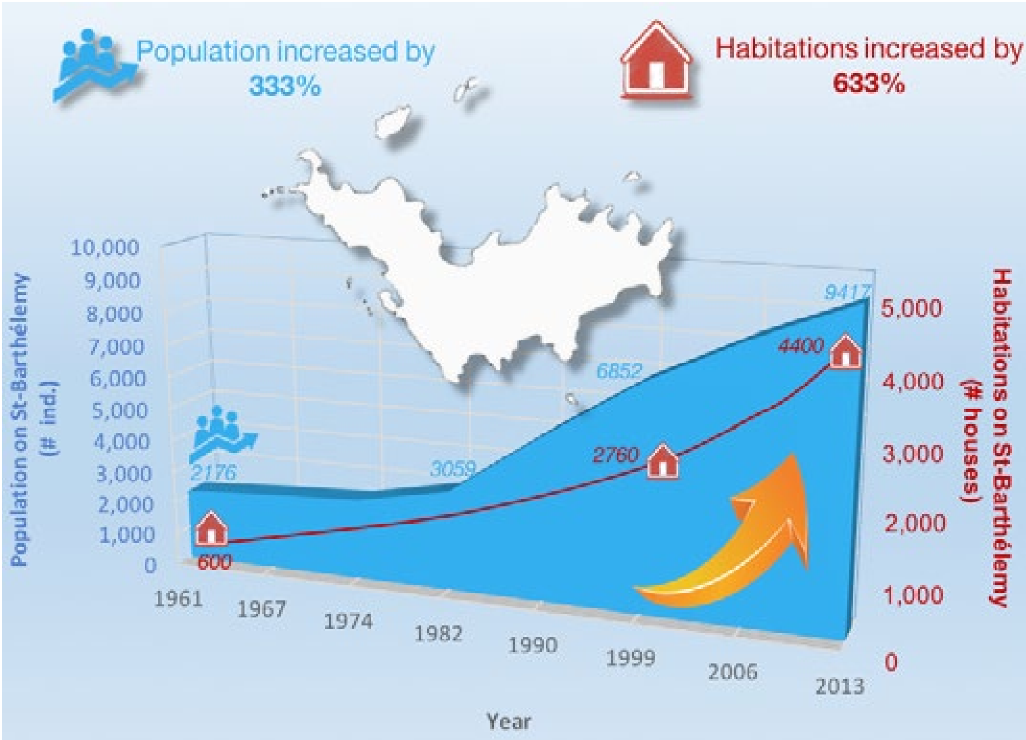

Figure 2. Evolution of St-Barthélemy Population and Habitations from 1961 to 2013

ECONOMIC ACTIVITIES

TOURISM

Tourism is the main driver of St-Barthélemy's economy with the important development of high-end tourism over the last 50 years. In 2014, 355,000 tourists visited the island (IEDOM, 2015). The 2008 financial crisis and the dip in tourism over the subsequent years highlighted that St-Barthélemy's economy relies on the health of the US market. Today the Collectivity has a very low unemployment rate (4.3%, IEDOM, 2015). More than half of the island's employment is related to the tourism sector, including nearly one third based in hotels and restaurants, and other tourism-related market services. Both the retail and construction sectors employ about one fifth of the population (IEDOM, 2015).

FISHERIES

As with many islands in the Caribbean, fishing used to be a critical livelihood for St-Barthélemy inhabitants. However, today the commercial fishing industry has been significantly limited by the presence of ciguatera toxin on the reefs (Box 1).

Three different types of fishing activities are recognized on St-Barthélemy (Préfecture de St-Barthélemy, 2015):

1. ***Shore fishing*** – any fishing activity without the use of a boat,
2. ***Artisanal fishing*** – any fishing activity done by registered fishermen, and
3. ***Recreational fishing*** – any fishing activity done by non-registered individuals

By law, shore fishing does not require a permit, whereas artisanal and recreational fishermen are required to obtain a fishing license by the ATE. Only 43 artisanal fishermen are registered on the island, working across 32 registered boats that are equipped with outboard engines ranging from 40 to 300 hp (Maritime Affairs, 2015). A permit is compulsory for recreational fishing as of January 1, 2016. In the last nine months, a total of 340 permits have been issued (ATE, pers. comm.). This fishing activity is regulated through licensing but not monitored through fish landings.

Fishing gear

Various types of fishing gear are used by both artisanal and recreational fishermen. They target demersal and pelagic species (Diaz, 2003; Caraïbes Aqua Conseil, 2010).

Bottom Fishing is practiced year round mainly by recreational fishermen, typically using lighter lines equipped with one to four hooks. Bottom fishing is allowed in the Marine Protection Zones, shown in “yellow” in the reserve map Figure 4. The main targeted species are within three families: the Priacanthidae, Holocentridae, and Serranidae. Bottom fishing is mainly practiced by boaters around Le Pain de Sucre and all the satellite islands.

Trap or Pot Fishing is only allowed to be conducted by artisanal fishermen. It targets reef fish species and both of lobster species present in these waters (*Panulirus argus* and *P. guttatus*). The traps used are those that are common to all northern islands of Guadeloupe, made from reinforced galvanized wire. These traps are specifically designed to resist shark attacks and to be more selective for crustaceans. Typically, traps are pulled out of the water every three to four days and have an efficiency ratio estimated at 2 kg (4.4 Lbs) per hold (Lorance & Huet, 1988). By law, several traps must be linked together to limit the risk of losing the traps, and be securely closed by a degradable iron wire of 6/10 mm or by a jute twine (Préfecture de St-Barthélemy, 2015). These regulations are intended to minimize the possibility of “ghost traps” – traps that are left in the water and, if they remain intact, are able to continue to capture animals. A maximum of 400 traps have been allocated per fishing boat.

Spear Fishing is practiced by a majority of the recreational fishermen and is not allowed to be conducted with SCUBA gear nor within the Marine Reserve limits (including both the Protection Areas and High Protection Areas shown in the reserve map, Figure 4).

Shore Fishing does not require a permit and is allowed everywhere, except in the High Protection Areas of the Marine Protected Area (MPA) (Figure 4).

Trolling is practiced offshore by both artisanal and recreational fishermen. It is allowed in the MPA only for licensed artisanal fishermen (Figure 4). It is not allowed in the more highly protected High Protection Areas. This practice targets species such as: needlefishes (Belonidae), garfish or ballyhoos (Hemiramphus). From December to May, big game fishing is very developed and both recreational and artisanal fishermen target dolphin (*Coryphaena hippurus*), tuna (Scombridae) and billfish (Istiophoridae). Daily catch limits per vessel have been established (see Appendix A), however they are not yet monitored or enforced.

Casting Nets are used around the island by both artisanal and recreational fishermen. They are allowed within the boundaries of the Marine Protection Zones, shown in "yellow" in the reserve map for the artisanal fishermen and in the Bay of Grand Cul-de-Sac only from September 1st to May 31st. Casting nets are used to harvest bait fish (Engraulidae and Clupeidae).

Seine fishing is employed by artisanal fishermen around the island and allowed in the Marine Protection Zones, shown in "yellow" in the reserve map after agreement from the ATE (Figure 4). The net is commonly 25 to 30 m long (80 to 100 ft) and targets ballyhoos (*Hemiramphus* spp.) and bigeye scads (*Selar crumenophthalmus*).

Fish Aggregating Devices (FADs) are used by artisanal fishermen, deployed off the island shelf, in water of 2000 m (6,500 ft) deep. This type of fishing is well developed and helps fisherman overcome the risk of ciguatera poisoning. Each fisherman deploys their own FADs; no collective devices have been deployed. FADs are relatively far away from the island, between 20 to over 45 nmi off the coast of St-Barthélemy, due to the extended continental shelf. The vast majority of FADs are concentrated on the West of Barbuda outside the French EEZ at depths of 500 to 2000 m (1,640 ft to 6560 ft). Only a small number of FADs have been declared to the authorities but it is estimated that each fishermen has on average 20 units and some up to 50 (Cuzange, 2011). The locations of the declared FADs deployed around St-Barthélemy are indicated in Figure 3.

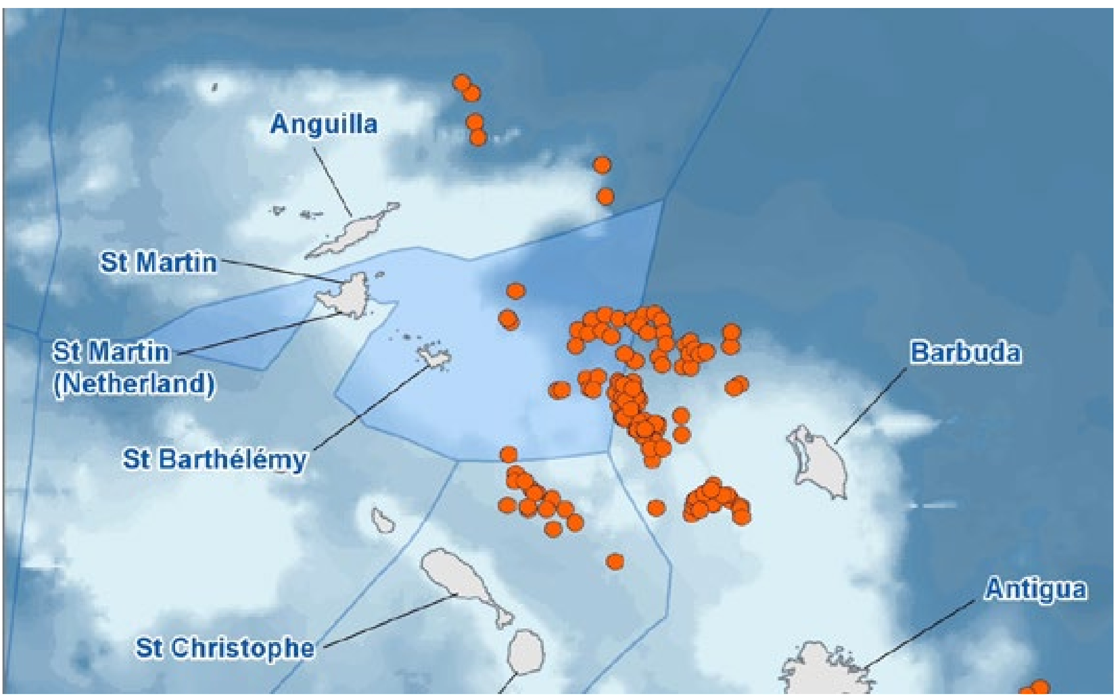

Figure 3. Declared Fish Aggregation Devices (FADs) deployed around Saint Barthélemy waters (Source: Cuzange, 2011)

Targeted species and regulations

In 2015, updated fisheries regulations were issued by the ATE. The agency plans to release a new plasticized card with the updated fishing regulations by the end of 2016 for recreational and artisanal fishermen alike (see Appendix A).

Queen Conch – Conch (*Lobatus gigas*) fishing is allowed only for artisanal fishermen and is restricted to September 1st through May 31st each year. In St-Barthélemy, queen conchs are fished mainly with a tangle net with a maximum length of 300 m (1,000 ft). The nets are left in the water for no more than 72 hours. The tangle net's larger mesh size is considered less harmful than other nets, reducing the risk of bycatch. The conch must have a well-developed shell lip of at least 7 mm (0.3 in) (See Appendix A); only mature animals that have reached reproductive age have these well-developed lips The meat, once cleaned, must weigh a minimum of 250 g (0.55 Lbs).

West Indian Top Snail, or Burgos – Top snails, also known locally as burgos (*Cittarium* pica), fishing is allowed for both artisanal and recreational fishermen outside the MPA and in the Marine Protection Zones, shown in "yellow" in the reserve map (Figure 4) only for the the artisanal fishermen. The season is from December 31st to June 1st. In season, the minimum legal largest whorl of the shell is 60 mm (2.4 in).

Lobsters – Both the spiny lobster or royal lobster (*Panulirus argus*) and the Brazilian lobster (*P. guttatus*) are found in the waters of St-Barthélemy. The minimum allowable catch size for the spiny lobster is 21 cm (8.3 in) and 14 cm (5.5 in) for theBrazilian lobster. Gravid females can not be landed.

Reef Fish – Reef fish are not typically targeted by recreational fishermen and are not the main target of artisanal fishermen of St-Barthélemy, as the market on-island for reef fish is very limited. Some are sold to foreign boats, but it is unclear today, the extent of this undocumented market. The yellowtail snapper (*Ocyurus chrysurus*) is the main species targeted using fishing rods at night, by boat, off the island shelf.

Deep Sea Fish – Deep sea fish, such as the silk snapper (*Lutjanus vivanus*) and the queen snapper (*Etelis oculatus*), are fished by line at depths between 100 and 300 m (300 and 1,000 ft).

Pelagic Fish – Several large pelagic fish species such as the dolphinfish (*Coryphaena hippurus*), tuna (Scombridae), and billfish (Istiophoridae), are caught around the islands.

Sharks – Shark fishing season is closed from May 1st to August 31st. In season, all sharks fished must be landed whole to allow for species identification. Three species are protected:

1. ***Whale sharks*** (*Rhincodon typus*),
2. ***Hammerheads*** (*Sphyrnidae* spp.), and
3. ***Nurse sharks*** (*Ginglymostoma cirratum*)

Illegal fishing gear

Trammel net fishing, dredging, and trawling are not allowed anywhere within St-Barthélemy's territorial waters.

Box 1 – **Ciguatera Toxin**

The ciguatera toxin has significantly limited commercial fishing in St-Barthélemy and several studies have looked at its impact on the fish populations around the Island (Morris et al., 1982; Vernoux et al., 1986; Vernoux & Abbad El Andaloussi, 1986; Vernoux, 1988; Bourdeau & Bagnis, 1989; Pottier et al., 2001; Bouchon et al., 2002; IFRECOR, 2016). When the toxic benthic dinoflagellate *Gambierdiscus toxicus* accumulates on dead coral reefs it can be consumed by herbivorous fishes. The ciguatera toxin, produced by the dinoflagellate, is then bio-accumulated up the food chain in the flesh and viscera of top predators (Vernoux & Abbad El Andaloussi, 1986; Bourdeau & Bagnis, 1989). Ciguatera is a foodborne illness caused by eating fish that is contaminated by the ciguatera toxin.

The western and southern coasts of St. Barthélemy are high risk areas for ciguatera, especially the satellite island of Le Pain de Sucre. In the 1980s, up to 30 cases per year were reported (Diei, 1991; Pottier et al., 2001). Today an increased awareness and a local regulation forbidding the sale of 14 species known to carry toxins has drastically reduced the number of reported cases. Those 14 species are grouped into 4 species of trevally, 4 species of groupers, 3 snappers (unless they are under 1kg – 2.2Lbs), green morays, barracudas, all species of puffersfish and diodons (Diaz, 2003; Caraïbes Aqua Conseil, 2010). Recently Soliño et al. (2015) showed that out of 55 lionfish captured in the waters of St Barthélemy, 27 were found to contain ciguatoxins, compared to no ciguatoxins for the lionfish captured from Guadeloupe and the nearby island of St-Martin. For these reasons, certain restrictions exist regarding fish that can be caught, held or sold in St-Barthélemy (see Appendix B).

OTHER ECONOMICAL ACTIVITIES

With limited arable soil, an absence of fresh lakes and rivers, and a low precipitation rate, agriculture is underdeveloped on the main island. In the mid-19th century, some crops were introduced such as pineapple, cotton, peanut, and yam, but none of these are cultivated today. Early settlers imported goats to the island and today, goats are free roaming. No structured livestock enterprise exists on the island.

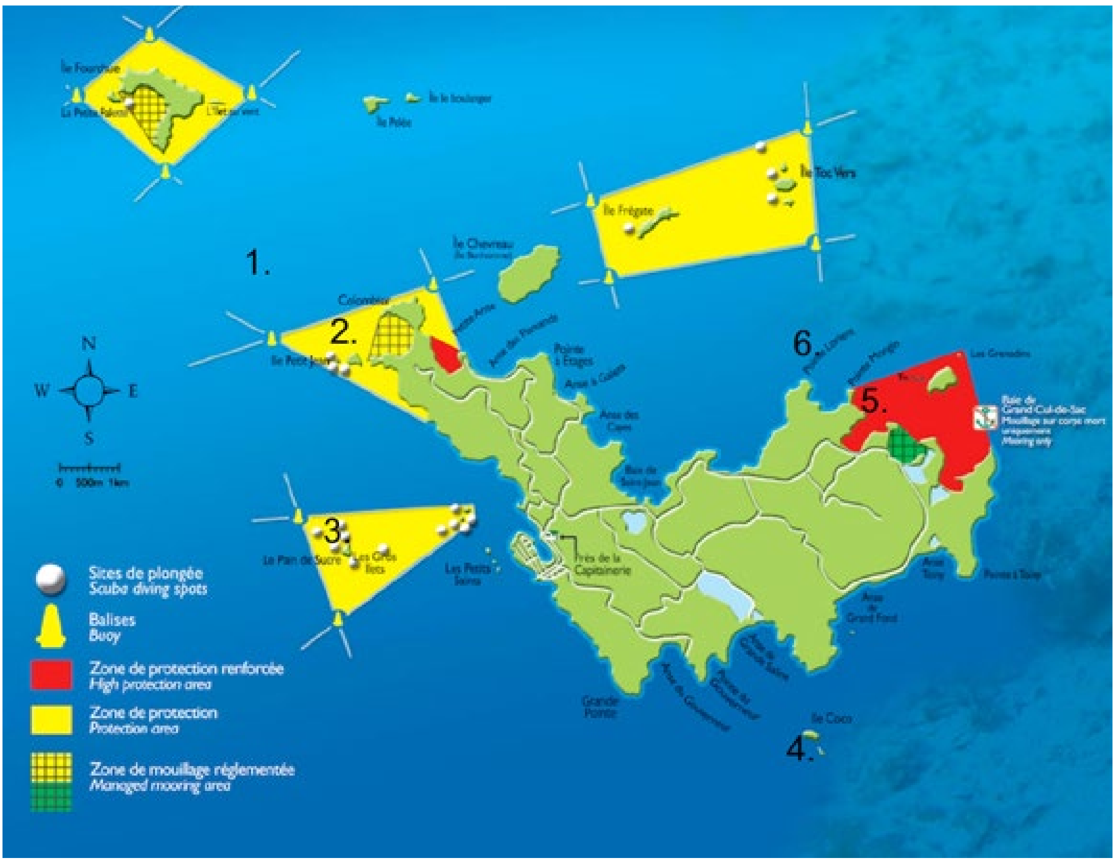

Figure 4. Saint Barthélemy Reserve limits, with the six stations studied for reef and seagrass health by PARETO (2012) and the UAG (Bouchon et al., 2008): 1. Le Boeuf, 2. Colombi-er, 3. Baleine le pain de sucre, 4. Ile Coco, 5. Marigot and 6. Point Milou (Source: ATE)

St-Barthélemy is highly dependent upon the outside. The majority of food items are imported and power generation is almost exclusively generated from imported fossil fuels. Maritime transportation is therefore crucial to the island. The bulk of the imported goods come from the USA via Tropical Shipping Company and mainland France via CMA-CGM through the port of Guadeloupe (IEDOM, 2015). The commercial port activity has been increasing over the last decade.

With one of the smallest runways in the world (only 650 m / 2100 ft long), the St-Jean Gustave III Airport, is limited to smaller planes.

Many passengers come either through the airport of Saint Martin, the main hub in the area, or via private planes. Passengers are mostly French nationals (47.6%), followed by Americans (37.4%) and Europeans (10.2%). Canadian, South American, and Caribbean passengers represent less than 3%. The number of passengers disembarking has steadily increased over the past five years (+6.0% on average) (IEDOM, 2015).

NATURAL RESOURCES


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The French Oversea Territories have been identified as a hotspot for biodiversity (Moncorps, 2004) and, despite its small size, Saint-Barthélemy has diverse fauna and flora. A total of 1069 aquatic species were inventoried in 2014, including 116 semi-aquatic species and 561 terrestrial species (St Barth Essentiel, 2014; Questel, 2014). Several forms of protected areas exist to protect this rich biodiversity that is affected by rapidly growing anthropogenic pressures.

INTRODUCTION

During the last few decades, Caribbean reefs have been severely impacted by overfishing, disease, coastal development, and pollution. St-Barthélemy is no exception, especially in light of its population increase of 333% over the last 50 years.

After the impact of hurricane Luis in 1995, importation of topsoil and plants from the USA and neighboring islands (for landscaping purposes in hotels and luxury villas) has significantly altered the flora and has provided a vector for the introduction of alien and invasive species of plants. Also, accidental and intentional introductions of alien and invasive animal species have deeply modified the island landscape. A recent emblematic example is the introduction of *Iguana iguana* from St-Martin. *I. iguana* threaten the endemic and endangered species of iguana (*I. delicatissima)* by displacement through competition and hybridization (Knapp et al., 2000).

Recent inventories of the fauna and flora of the island indicate a rich biodiversity despite the small size of the territory (Breuil et al., 2009a, 2009b; Questel, 2012; Marechal & Linuma, 2013, 2015; St Barth Essentiel, 2014; Celini, 2013, 2015; de Bettencourt & Imminga-Berends, 2015) (Figure 5).

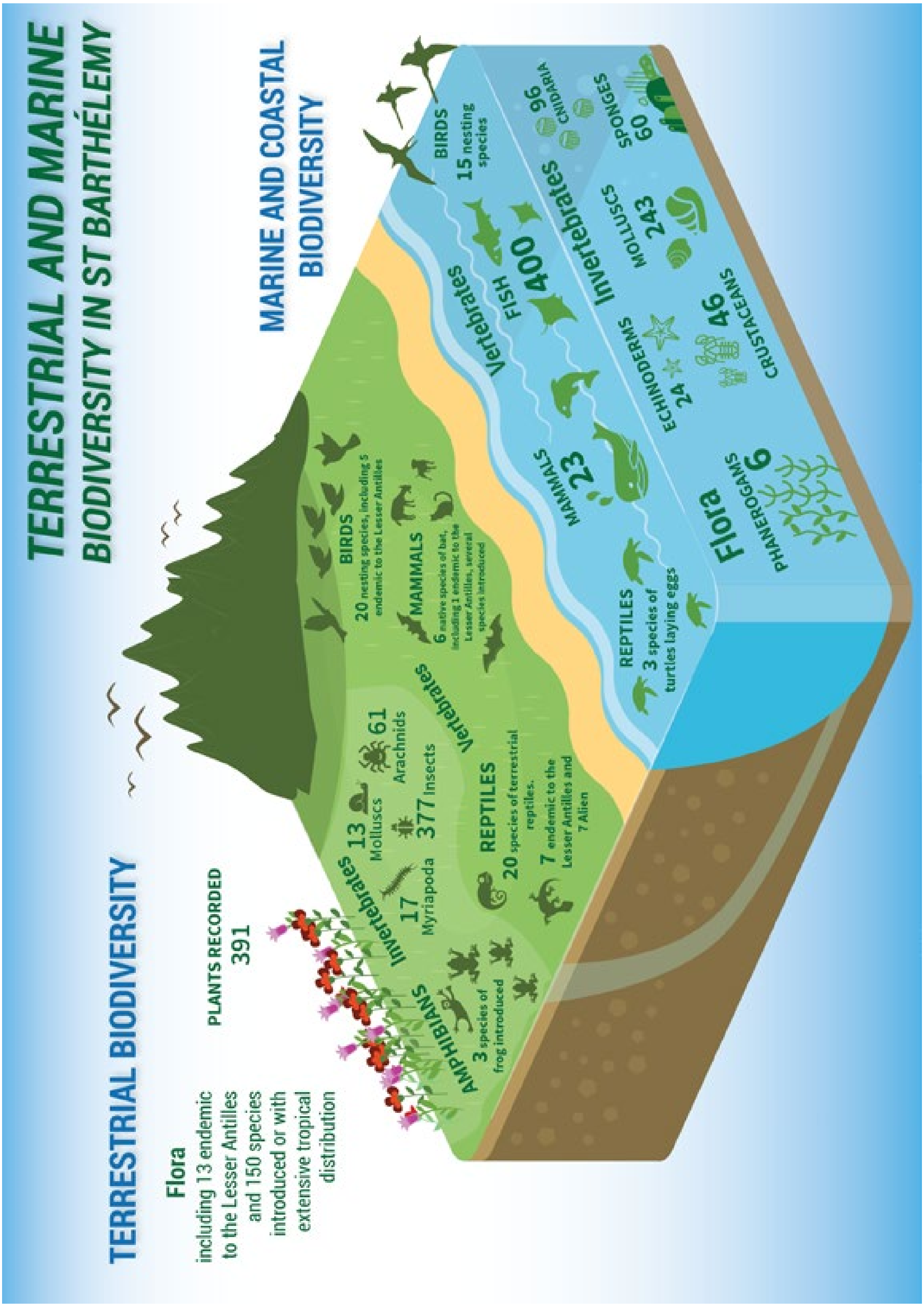

Figure 5. The terrestrial and marine biodiversity in Saint Barthélemy

CORAL REEFS

Around St-Barthélemy, two types of coral formations exist:

(a) ***Non-reef building coral formations*** on rocky substrate, observable along the entire rocky coastline of the island and around the satellite islands (Fourche, Chevreau, Tortue, Pain de Sucre, Beef, Barrel).

(b) ***Reef building coral formations*** present in shallow waters (less than 10 m / 33 ft) of certain semi-enclosed embayments around the island (e.g., Baie de St-Jean) and around the satellite islands (mainly Chevreau and Tortue). They are characterized by small colonies and reduced growth rate, except for some shallow reefs dominated by *Acropora* (CAREX, 2001). These discontinuous fringing reefs are the main coral formations of St-Barthélemy.

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The limited development of the reefs around St-Barthélemy can be explained by several factors, including geographic and anthropogenic factors. First, St-Barthélemy, St-Martin, and Anguilla are the tip of a large underwater shallow plateau of nearly 4600 km² / 1800 mi². This plateau is covered by sediments of variable thickness, from a few centimeters to a few meters. These sediments are favorable for the development of large seagrass beds but are not as favorable for the development of coral reefs. In addition, these sediments shift due to currents and waves that periodically cover rocky outcrops where corals could otherwise settle. Finally, due to the shallowness of the plateau (40 m /130 ft on average), hurricanes and warming events have a particularly destructive impact on these shallow reefs (Delord, 2004; Bouchon et al., 2008). The fringing reefs around the island remained relatively healthy until 2005, when they were severely impacted by the global bleaching event which resulted from abnormally high water temperatures that can stress corals. These corals were already stressed by sediment runoff, rapid coastal development, and nutrient pollution when the warm waters led to the bleaching event (de Bettencourt & Imminga-Berends, 2015). In 2006, many corals had not recovered from the bleaching event and showed additional signs of infection from a variety of coral diseases (Bouchon et al., 2008).

Detailed GIS maps of the aquatic ecosystems are available and have been updated recently (Courboulès et al., 1992; Delord, 2004; Chauvaud, 2001, 2013) (Appendix C). In 2004, almost half the coral reefs (49.7%) around the island were estimated to be "healthy"[1]. Only 4% were considered in a "very good state"; these were located at Colombier and Corossol (Delord, 2004). The latest cartography study reports 9.6 km² / 3.5 mi² of living reef around St-Barthélemy and the satellite islands, representing about 5% of the total substrate (Chauvaud, 2013). However, the author noted that this number does not represent only coral reefs formations, but also small coral colonies scattered across sandy areas for a total of 4.15 km² / 1.6 mi², representing 54% of the reported substrates with coral reefs. The live coral cover is extremely low (below 5%) across 45% of the reefs around the island. Only 1% of the reefs have a coral over 5%, but never exceeding 20%. The highest coral cover was observed on the shallow barrier reef at Grand Cul-de-Sac.

Only two groups have conducted long-term benthic and fish surveys around St-Barthélemy. They looked at the patterns of coral and fish populations over several years using different methodologies and different sites. From 2007 to 2012, the consulting firm PARETO surveyed two sites for coral reef health, one in a Marine Protected Area (MPA) at Colombier and another site outside of the protected area at Le Boeuf (Figure 4). Since 2002, the University of the French West Indies and Guiana (UAG) have conducted additional yearly monitoring of two sites, one in the Marine Protected Area (MPA) at La Baleine du Pain de Sucre (BPS) and another at a site outside of the protected area at îlet Coco (Figure 4). Data from the UAG between 2002 to 2006 and from PARETO (2007 to 2012) are currently published and available.

Four indicators have been assessed over the years:

1. ***Benthic cover,***
2. ***Coral recruitment***,
3. ***Density of the Diadema*** sea urchins, and
4. The degree of ***coral bleaching***.

NATURAL RESOURCES

[1] According to Delord classification (2004): **Healthy Reefs** correspond to reefs where only a few sign of necrosis on the corals colonies are observed and only a few areas of macroalgae are present. **Very Good State** is defined as: no sign of necrosis and no macroalgae.

NATURAL RESOURCES

Benthic Cover

Benthic cover is typically assessed through the coverage by ecologically significant groupings of plants and animals that cover the sea bottom, or benthos. Live coral cover is the amount of reef surface covered by living stony corals which are critical contributors to a coral reef's three-dimensional framework and structural complexity. Similarly, fleshy macroalgae cover is the proportion of reef covered by fleshy algae. Macroalgae often overgrow corals, can occupy the valuable space where new coral larvae could otherwise settle, are commonly toxic, and can induce coral disease. Coral and macroalgae cover data can reflect a reef's health and its overall resilience to disturbances.

Overall, the coral cover at monitored sites has dropped and then stabilized. From 2002 to 2006, the coral cover inside the MPA (BPS) dropped by 36% (from 22% to 14%). Outside the reserve (îlet Coco), the same downward trend was observed with a decrease from 18% to 12% (Bouchon et al., 2006). From 2007 to 2012, the stations studied inside (Colombier) and outside (Le Boeuf) the reserve showed stable coral cover, around 15% and 11% respectively (PARETO, 2012) and is consistent with the wider Caribbean coral cover average of 16% (Schutte et al., 2010). **The macroalgae cover at all four stations being monitored has increased.** In 2003, the recorded macroalgae cover was about 25% (Bouchon et al., 2008). In 2012, the algal cover was above 50% in the reserve and above 60% outside the reserve, well over the regional average of 15.3% (Schutte et al., 2010).

Coral Recruitment

Recruitment is the process by which drifting coral larvae undergo larval settlement and become part of the adult population. Coral recruitment rate and spatial structure have important implications for population dynamics, marine reserve localization, and overall resilience of the reef.

Between 2002 and 2006, Bouchon et al. (2006) studied the species richness of recruits. No variation was observed during the period studied and stayed stable between 7 and 10 species. During the same period, the density of recruits was 4.5 individuals/m² (Bouchon et al., 2008). Between 2007 and 2012, the density of recruits increased inside and outside the marine park, reaching a maximum of about 3 individuals/m² inside the park (PARETO, 2012) (Figure 5b). The recruits were not identified to species level and it is therefore unclear what proportion of the recruits represent the various coral growth forms, such as branching, plate or massive, leaving it difficult to predict the future potential contribution to overall reef-building processes.

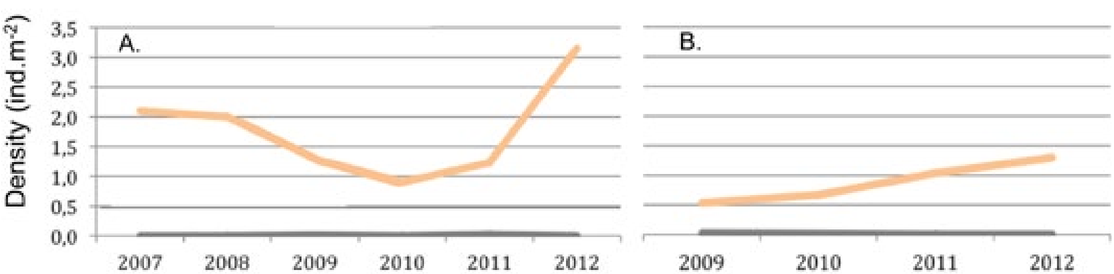


Figure 5b. Evolution of coral recruits inside and outside the reserve, at Le Colombier (A.) inside the Marine Protected Area and Le Boeuf (B.) outside, between 2007 and 2012 (source: PARETO, 2012).

Overall, the total number of coral recruits remains lower than the wider Caribbean average (~4 individuals/m^2, Kramer, 2003) and could be explained by:

- lack of adequate substrate for the coral larvae to settle on (sand cover was high in both stations),
- decline in parental broodstock,
- increased larval mortality,
- conditions that are unfavorable to dispersal,
- direct competition for space with turf, cyanobacteria, algae, and *Palythoa* sp. — indeed, *Palythoa* sp. represented 13% of the benthic cover inside the marine park, and
- other parameters such as water quality.

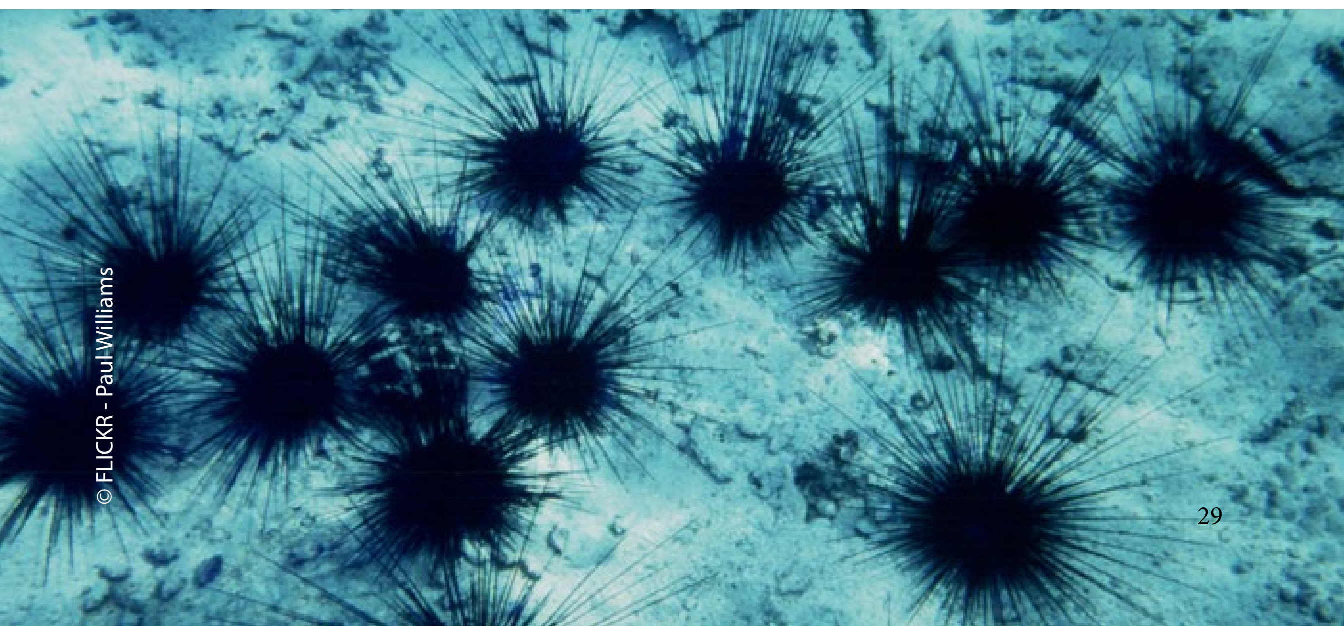
However, the upward trend in the number of recruits is encouraging and further monitoring is needed to verify the evolution of the density of coral recruits at these stations.

Sea Urchins Populations

The long-spined sea urchin (*Diadema antillarum*), is a key factor in biological processes on Caribbean reefs. They graze and scrape off the outer, living tissue layers of plants and animals that can coat benthic features like coral rock; they can clear away turf, endolithic, and coralline algae, helping to keep the algae population under control and creating clean substrate that can be colonized by coral larvae. The presence of long-spined sea urchins is a good indicator of coral reef health. From 2002 to 2006, the observed population of long-spined sea urchins at the station BPS increased from 1 to 3 individuals/m^2 (Bouchon et al., 2006). From 2009 to 2012, the population of *Diadema* at the Le Boeuf station (inside the protected area) had slightly increased, from 0.5 to almost 1.5 individuals/m^2. However, during the same period, no individuals were observed outside the Marine Park (PARETO, 2012).

Before the pathogen-induced mass mortality event of 1983, densities of up to 7.1 individuals/m^2 were not uncommon (Sammarco, 1980). However, the densities observed in the two stations of St-Barthélemy are consistent with the low densities observed around other islands of the Caribbean today (Kramer et al., 2015), although recoveries of *Diadema* populations have been reported for certain areas (Idjadi et al., 2010).

Even if the populations surveyed in St-Barthélemy have shown a slight increase, it is too early to talk about recovery due to the limited number of stations surveyed and the complete absence of individuals outside of the MPA.



Coral Bleaching

Coral bleaching is caused when corals expel symbiotic algae (zooxanthellae) living in their tissue due to excessive environmental stress, including changes in salinity, increased water temperature, and pollution (Dalton & Carroll, 2011). The coral without algae turns completely white and if the coral does not reabsorb algae within a short period of time, it dies. Bouchon et al. (2006) showed that the proportion of total bleached coral colonies had significantly increased to reach a maximum of 40% in the reserve and 57% outside the reserve in 2006, a few months after the 2005 bleaching event. No bleaching data since 2006 is available today.

Coral Restoration

The geological plateau of St-Barthélemy is favorable to the development of vast seagrass beds but unfavorable for the expansion of large coral reefs. Favorable substrate for coral expansion is therefore in short supply, however dead corals can provide suitable substrate for new corals to settle. Interestingly, in the waters around the island, large areas of dead coral are rarely re-colonized. The lack of colonization indicates environmental pressures or a reduction in viable coral spats, which has not allowed for natural restoration of these sites that historically had thriving coral colonies (Chauvaud, 2013).

Three different grassroots organizations have started coral restoration projects around the island, Coral Restoration St Barth, ARTIREEF, and Reef of Life. All three are setting up coral nurseries around the island, which are in various stages of advancement. Two are using the BIOROCK technology, the third is using rebar structures (Figure 6). All three are using different methodologies, in different locations.

Figure 6. Coral tables with *Acropora cervicornis* from Coral Restoration, St Barth - 2016

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REEF FISH

Similar to the coral surveys, two groups (PARETO and UAG) have gathered long-term information on the fish communities of the waters around St-Barthélemy, using different methodologies, at different locations. Three indicators were surveyed:

1. ***Species richness*** (number of individuals),
2. ***Density*** (individuals/100m²), and
3. ***Biomass*** (g/100m²).

In addition, Brosnan studied fish density in 1996 and 2001 (Brosnan et al., 2002).

Species Richness

Forty-four species of fish were observed in 2003 inside the reserve while 49 species of fish were observed outside the reserve (Bouchon et al., 2006). In 2012, this dropped to 24 and 21 respectively (PARETO, 2012). **These levels are much lower than those from nearby islands** such as Saint Vincent and the Grenadines (105), Bonaire (104), or Puerto Rico (86) (Newman et al., 2015).

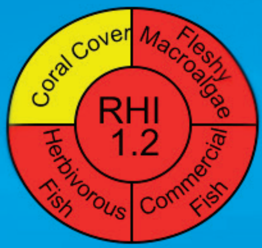
Fish Density

Although an earlier study had noted a significant increase of fish density between 1996 to 2001 (from 152 to 522 individuals/100m² at BPS) (Brosnan et al., 2002), **over the years the fish density showed an important decrease**. In 2003, the fish density was significantly higher inside the reserve (BPS, 453 individuals/100m²) than outside (îlet Coco, 103 individuals/100m²) (Bouchon et al., 2006). No changes in densities were observed over the study period (2003 - 2006). From 2007 to 2012, the densities at two sites studied (Colombier and Le Boeuf) were also stable over that time frame, yet, the densities estimated were about half compared to the prior years, 206 and 47 individuals/100m², respectively (PARETO, 2012).

St-Barthélemy Reef Health

Inside the MPA
(Site Le Boeuf)

Outside the MPA
(Site Colombier)



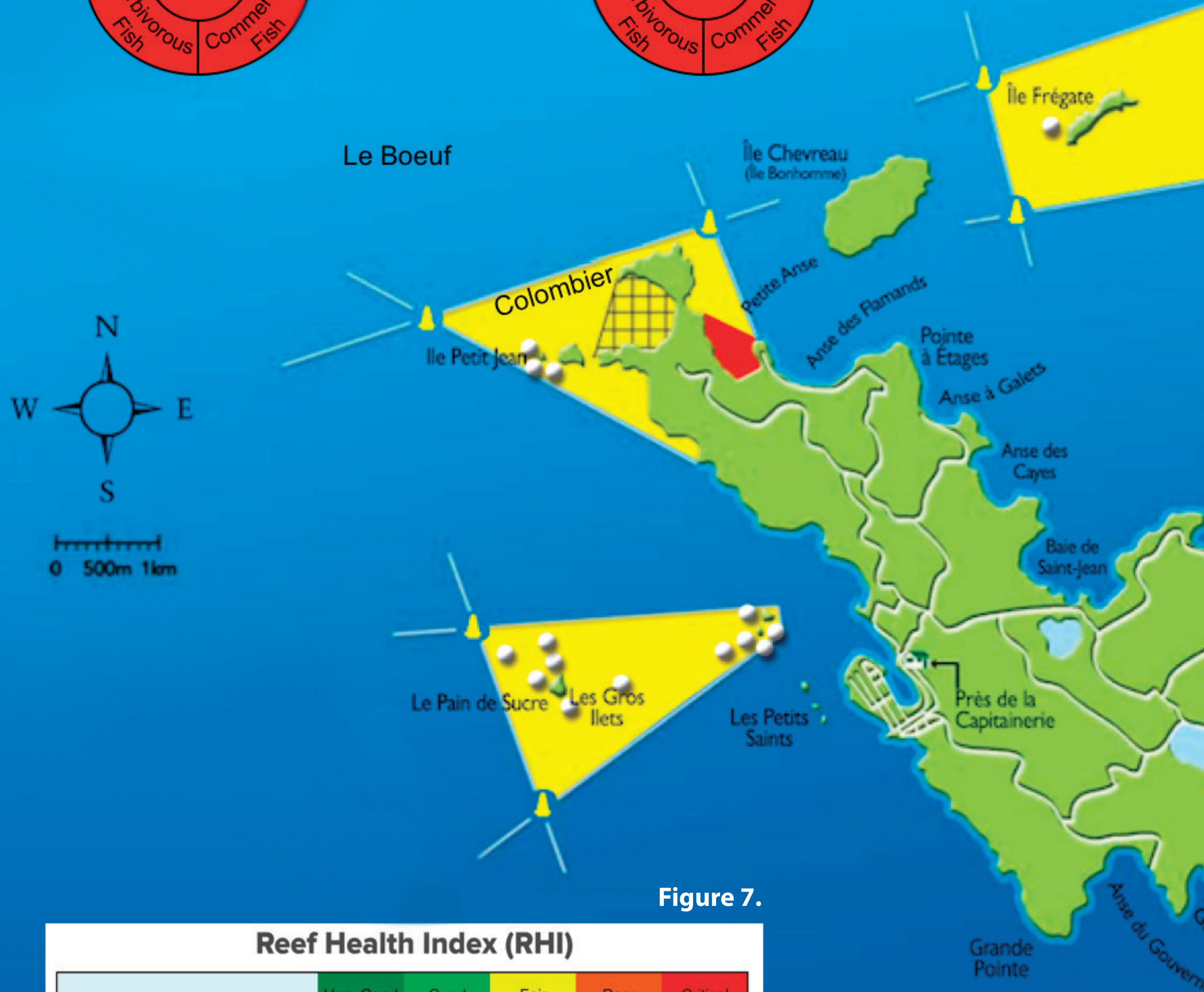


Figure 7.

Reef Health Index (RHI)

Reef Health Index Indicators	Very Good (5)	Good (4)	Fair (3)	Poor (2)	Critical (1)
Coral Cover (%)	≥40	20.0-39.9	10.0-19.9	5.0-9.9	<5
Fleshy Macroalgal Cover (%)	0-0.9	1.0-5.0	5.1-12.0	12.1-25	>25.0
Key Herbivorous Fish (g/100m^2) *(only parrotfish and surgeonfish)*	≥3480	2880-3479	1920-2879	960-1919	<960
Key Commercial Fish (g/100m^2) *(only snappers and groupers)*	≥1680	1260-1679	840-1259	420-839	<420

Reef Health Index
[developed for the Mesoamerican Reef by Kramer et al., 2015]

Biomass

Overall, the fish biomass inside the marine park was found to be significantly higher than outside the marine park. Strong seasonal variability has been identified with a peak in biomass in July through August and a minimum in January through February (Bouchon et al., 2006). The latest surveys in 2012 recorded a fish biomass inside the marine park of 2399 g/100m^2 and 1241 g/100m^2 outside the marine park (PARETO, 2012). A steep decrease from the previousstudy which recorded an average of 7910 g/100m^2 inside the reserve and 5390 g/100m^2 outside the reserve between 2002 and 2006 (Bouchon et al., 2006). However, it is unclear if this decline reflects a real ecological change or is due to the different methodologies used and different locations studied.

Within the MPA, the four most represented families of fish are the Pomacentridae (the damselfishes), Acanthuridae (the surgeonfishes), Scaridae (the parrotfishes), and Haemulidae (the grunts), with the damselfishes and their family alone representing over 75% of the counts (Brosnan et al., 2002). Outside the MPA, the Acanthuridae, Scaridae, and Haemulidae have the highest recorded biomass. In 2012, the commercial fish biomass (only snapper and grouper) was 320 g/100m^2 inside and only 47 g/100m^2 outside the MPA. The biomass of key herbivorous fish (parrotfish and surgeonfish) remained at under 500 g/100m^2 inside the reserveand under 1000 g/100m^2 outside (PARETO, 2012).

Conclusions

The lack of repetition per study site, limited number of sites studied, and different methodologies used, render the interpretation of results challenging. However, results highlight the significant effect of the MPA on commercial fish (snappers and groupers) although even inside the protected area, their biomass was below the critical benchmark reef recovery value of 420 g/100m^2 established for Caribbean fish populations (Kramer et al., 2015). Similarly, the biomass of key herbivorous fish was lower than the critical threshold (960 g/100m^2) and even lower inside the reserve.

Overall, fish **populations have dropped below the benchmark for recovery** that has been established for the area (5000 g/100m^2 for total fish abundance and 1400 g/100m^2 for commercially significant fish) (Kramer et al., 2015). Compared to the Reef Health Index[2] (RHI) established for other Caribbean reefs (Figure 7), St-Barthélemy's reefs score poorly with a RHI of 1.75, on a scale of 'critical' (1) to 'very good' (5). **The reefs around the island are in critical condition**. Reefs under this category are characterized as *"missing structural and functional components and are less likely to recover from future disturbances. They require management intervention and likely proactive restoration to prevent them from shifting towards irreversible decline"* (Kramer et al., 2015).

[2] According to Kramer et al. 2015: *"The mean value of each indicator is compared to the thresholds in the table and given a grade from one ('critical') to five ('very good'). The four grades are averaged to obtain the RHI score for each site. It is important to highlight that a site with a given RHI score (e.g., 'fair') may have some indicator(s) ranking in different conditions (e.g., 'good')."*

SEAGRASS MEADOWS

The seagrass meadows were one of the most characteristic and highly developed benthic ecosystem around the island, present in lagoons and in front of bays. Seagrass meadows provide key ecological services, including nursery habitats for commercially and recreationally important fish, nutrient cycling, protection of the coastline, and food web structure (Hemminga and Duarte, 2000; Orth et al., 2006; Maxwell et al., 2016). They are also an important food source for the endangered green turtle (*Chelonia mydas*) and the queen conch (*L. gigas*) (Marquez et al., 2016; Stringell et al., 2016). Seagrass blades dampen water energy and trap particles, thereby becoming a "filter" for the ecosystem, helping to improve the water quality and prevent siltation on nearby coral reefs (Borum et al., 2004).

The main seagrass beds in St-Barthélemy are composed of three species – *Thalassia testudinum, Syringodium filiforme*, and *Halophila stipulacea* (Figure 8). Unlike algae, these seagrasses are flowering plants with a well developed root system.

T. testudinum, the turtle grass, is an angiosperm growing in depths ranging from 1 to 20 m (1 to 65 ft). It colonizes sandy or sandy-muddy bottoms in sheltered areas. Thalassia forms meadows that can cover large areas.

S. filiforme, the manatee grass, grows in depths between 1 and 12 m (1 to 40 ft).

H. stipulacea is originally from the Indian Ocean and has colonized the Mediterranean and Caribbean Seas. This species is fast-growing

Figure 8. Seagrass species in St-Barthélemy

Thalassia testudinum

Syringodium filiforme

Halophila stipulata

and produces abundant seeds and consequently can invade large areas rapidly (Malm, 2006). It grows in a wide range of environments, including areas of high salinity (up to 60 psu) and temperature (up 39°C / 102°F) (Short et al., 2016). It is also the deepest seagrass reported worldwide. It has been collected by dredge from 145 m / 475 ft (Short et al., 2007).

Seagrass meadows used to thrive around the island as deep as 15-20 m (50 to 65 ft), with densities above the Caribbean average (CAREX, 2001). Urbanization, pollutions and other threats have severely damaged the health of these ecosystems. Today, only a fraction of these meadows exist around the island and cover a total of 374 ha (924 acres) (Chauvaud, 2013) (Figure 9). A striking example of this drastic reduction can been observed in St-Jean Bay, where recent studies, based on aerial photographs, indicate that over 99% of the seagrass in the central part of the bay was lost between1995 and 2003 (Brosnan et al., 2009; Le Nagard, 2016).

Single and mixed species meadows of turtle and manatee grass cover relatively small areas in the lagoons or in shallow or protected areas (90 ha / 222 acres). The invasive *Halophila* is present on a total of 277 ha / 680 acres, forming mono-species meadows on 264 ha / 650 acres. It seems, however, that *Halophila* is not in direct competition with the local seagrasses but colonizes areas where typically the green algae *Halimeda* sp. is established (Chauvaud, 2013). *Halophila* is shallow-rooted compared

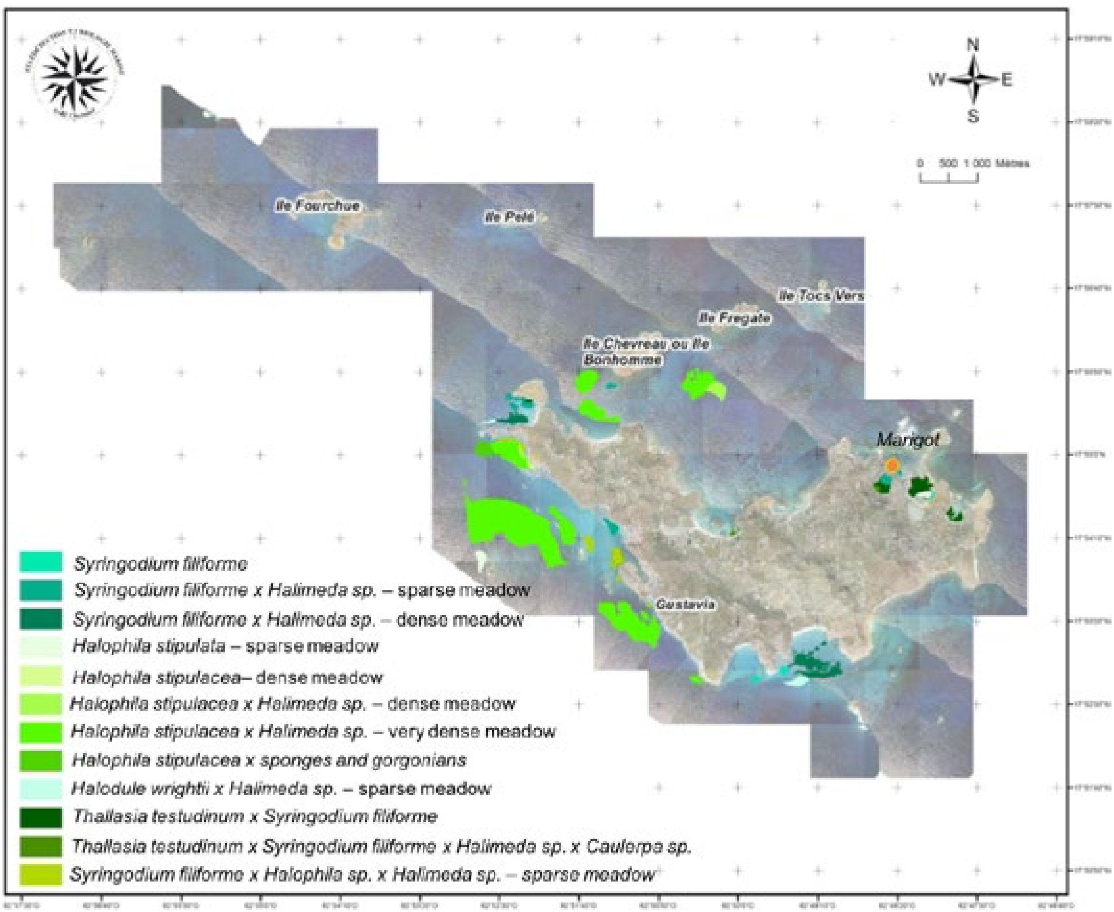


Figure 9. Types and map of marine phanerogams around St Barthélemy (from Chauvaud, 2013) and location of the benthic station studied between 2007 and 2012 (PARETO, 2012)

to most seagrasses. If this species were to replace large areas, ecosystem services of seagrass beds would be compromised (van Tussenbroek et al., 2016), such as a decrease in coastal protection (Christianen et al., 2013) and carbon sequestration (Marba et al., 2015).

Between 2007 and 2012, one station was monitored for seagrass health: Marigot (Latitude N 17°54,760' and Longitude W 62°48,462') located inside of the MPA (Figure 9) (PARETO, 2010, 2012). Three indicators were followed:

1. ***Density*** (number of plants/m^2),
2. ***Average length*** (cm) of the leaves, and
3. ***Overall health*** of the meadow (value from 1 to 5)[3].

In 2012, the meadow was composed of both turtle and manatee grass and the average ***density*** was high (1435 plants/m^2). However, it is important to note that the structure of the meadow appeared to be unbalanced. Indeed, in addition to the significant decreases in density of the turtle grass over the five year study, the meadow was composed of manatee grass (86%), which had been absent from that location before 2009 (Figure 10). The average ***canopy height*** measured on plants of turtle grass is relatively low (13.5 cm ± 4.9 /5.3 in ± 1.9) and has slightly decreased compared to 2011 (Figure 11). The ***overall health of the meadow*** was categorized as level 4, corresponding to a ***"mediocre" health***, with presence of macroalgae and pronounced hypersedimentation and eutrophication (PARETO, 2012).

This rapid and problematic trend could be the result of new coastal development (including a desalination unit) leading to an increase in sedimentation, input of organic matter and nutrients, and a drop in salinity within the area surveyed. However, the lack of water quality assessments in the Bay, does not allow us to confirm or refute this hypothesis (PARETO, 2012). CAREX (2001) cite the following as the main causes of seagrass degradation around St-Barthélemy:

- Mechanical destruction during earthworks,
- Hypersedimentation in the bays around the island - siltation of leaves and asphyxia of seagrass. This phenomenon is related to important overload of soil runoff in a confined area (absence of sufficient hydrodynamic movements allowing removal of these very fine sediments),
- High turbidity - turbid plumes associated with soil runoffs or discharged pollutants, limits light penetration and thus photosynthesis,
- Eutrophication - increasing epiphytic algal proliferation on seagrass and can lead to their asphyxia ,
- Mechanical destruction during dredging, and
- Mechanical destruction by anchors.

[3] Level 1 corresponds to a very healthy meadow, with only *T. testudinum*. Level 5 corresponds to a meadow in a degraded state, invaded by macroalgae or under heavy sedimentation pressure (PARETO, 2012).

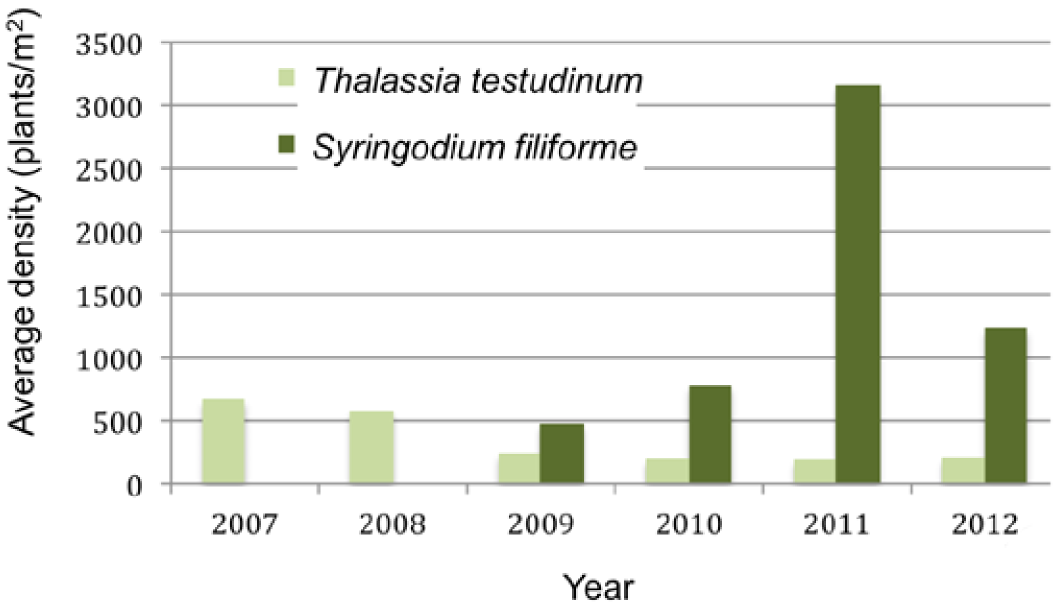


Figure 10. Evolution of the average density of the seagrass meadow at Marigot benthic station (PARETO, 2012)

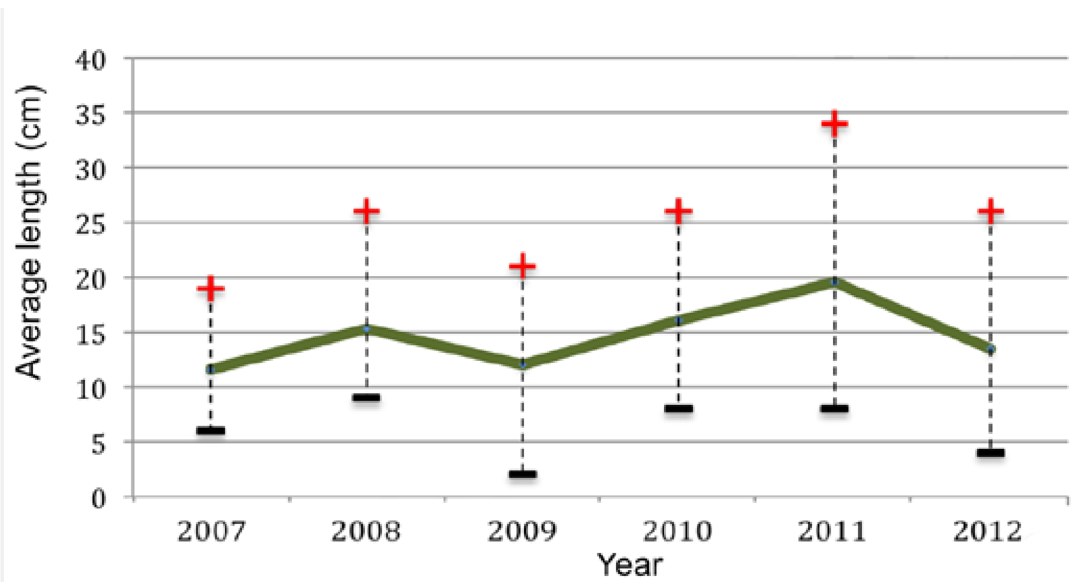


Figure 11. Evolution of the average length of the longest leave of *Thalassia testudinum* at Marigot benthic station (PARETO, 2012)

QUEEN CONCH

The Queen Conch (*Lobatus gigas*) is an ecologically and commercially important marine resource in many Caribbean countries. Fishing pressure in most of these countries has caused significant reduction of its populations (FAO, 2012).

Brosnan & Troyer (2011) looked at the conch population in the ***Grand Cul-de-Sac Bay*** in order to determine the impact of a dredging project in the Bay. At the time of the study, about half (45%) of the population was sexually mature (shell length >19 cm). The area was identified as a nursery ground, with a high density of individuals (253 individuals/ha).

No other population data is available for the Bay.

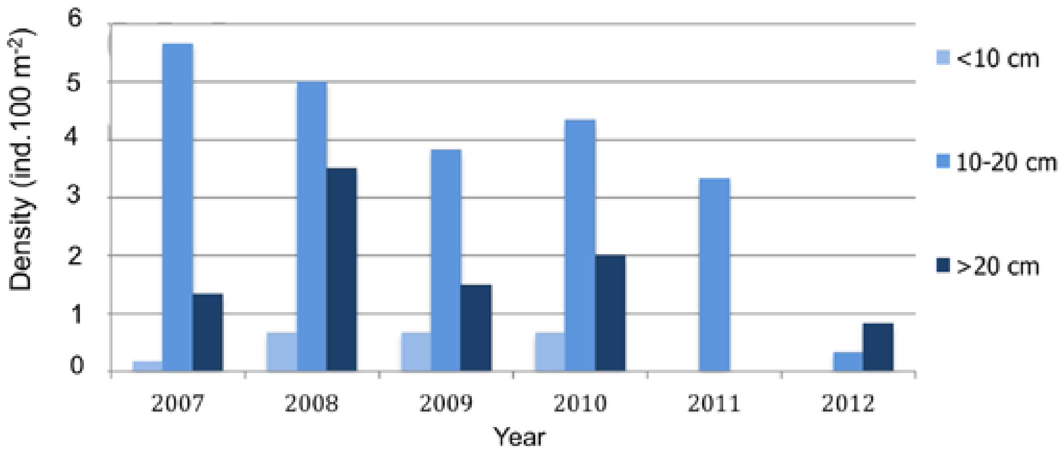


Figure 12. Evolution of Queen Conch (*Lobatus gigas*) density per class size in Marigot, Saint Barthélemy (PARETO, 2012)

Between 2002 and 2007, one station inside the Marine Park was monitored for conch (Marigot, Figure 9, PARETO, 2012). The observed density of queen conch dropped over the years to reach a significantly lower density in 2012 (1.17 living individuals/ha). Additionally, no juveniles were recorded for the last two years of the survey (Figure 12).

The ***density of conch*** observed in 2012 **has fallen below the benchmark for recovery.** Indeed, as the conch density decreases, the conchs' ability to locate mates becomes limited and below a density of 56 mature adults per hectare, no mating will occur. This is known as the 'Allee Effect' or 'depensation' (Appeldoorn, 1988a; Stoner & Ray-Culp, 2000).

The conch density decline observed inside the Marine Park could be due to the increased fishing pressure. Conch are particularly vulnerable to overharvesting due to their slow growth rate, late maturation, limited mobility, occurrence in shallow waters, and propensity to aggregate (NMFS, 2014). The last three of these features make them easy to harvest. The lack of recruits has been explained in other locations in the Caribbean by the degradation of shallow water nursery habitats and water pollution (specifically high concentrations of zinc and copper). Zinc and copper have been shown to reduce the recruitment of juvenile conch and cause reproductive failure (NMFS, 2014). It is interesting to note that high concentrations of copper were recently observed in St-Jean pond (from 35 to 50 µg. kg^{-1}), slightly higher than the first contamination threshold set by the French Government (Tollu & Yvon, 2015). **The potential source(s) of the pollution have not been identified.** Moreover, Aldana Aranda et al. (2011) have reported the presence of an Apicomplexa-like parasite in the digestive gland of queen conch population of St-Barthélemy. Conch sampled nearshore had an average of 34.34 parasites. Their findings suggest that the occurrence of Apicomplexa could be a facto affecting the gonad development, hence reducing their reproductive capacity.

The queen conch population observed in St-Barthélemy's MPA has reached critically low densities. Currently, no database exists on queen conch stock in the waters of St-Barthélemy. In addition, fishing and poaching pressures are not monitored. This does not allow one to gauge the effectiveness of the various management measures.

BURGOS

Burgos (*Cittarium pica*) collecting has always been an important fishing activity in St-Barthélemy. The burgo, a species of sea snail, lives in areas subject to strong wave actions and are characterized by a slow growth rate (1 to 1.8 mm/month). It reaches its first year of maturity at 40 mm (Frenkiel, 2007). The larvae development is short which is an important characteristic for stock management. Indeed, inside an MPA, a population with short larvae development is identified as “self-seeding”, i.e. the MPA receives recruits primarily as larvae produced from spawning occurring in its own population and does not rely on connectivity with upstream populations (Mora and Sale, 2002). This characteristic could also limit the spillover benefits.

To better understand the burgos biology and the fishing pressure on this species, a study was conducted in 2007 on the populations around the island (Frenkiel, 2007). A dozen artisanal fishermen collected burgos inside and outside the MPA (see Box 2). In 2006, they harvested about 10,000 individuals. A year later, in 2007, the catch dropped to 6,000 but rebounded to 10,000 in 2008. The author noted that several biases impaired the results of the study such as a lack of reporting from some commercial fishermen of their catch and recreational catch was not monitored.

A conservation initiative introduced by artisanal fishermen raised the minimum allowable catch size to 60 mm. Additionally, a closed season was set up from June to December, during the burgos reproduction period. However, artisanal fishermen denounced the abusive fishing activities of recreational fishermen (poaching in the MAP, no respect of minimum size, fishing at night). Hopefully, the recently appointed (October 2016) Environmental Police will mitigate the problem.

Box 2 – **Fishing practices as cultural heritage of the island**

In Saint Barthélemy, certain fishing practices are allowed inside the marine parks for artisanal fishermen (in particular, cast netting, seine netting, and burgos fishing). These ancient fishing practices have been disappearing in favor of activities related to tourism. Decision makers have decided to maintain the fishing rights for artisanal fishermen in order to help maintain the cultural heritage of the island.

SALT PONDS

Figure 13. This dead pelican in St-Jean pond (2013) is a stark reminder of the degradation of water quality which can lead to bird mortality due to botulism (PARETO, 2016)

NATURAL RESOURCES

Salt and brackish ponds are unique habitats with an extremely high biodiversity and are vital transition areas between the terrestrial and the marine environment. Salt ponds and their surrounding mangrove forest are the predominant type of coastal wetlands in the Caribbean and provide important ecological services. Indeed, these ponds act as natural buffers, ***filtering pollutants and runoffs*** from heavy rains and hurricanes. The ponds also act as natural ***sediment traps***, protecting the nearshore environment by limiting the amount of sediments and pollutants that would otherwise reach the ocean where they could have negative impacts, smothering corals and seagrass. Additionally, salt ponds are home to dense benthic mats of bacteria. The bacterial mat ***biodegrades nutrients*** such as nitrogen, reducing the risk of eutrophication (Jarecki, 1999; Brin, 2007). Furthermore, coastal salt ponds buffer wave impacts ***limiting erosion*** on the coastlines during storm events. Finally, properly functioning ponds greatly contribute to the ***richness and biodiversity*** of an island and provide nesting, feeding, and nursery grounds for many species of birds and fish (Division and Fish and Wildlife, 2005), and are an important stop for many migratory birds (Devenish et al., 2009).

St-Barthélemy used to have about a dozen brackish water ponds in the 20th century; today, only five ponds remain (Magras, 2011). The other ponds have been filled for various reasons, mainly for urbanization projects such as land reclamation for the airport, a sanitation project, and the creation of an industrial area for the island (Sastre & Bernier, 2014).

Parameters	Station 1 (canal)	Station 2 (South)	Station 3 (West)
Temperature	25	25.2	25
pH	7.16	8.28	14.6
Salinity (g/kg)	7.67	36.34	8.19
Total Phosphorus (microM)	22.68	40.65	39.68
Total Nitrogen (microM)	85.71	1164.29	1192.86
Nitrates (microM)	41.77	63.87	25.16
DBO5	14.00	35.00	10.00
DCO (mg/l)	67.60	1147.00	764.00
Ratio DCO/DBO5	4.83	32.77	76.40
MES (mg/l)	12.00	226.00	75.00
Total Coliforms (NPP/100ml)	36.00	750.00	4300.00
E. coli	144.00	10559.00	1166.00
Enterococcus	<15	1188.00	142.00

Table 1. Results of the physico-chemical 2015 analysis of the water of St-Jean Ponds (PARETO, 2016). Color code: Red: very bad, Orange: mediocre and Blue very good; according to the French legislation.

The remaining ponds are located in ***St-Jean, Grand Cul-de-Sac, Petit Cul-de-Sac, Toiny***, and ***Saline*** and are lined with narrow bands of mangrove in a survival state (Figure 1). Many of the ponds dry up during the dry season, and due to that peculiarity, four of the salts ponds (***Grand and Petit Cul-de-Sac, St-Jean and Saline***) were used for salt extraction from before 1784 and up until 1972. The 5 ponds are classified as ZNIEFF type II (*Zone Naturelle d'Intérêt Ecologique, Faunistique et Floristique*), a French classification for natural areas with remarkable ecology, fauna, and flora; however, this classification does not provide for any protection status. Only the biotope of the pond in St-Jean is protected under a prefectural decree of biotope protection (No. 94-1056 of 03.10.94).

Typically, the connections between the ponds and the open sea are made through channels and a succession of beach-dune systems built by waves and coastal currents. Salt ponds are dynamic ecosystems evolving through natural changes from near-marine ecosystems to near-terrestrial ones due to sedimentation and changing hydrological conditions (Jarecki & Walkey, 2006). In St-Barthélemy, a gradual reduction in the communication between the ponds and the open sea has been observed, together with a slow degradation of these ecosystems (Bouchon et al., 1998). Only the pond ***Grand Cul-de-Sac*** has had a constant communication with the sea. The connection with the sea is intermittent for ***St-Jean*** and ***Saline*** ponds. The ponds of ***Toiny*** and ***Petit Cul-de-Sac*** have completely lost their connection with the sea (Sastre & Bernier, 2014). Physical circulation and flushing of the pond moderate the impact of nutrient loading from the watershed. Reduction in connections with the open ocean limits water circulation, resulting in an accumulation of nutrients. The west side of the pond at ***Grand Cul-de-Sac*** is the only pond that still has a permanent connection with the open sea. This pond has the highest biodiversity and is the refuge of the very last stands of red mangrove (*Rhizophora mangle*) (Sastre & Bernier, 2014).

In 1998, the first ecological diagnostic of the ponds was completed and the results indicated that urbanization, pollution and the vanishing connections to the open sea had a systemic withering impact on the health of the few wetlands left on the island (Bouchon et al., 1998). Since 1991, nuisances have been reported, including the degradation of the water quality and massive fish kills during dry periods (Bouchon & Bouchon-Navaro, 1991).

A restoration project for the pond in ***St-Jean*** is currently under review with the aim to re-establish a permanent connection between the pond and the open sea. Several recent studies have looked at the ecological state of the pond and indicated a severe degradation of the physico-chemical quality of the water and substrate which has important biological and ecological consequences (Tollu & Yvon, 2015; PARETO, 2016). These consequences include:

- Bird mortality due to botulism (Figure 13),
- A drop in the passage of migratory birds (-55% decrease between 2001 and 2002 and no nesting migratory observed in 2012),
- Strong odors during dry periods, and
- A decline of the population of *Iguana delicatissima*, which use coastal forests as their main habitat (Knapp, 2000; Tollu & Yvon, 2015; PARETO, 2016).

Today, the pond in St-Jean is a dysfunctional anoxic ecosystem with hazardous levels of several nutrients, bacteria, and metals (Table 1). This is mainly due to excessive cutting of surrounding mangroves, lack of water aeration and circulation, and excessive input of pollutants coming from point and non-point sources, including wastewater from the watershed and auto repair garages with no specific system for retaining oils and other caustic products (PARETO, 2016).

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MANGROVES

Mangroves are extremely productive habitats and are vital to overall environmental health. They provide numerous goods and services, not only to the marine environment but also to people (UNEP, 2014) including benefits for:

Fisheries
Mangroves provide habitat for a large variety of fish, crabs, shrimp, and mollusks. They also play a key role as a nursery for many reef fishes (Ley et al., 1999; Nagelkerken et al., 2001; Vaslet et al., 2008). Studies show that reefs close to mangroves can have up to 25 times more fish of certain species than areas where mangroves have been cut down (Nagelkerken et al., 2002; Mumby et al., 2004).

Coastal Protection
The root system of mangroves trap sediment from runoff water, which flows down the gullies. This has several benefits such as coastline stabilization, erosion prevention, and protection of seagrass beds and coral reefs (Delfino et al., 2015; Guannel et al., 2016; Atkinson et al., 2016).

Tourism
Mangroves' ecosystems with their diversity of fish and other sea creatures have a great potential for revenue generation directly linked to tourism activities such as kayaking or snorkeling expeditions (UNEP, 2014; Masnavi et al., 2016).

Timber and Plant Products
Many coastal communities use and rely on the rot resistant wood of the mangroves for construction or as fuel (Aziz et al., 2015).

In the wider Caribbean, the majority of the mangrove forests are located along the seashore (Roussel, 2002). However, in St-Barthélemy, mangroves are not located along the seashore but along semi-enclosed salt ponds and constitute the only wetlands on the island (Sastre & Bernier, 2014; Pole-relais, 2016). Four species of mangrove trees are found on St-Barthélemy:

1. ***Red mangrove*** (*Rhizophora mangle*),
2. ***Black mangrove*** (*Avicennia germinans*),
3. ***White mangrove*** (*Laguncularia racemosa*),
4. ***Grey mangrove*** (*Conocarpus erectus*).

About 50 ha (123 ac) of lagoons and mangroves have been destroyed for coastal development over the years (de Bettencourt & Imminga-Berends, 2015), which represent 2% of the total surface of the 25 km² (9.6 sq mi) island. With the lost connectivity between the ponds and the sea (see Section Salt ponds), the health of the mangroves on the island has severely deteriorated (Geolittomer, 1997; Bouchon et al., 1998). Today, the mangrove community of Grand cul-de-sac is the only one still connected to the open sea, where the very last stand of red mangroves is located (Sastre & Bernier, 2014). Based on preliminary analysis of satellite images, the total area of the combined four species of mangroves on the island is less than 6 ha (15 acres).

These relict ecosystems are one of the last refuges for the large flow of migratory birds passing through the West Indies. The latest report from the Pole Relais relating to St-Barthélemy's wetlands indicates that most mangroves have disappeared or are in a dire state due to land reclamation or pollution (Pole Relais, 2016).

TERRESTRIAL VEGETATION

With a year-round warm climate and low precipitations, environmental factors (topography, soil composition, wind, and salt air) and anthropogenic pressure determine the distribution of the wild terrestrial indigenous species on the island. Some species were naturalized and have adapted to local climate conditions such as the xerophyte[4] plants, including two iconic species:

1. ***Turk's Head cactus*** (*Melocactus intortus*), and
2. ***Lignum vitae*** (*Guaiacum officinale*), an endangered tree.

From 2011 to 2014, an extensive inventory of the wild vascular flora of St-Barthélemy was completed and 391 species were identified (Sastre et al., 2014). A Red List of species to protect has been proposed in accordance to the IUCN classification (Appendix D). The same authors indicate that 87% of the threatened species and 72% of the island total flora are located in only 4 areas of the island that include mangroves, beaches and backshores, hill tops, gullies, and islets (Figure 14).

[4] A ***xerophyte*** (from Greek *xero* dry, *phuton* plant) is a species of plant that has adapted to survive in an environment with little liquid water. The morphology and physiology of xerophytes are adapted to conserve water, and commonly also to store large quantities of water, during dry periods (Wikipedia).

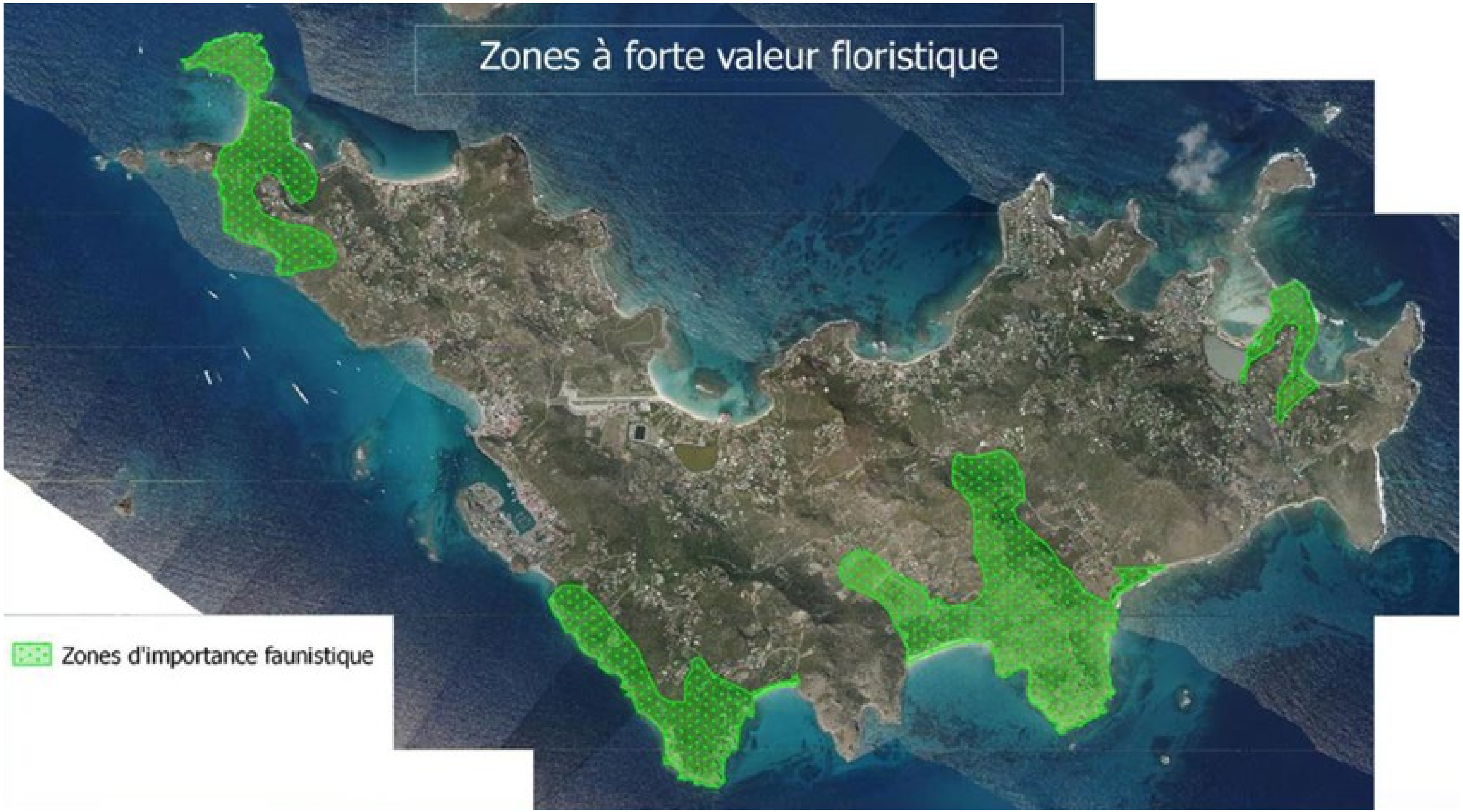

Figure 14. Zones with high flora importance (source: ATE)

SEA TURTLES

Very few studies have looked at the marine turtles of St-Barthélemy. The island was a region of Guadeloupe until recently (2007) and the vast majority of studies did not include the remote commune of St-Barthélemy but rather focused on the main island of Guadeloupe.

Historically, turtle meat was exported to St-Barthélemy from St-Kitts and Nevis (Brautigam and Eckert, 2006). Eckert and Honebrink (1992) note that 636 kg (1400 Lbs) of turtle meat had been exported in one single shipment in October 1991 to a buyer in St-Barthélemy. Today, the protected status of the turtles seems to have helped the local turtles populations to replenish; however, the absence of historical data, in particular on nesting numbers, precludes a definitive assessment of population trends. The ATE has recently started a monitoring program in collaboration with the PRMTG (The Marine Turtle Network of Guadeloupe).

Five species of marine turtles have been observed at St-Barthélemy:

1. ***Green turtles*** *(Chelonia mydas),*
2. ***Hawksbill*** *(Eretmochelys imbricata),*
3. ***Loggerhead*** *(Caretta caretta),*
4. ***Leatherback*** *(Dermochelys coriacea), and*
5. ***Olive Ridley*** *(Lepidochelys olivacea).*

Green turtles and hawksbills are the most commonly observed sea turtles in St-Barthélemy's waters, primarily in the seagrass beds around the island and other coastal habitats (Maylan, 1983; Brosnan et al., 2009). Loggerheads and leatherbacks are not as common and are typically only seen in the open sea (Maylan, 1983). Leatherbacks, hawksbills, and green turtles nest on the island, whereas olive ridleys and loggerheads visit feeding grounds around the islands (A. Chabrolle, pers. comm.). Pelican Bay and St-Jean Bay have been identified as a feeding grounds for green turtles (Brosnan et al., 2009).

From 2004 and 2012, SCUBA divers taking part in citizen science programs under the coordination of the PRMTG, recorded turtles observed feeding on St-Barthélemy grounds. From 2004 to 2010, the number of turtles observed feeding increased significantly (from a single observation in 2004 to 13 in 2012); however, it is unclear if this is due to an increased number of nesting turtles or an increased observation and reporting effort (PRMTG, pers. comm). The number of turtles observed from 2011 to 2014 remained stable (8 individuals/year) after a drop from the previous year's observation of 20 individuals in 2010.

Figure 15. Location of nesting turtles on Saint Barthélmy. Orange: ***Hawksbill*** (*Eretmochelys imbricate)* Green: ***Green turtles*** (*Chelonia mydas)* Blue: ***Leatherback*** (*Dermochelys coriacea*) Black: unidentified Numbers indicate the total number of observations (1982 - 2016) (source: ATE)

SEA BIRDS

A total of 111 species of birds have been recorded on St-Barthélemy (Questel & Le Quellec, 2011), 15 of which are known to nest in the islands (de Bettencourt & Imminga-Berends, 2015). This includes four species endemic to the Lesser Antilles:

1. ***Antillean crested hummingbird*** (*Orthorhyncus cristatus*),
2. ***Green-throated carib*** (*Eulampis holosericeus*),
3. ***Caribbean Elaenia*** (*Elaenia martinica*), and
4. ***Lesser Antillean bullfinch*** (*Loxigilla noctis*) (Levesque et. al, 2009).

The NGO BirdLife International has identified three Important Bird Areas (IBAs) covering a total of 1,055 ha, including marine areas and about 0.4% of the country's land area (Figure 16) (Birdlife International, 2016). The IBAs have been identified based on the presence of four key bird species:

1. ***Brown booby** (Sula leucogaster),*
2. ***Laughing gull** (Leucophaeus atricilla),*
3. ***Royal tern** (Thalasseus maximus), and*
4. ***Common tern** (Sterna hirundo).*

The three IBAs are all located on St-Barthélemy's satellite islands. Even though the mainland supports three species of Lesser Antilles endemic species, all three are well represented within their biogeographic area.

Figure 16. Location of Important Bird Habitats on Saint Barthélemy (Source: BirdLife International, 2016)

The IBA is regionally significant for its brown booby colony, with more than 60 pairs found nesting in 2002. A survey in 2007 confirmed the species' continued presence with at least 80 adults and some young birds counted on the satellite islands (Leblond, 2012).

Only one species of bird, the red-billed tropicbird (*Phaethon aethereus*), has been monitored on a yearly basis. The yearly monitoring started in 2014, five indicators were surveyed (Leblond, 2012):

1. The number of nests,
2. The distribution of nests,
3. The recruitment,
4. The ratio size/weight of the young of the year, and
5. The vulnerability index.

SEA MAMMALS

Twenty-one species of cetaceans have been observed in the waters of the Lesser Antilles (Dars, 2011):

- 4 species of **Balaenopteridae**: the sei whale (*Balaenoptera borealis*), the bryde's whale (*B. edeni)*, the minke whale (*B. acutorostrata*), and the humpback whale (*Megaptera novaeangliae*),
- 2 species of **Kogiidae**: the dwarf sperm whale (*Kogia sima*) and the pygmy sperm whale (*K. breviceps*),
- 1 species of **Physeteridae**: the sperm whale (*Physeter macrocephalus*),
- 13 species of **Delphinidae**: the melon-headed whale (*Peponocephala electra*), the false killer whale (*Pseudorca crassidens*), the killer whale (*Orcinus orca*), the pilot whale (*Globicephala macrorhynchus*), the rough-toothed porpoise (*Steno bredanensis*), the Fraser's dolphin (*Lagenodelphis hosei*), the bottlenose dolphin (*Tursiops truncatus*), the Atlantic spotted dolphin (*Stenella frontalis*), the pan-tropical spotted dolphin (*Stenella attenuata*), the striped dolphin (*Stenella coeruleoalba*), the spinner dolphin (*Stenella longirostris*), the Clymene dolphin (*Stenella clymene*), and the Risso's dolphin (*Grampus griseus*),
- 1 species of **Ziphiidae**: the Cuvier's beaked whale (*Ziphius cavirostris*).

The habitats most associated with high densities of cetaceans are located to the east of the Caribbean Arc, where the slopes are the steepest (Figure 17) (Van Canneyt et al., 2009; Dars, 2011). Common cetacean habitats have also been identified to the east of St-Barthélemy. However, no abundance estimates have been made for the cetaceans visiting the waters nearby and the status of many species is still unknown (Dars, 2011).

The most encountered species seems to be the humpback whale, observed occasionally by local tour operators (diving, jet ski, or day cruise). Other species of Delphinidae are also observed but less frequently at up to 10 times per year (Figure 18) (Cuzange, 2011; Questel, pers. obs.).

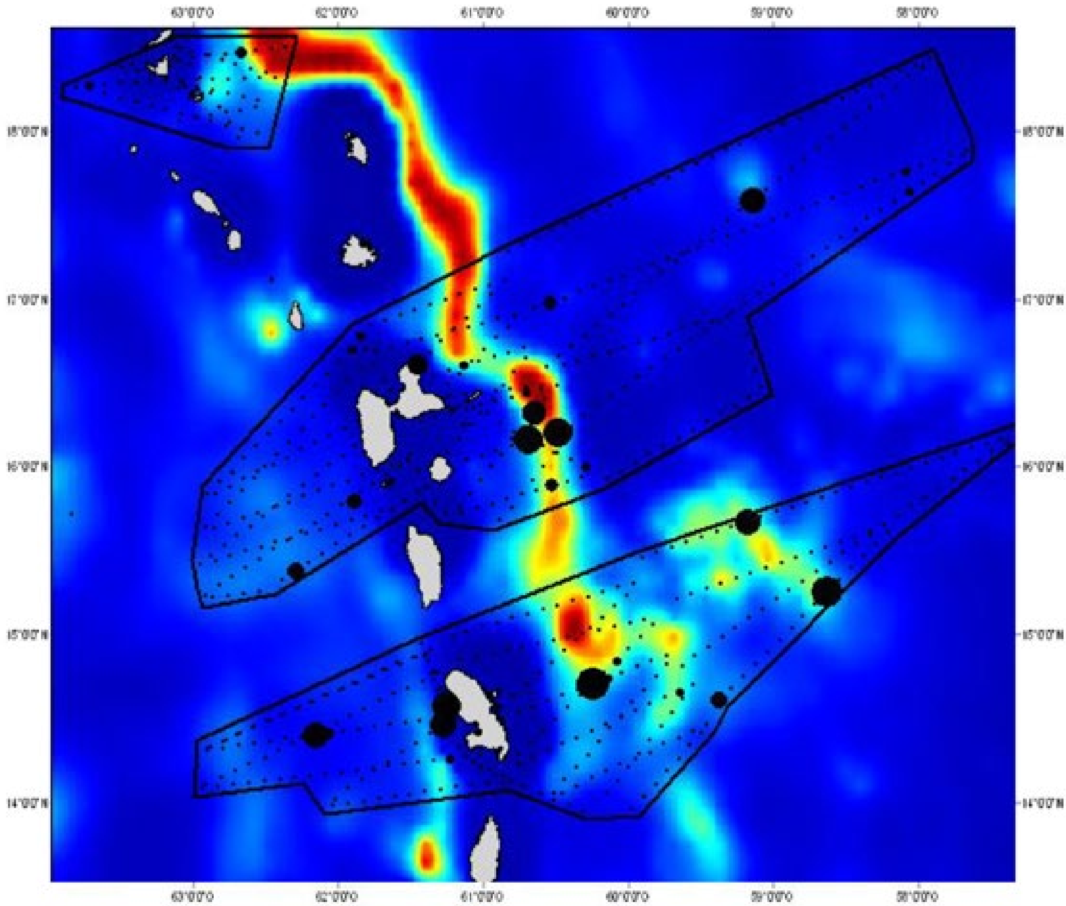

Figure 17. Predictions of cetaceans densities in the West Indies (from spatial models). Color scale: Blue is low density, red is very high densities.
(Source: Van Canneyt et al., 2009.)

The waters of St-Barthélemy are located on cetaceans' migratory path and this area has become key for the global protection of these mammals. Hunting of whales is no longer practiced in French waters but other threats have emerged such as underwater noise pollution, pollution of the marine environment, and habitat degradation (Cuzange, 2011; Dars, 2011).

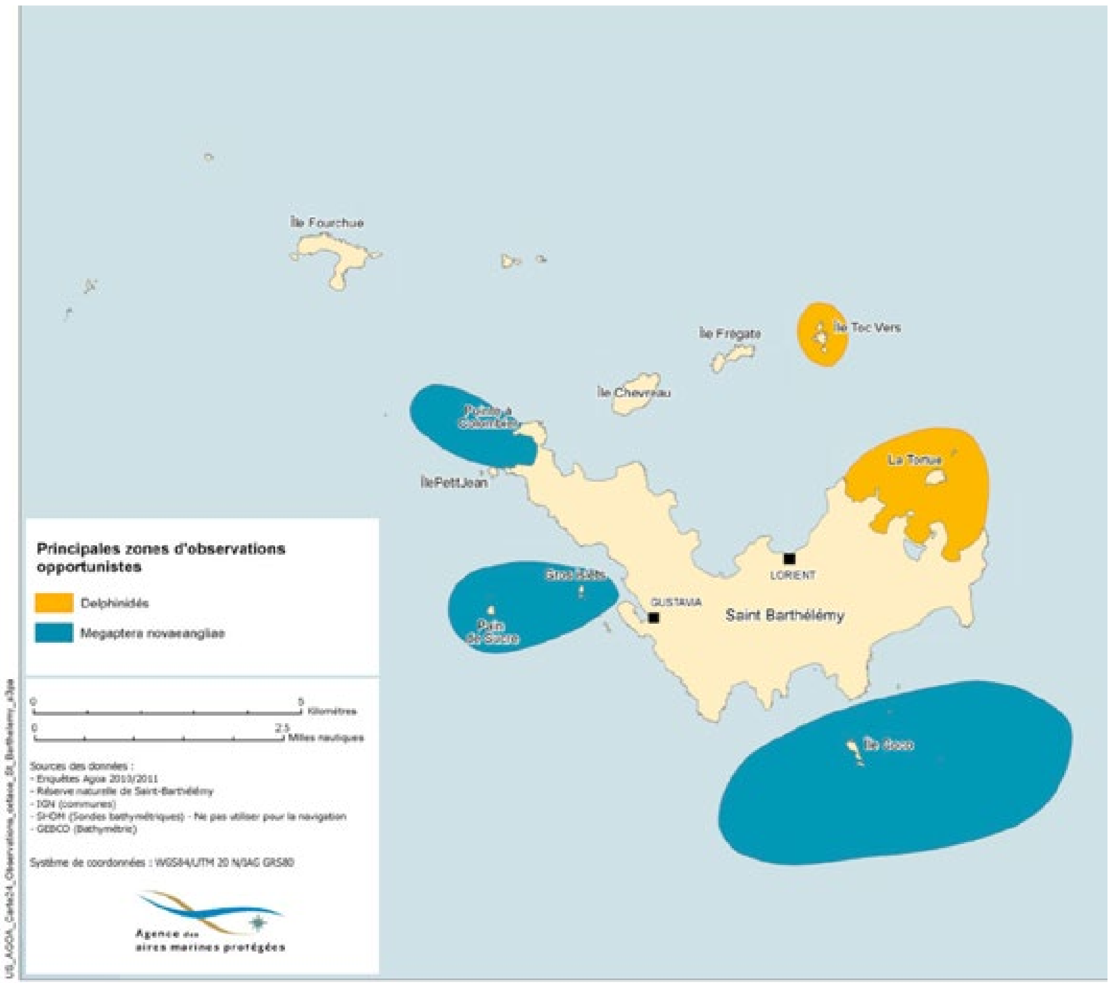

Figure 18. Main opportunistic observation areas for cetaceans around Saint Barthélemy (Source: Cuzange, 2011)

REPTILES

Twenty-two species of reptiles are reported on St-Barthélemy (Breuil et al. 2009a, 2009b, Questel, 2012; RNSM and SPAW-RAC 2016):

- Seven species of **turtles**: including 5 marine turtles (see section: Sea Turtles), the red-footed tortoise (*Chelonoidis carbonaria*), and the red-eared slider (*Trachemys scripta elegans*),
- Two species of **geckos**: the house gecko (*Hemidactylus mabouia*) and the turnip-tailed gecko (*Thecadactylus rapicauda*),
- Two species of **sphaero**: the Anguilla bank sphaero, (*Sphaerodactylus parvus*), endemic to the Anguilla Bank and the leeward banded sphaero (*S. sputator*), endemic to the Anguilla Bank and St Eustache Bank,
- Two species of **iguanas**: the Lesser Antillean iguana (*I. delicatissima*), an endemic and endangered species and the common iguana (*I. iguana*) an invasive species (see section: Threats and Issues, Invasive Species Iguanas) (Figure 19),
- Four species of **anole**: the Anguilla bank anole (*Ctenonotus gingivinus*), endemic to the Anguilla bank, and three exotics, the Cuban giant anole (*Deiroptyx equestris*), the Cuban brown anole (*Norops sagrei*), and the Carolina anole (*Anolis carolinensis*),
- One species of **ameiva** - the Anguilla bank ameiva (*Pholidoscelis plei*), endemic to the Anguilla bank,
- One species of **skink** - the Anguilla bank skink (*Spondylurus powelli*), endemic to the Anguilla bank,
- One species of **lizard** the smooth-scaled worm lizard (*Gymnophthalmus underwoodi*), and
- Four species of **snakes** - the Anguilla bank racer (*Alsophis rijgersmaei*), endemic to the Anguilla bank and endangered, the corn snake (*Pantherophis guttatus*), the flowerpot blind snake (*Ramphotyphlops braminus*), and the St-Barthélemy blind snake (*Antillotyphlops annae*) which is strictly endemic to St-Barthélemy.

Among all the reptiles, only iguana populations have been surveyed on the island. The Lesser Antilles iguana (*I. delicatissima*) has a very small distribution and its entire population is estimated at 26,000 individuals over six islands: Anguilla, St-Barthélemy, St Eustatius, Guadeloupe, Dominica, and Martinique (Knapp et al., 2000). The current status of populations in St-Barthélemy is unclear. The Lesser Antilles iguana has been found in a few

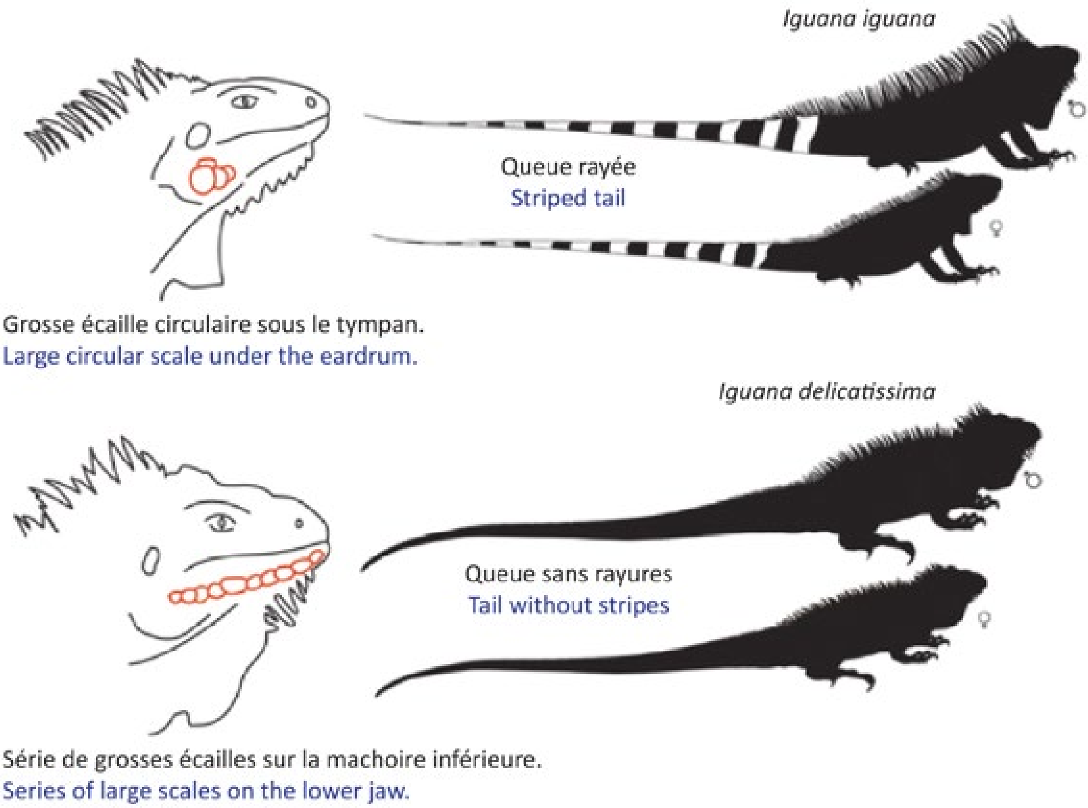

Figure 19. Two species of iguanas present on Saint Barthélemy: The Lesser Antillean iguana (*I. delicatissima*), an endemic and endangered species and the common iguana (*I. iguana*) and invasive species (ATE, 2011)

Figure 20. Installation of *Iguana delicatissima* nesting sites on Saint Barthélemy. Photo: ATE

locations on island with some areas having high densities (i.e., on the hills of Saint Jean, Anse des Cayes, Corossol, Fourchue Islet and Petite Islette; Breuil, 2000). However, the common iguana (*I. iguana*), an invasive species and direct competitor, has also been observed in St-Barthélemy since 2004 (Caraïbes Aqua Conseil, 2010). The common iguana is in direct competition with the Lesser Antillean iguana. Displacement and hybridization have been identified as main factors for the disappearance of the Lesser Antilles iguana (Knapp et al., 2000; Breuil, 2002; Breuil & Vuillaume 2012). Today a new threat, the actinobacterium *Devriesea agamarum*, is also impacting the population (see Box 3).

The iguana populations are monitored by agents of the ATE and since 2007, several monitoring sessions per year are performed at different locations on island. In 2011, the ATE reintroduced 28 specimens on 2 satellite islands (Fourche and Frégate) in an attempt to re-establish the population (Le Quellec, 2011). Additionally, in 2016, in an effort to help restore the population, the ATE built two nesting areas in an enclosed area since their natural nesting habitats are disappearing (Figure 20).

Box 3 – **A new threat for the endemic the Lesser Antilles Iguana**

“The influence of human presence and activity on gut-associated coliforms in *Iguana delicatissima* populations is recently garnering attention (G. Gentile unpublished data) because antimicrobial resistance patterns in gut-associated enterobacteria have been documented in iguanas (Thaller et al. 2010; Wheeler et al. 2012). Human/domestic livestock-iguana overlap is prevalent throughout the Lesser Antilles and may expose iguanas to antibiotic resistant microbial communities.

Attention to the impact of potential pathogens and associated antibiotic resistance is also particularly important in the light of a new possible threat represented by the actinobacterium *Devriesea agamarum* (Ballmann et al., 2014). This bacterium causes chronic proliferative dermatitis, with lesions occurring in several areas of the body, including around the oral cavity, the pericloacal region, and the legs. Septicemia is a frequent complication, resulting in the death of the affected animal. Since April 2011, several individuals of *I. delicatissima* on the island of St-Barthélemy have been found with large hard nodules and abscesses on the body. According to a case report of the Management of the Natural Reserve of St-Barthélemy, approximately 10% of the male population is af-fected.” From Knapp et al., 2000.

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BATS

Only a couple of studies have looked at the bat populations on St-Barthélemy (Allen, 1911 in Larsen et al. 2006; Larsen et al., 2006). To date, six species of bats have been reported:

1. ***Insular single leaf bat*** (*Monophyllus plethodon luciae*),
2. ***Antillean fruit-eating bat*** (*Brachyphylla cavernarum cavernarum*), endemic to the lesser Antilles (Figure 21),
3. ***Brazilian free-tailed bat*** (*Tadarida brasiliensis antillarum*),
4. ***Pallas's Mastiff bat*** (*Molossus molossus molossus*),
5. ***Jamaican fruit-eating bat*** (*Artibeus jamaicensis jamaicensis*), and
6. ***Greater bulldog bat*** (*Noctilio leporinus*) (Larsen et al. 2006; Questel, pers. obs. 2011 & 2013).

The low populations observed on the island is a concerning issue. This could be explained on one hand by the very dry climate of the island, as well as by the series of hurricanes that hit the island over the past ten years. On the other hand, the specific architecture of the homes and commercial buildings on the island offer little access and few roost sites for insectivorous bats (such as Pallas's mastiff bats) which typically roost under corrugated metal roofs and loose roofing tiles (Larsen et al., 2006).

St-Barthélemy has several **caves** that can be used as roosts by all but one species of bats presents on island (*M. molossus* being the exception) (Figure 22). These caves play a key role in maintaining a healthy bat population (Larsen et al., 2006). Today, the caves have been recognized as a habitat with high ecological and patrimonial interest but are not protected.

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Figure 21. The Antillean fruit-eating bat (*Brachyphylla cavernarum*)

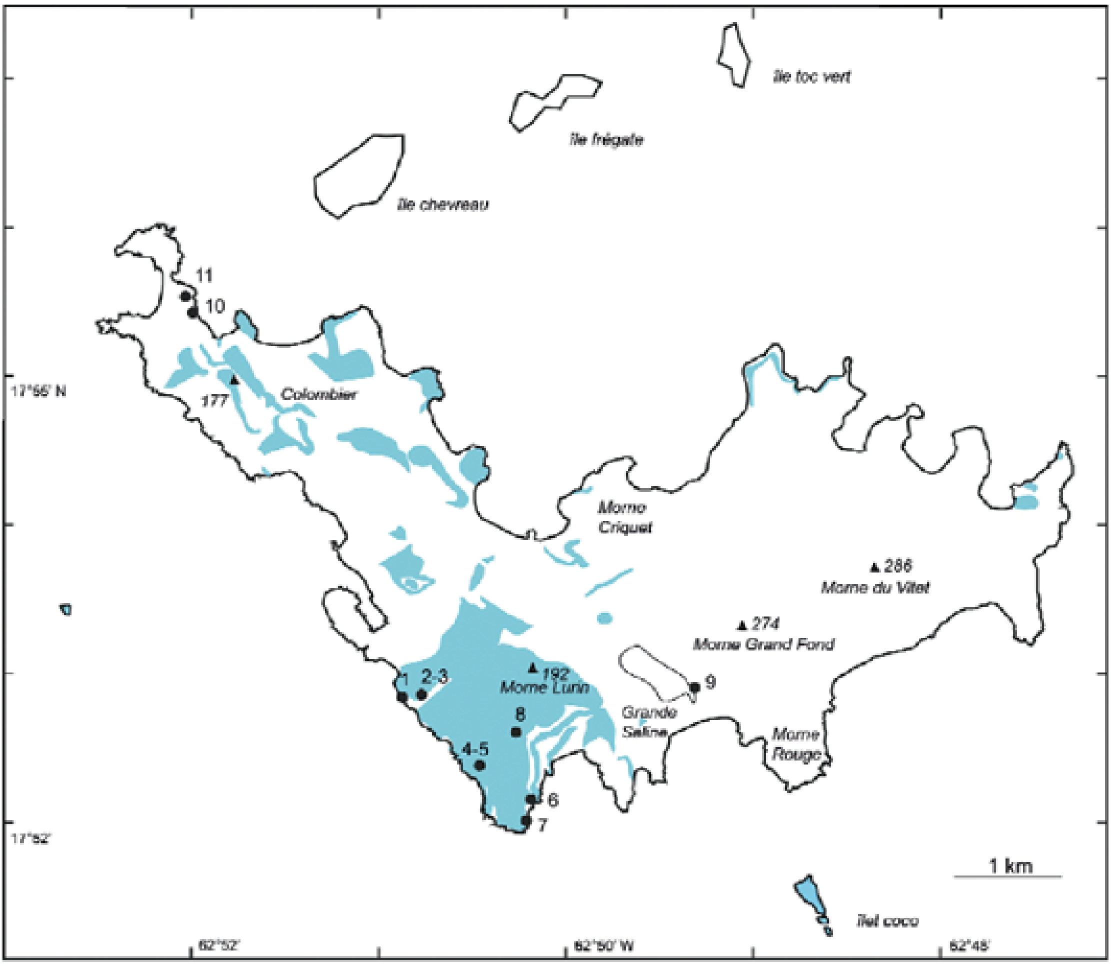

Figure 22. Map of Saint Barthélemy with representation limestone outcrops (blue areas) and main caves locations: 1 - Shell beach cave, 2 - Cave of the cursed fig tree, 3 - Cave of Morne Lurin, 4 - Bats cave, 5 - Cave Paille-en-queue, 6 - Montbars cave, 7 - Cave chaloupe, 8 - Mango tree cave, 9 - Tafoni of Grande Saline, 10 - Petite Anse shelter #1, and 11 - Petite Anse Anse shelter #2 (Source: Lenoble et al. 2012)


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OTHER

Amphibian

There are three species of amphibians on St-Barthélemy, all of which were introduced:

1. The ***Cuban treefrog*** (*Osteopilus septentrionalis*),
2. The ***Lesser Antillean whistling frog*** (*Eleuther-odactylus johnstonei*), endemic to the Lesser Antilles, and
3. The ***Tink frog***, (*Eleutherodactylus martini-censis*).

The strictly endemic St-Bart whistling frog (*Eleutherodactylus sp.*) is now extinct (Kaiser, 1992; Breuil et al., 2009a, 2009b).

Arachnids

The species richness, for the size of territory, is relatively high with 70 species including three species strictly endemic to St-Barthélemy:

1. The ***scorpion*** (*Oiclus questeli*),
2. The ***tailless whip scorpion*** (*Charinus bruneti*), and
3. The ***camel spider*** (*Ammotrechella beatriceae*) (Questel, 2013; Marechal & Linuma, 2013, 2015; RNSM & SPAW-RAC, 2016).

Formicidae

Twenty six species of ants have been inventoried from 2011 to 2013 (Celini, 2013), including six invasive species and two potentially dangerous species for the biodiversity of the island and the inhabitants: *Azteca delpini antillana Forel* and *Solenopsis invicta* (Celini, 2013). Ant identification can be challenging and the inventory work was completed through DNA sequencing of 20 species of ants (Mabroux, 2016). All the data collected were shared with the BOLD (Barcode of Life Data Systems), a public data portal and searchable database of Barcode Index Numbers (BINs).

STAKEHOLDERS

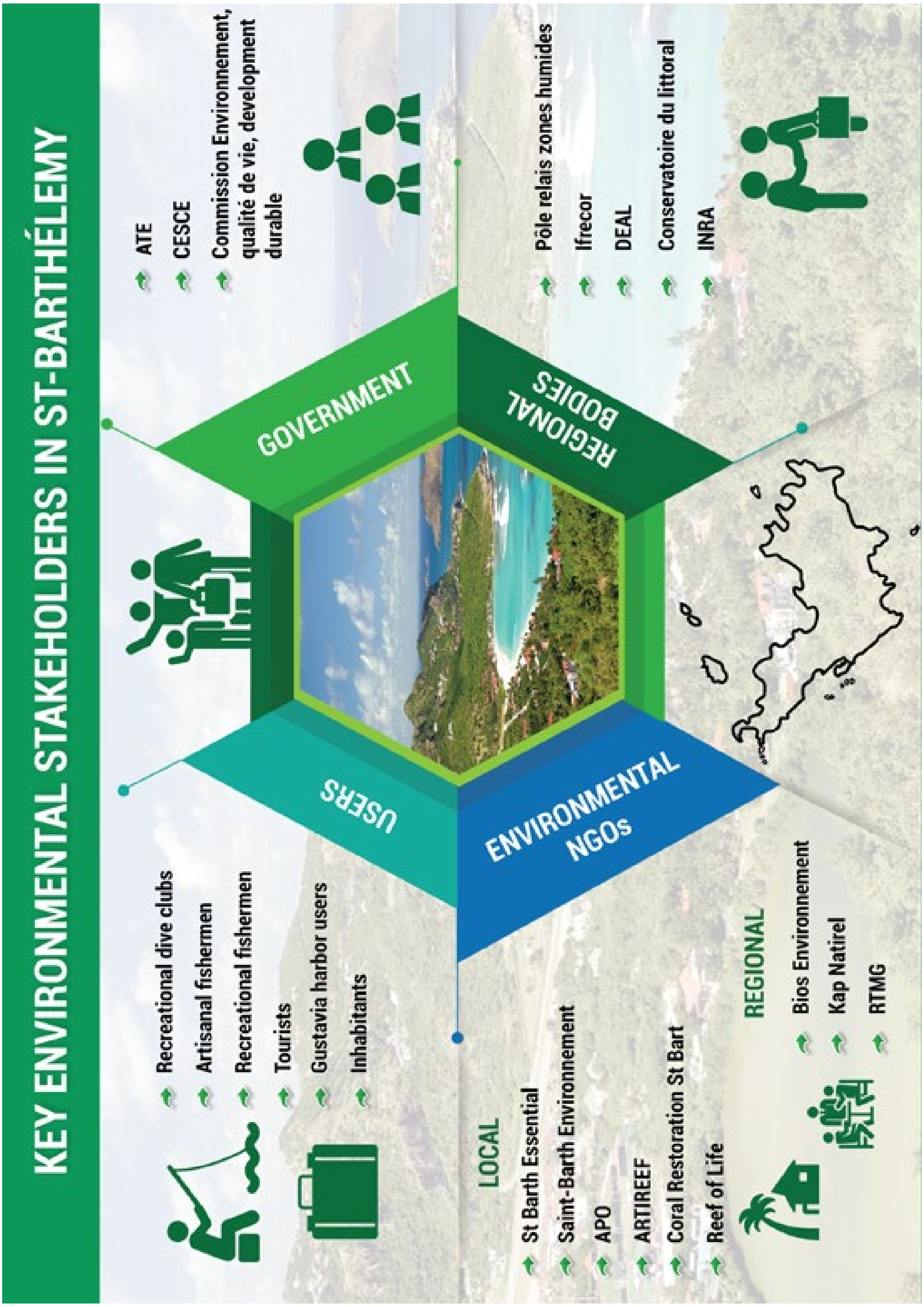

Figure 23. Main environmental stakeholders of Saint Barthélemy. ATE - *Agence Territorial pour l'Environnement*, CESCE - *Conseil Économique Sociale, Culturel et Environnemental*, DEAL - *Direction de l'environnement, de l'aménagement et du logement*, INRA: *Institut National de la Recherche Agronomique*, RTMG - *Restauration des Tortues Marines de Guadeloupe*, APO - *Association pour la Protection des Oiseaux*.

The environmental stakeholders of St-Barthélemy can be grouped into four categories: The government, the regional bodies, the local and regional non-governmental organizations, and the user groups (Figure 23).

Government

Territorial Environmental Agency (ATE)

Since May 2013, the Collectivity has entrusted the Territorial Environment Agency (*l'Agence Territoriale de l'Environnement* - ATE) for the environmental protection and sustainable development of the island (Box 4). The ATE is composed of an Administrative Council (12 members), a Scientific Council (18 members), and an administrative office (6 members).

BOX 4 | **The 4 key missions that guide the ATE activities**:

1. **Marine** - Management and protection of the marine resources, including legislation and enforcement
2. **Terrestrial** - Ecological monitoring of the islands' habitats and species, including invasive and pest species
3. **Energy** - Promotion and development of renewable energy
4. **Outreach** - Environmental communication and education.

The ATE is involved in research programs on endangered species and ecosystems, such as the monitoring of the iguana *I. delicatissima* on St-Barthélemy and its satellite islands and the monitoring of nesting marine turtles in association with other local or regional NGOs. Since October 2016, the six agents of the ATE are able to sanction offenses to the environmental code. The ATE also organizes events on the island to help increase public awareness surrounding environmental issues.

Economic, Social, Cultural and Environmental Council (CESCE)

The Economic, Social, Cultural and Environmental Council (*Le Conseil Économique, Social, et Environnemental* - CESCE) has an advisory capacity for economic, social, cultural, and environmental issues. The council consists of representatives of professional groups, trade unions, organizations, and associations that contribute to the economic, social, and cultural life of St-Barthélemy. In addition, the CESCE includes representatives of NGOs active in the field of environmental protection and qualified individuals chosen for their demonstrated environmental responsibility and sustainable development practices. Each business category is represented with a number of representatives directly proportional to the perceived importance of their activity in the economic, social, and cultural life the island. It does not play a role in the adoption of statutes and regulations, but advises the lawmaking bodies on questions of social and economic policies. The CESCE publishes reports which are sent to the President of the Collectivity and are published and shared online (**http://www.cesc-stbarth.org/**).

Commission for the Environment, Quality of Life and Sustainable Development

The Commission for the Environment, Quality of Life and Sustainable Development (*la Commission Environnement, Qualité de Vie, Développement Durable*) is formed of 6 elected members and has the mission to make recommendations and provide advice to the Territorial or Executive Councils on questions related to the environment, quality of life, and sustainable development of the island. The commission meets at the request of its Chairman.

STAKEHOLDERS

Regional Bodies

Pole Relais – Wetlands Overseas Territories

The *Pole Relais* is a consortium of organizations recognized by the French Government for their specific expertise in wetland conservation. Their mission is two-fold:

1. Establish a network between the actors involved in the conservation and management of wetlands (managers, politicians, teachers, scientists, and users), and
2. Share knowledge, best practices, and know-how to act more effectively for the preservation of these environments. The *Pole Relais* publishes reports that are available online (**http://www.pole-zh-outremer.org**).

French Initiative for Coral Reefs (IFRECOR)

Founded in 1999, the French Initiative for Coral Reefs (*l'Initiative Française pour les Récifs Coralliens* - IFRECOR) has for main objective to promote the protection and sustainable management of coral reefs and associated ecosystems in France's overseas territories. Local committees are designated for each of the French Overseas Territories; however, a local committee has not yet been established for St-Barthélemy. IFRECOR works in the region through the Guadeloupe Local Committee.

Regional Environment Directorate (DEAL)

The Regional Environment Directorate (*la Direction de l'Environnement, de l'Aménagement et du Logement* - DEAL) is no longer the competent authority for the environment since St-Barthélemy became an Overseas Country and Territory (OCT), however, an agreement has been signed between the DEAL and the ATE for control of ICPE[5] facilities. National legislation remains in force until the new legal texts proposed by the Collectivity to the State are ratified.

Coastal Protection Agency (Conservatoire du littoral)

The Coastal Protection Agency (*le Conservatoire du Littoral*) is a public administrative institution of the French State under the authority of the French Ministry in charge of the protection of nature. It was created for the protection of outstanding natural areas on the coasts and has a policy of land acquisition. The Coastal Protection Agency purchases land by private agreement, pre-emption, or from time to time, expropriation. Land may also be given to the Coastal Protection Agency by donation or legacy. After ensuring all the restoration work, the Agency entrusts the management of its lands to local authorities or other local organizations. Today, the ATE manages Fort Karl, located on the heights of Gustavia, acquired by the Coastal Protection Agency in 2007.

French National Institute for Agricultural Research (INRA)

The French National Institute for Agricultural Research (*l'Institut National de la Recherche Agronomique* - INRA) carries out mission-oriented research on agriculture, food, and the environment and is involved on an ongoing basis with education, training, and the sustainable development of agriculture in the Antilles. INRA does not have a branch on St-Barthélemy, but experts from Guadeloupe are sometimes consulted for specific questions.

[5] Installations Classées pour la Protection de l'Environnement (ICPE) refers to facilities that have been classified for environmental protection such as depots, yards, workshops, and other facilities that are operated or owned by a public or private individual or corporate entity, and which generate hazards or inconvenience for a neighborhood relating to health, safety, agriculture, or the protection of nature and the environment (Ministry of Ecology, Sustainable Development and Energy, 2015).

Local Environmental NGOs

St Barth Essentiel

St Barth Essentiel was created in 2009 with the goal to "protect the historical, cultural, and environmental heritage of St-Barthélemy and preserve its living environment." St Barth Essentiel has generated, with the support of local, regional, and national experts, various scientific studies ranging from flora inventorying to DNA barcoding of ants. The association also organizes numerous awareness campaigns, including beach cleanups and thematic conferences about the environment.

Saint Barth Environnement

Created in 2004, *Saint Barth Environnement* works to protect the island environment (natural and architectural) and promotes the adoption of environmentally responsible behaviors through awareness campaigns.

Association for Bird Protection (APO)

The Association for Bird Protection (*l'Association pour la Protection des Oiseaux* - APO) is a group of about 15 members, including one ornithologist, and aims to protect the birds of St-Barthélemy and the ecosystems on which they depend. The association works in collaboration of BIOS and the ATE to organize bird surveys.

Coral Restoration St Barth

Coral Restoration St Barth works to restore the coral reefs around the island and has created six rebar nursery tables to propagate the endangered *Acropora cerviconis* at three locations around the island. No monitoring data are yet available. The corals will be outplanted in 2017 on the degraded reefs inside the MPA. Moreover, Coral Restoration St Barth also organizes lionfish hunts on a bi-monthly basis, in addition to coral awareness campaigns directed towards schools around the island. The organization is also the instigator of a sustainable fisheries program encouraging fishermen to drop off their old fishing traps to the incineration plant, which has committed to collect and incinerate them for free.

ARTIREEF

ARTIREEF is a project dedicated to restoring the reef at Pointe Milou. Their approach uses structures on which a low voltage electric current passes to stimulate mineral accretion which, in turn, stimulates coral settlement growth (BIOROCK™). To date, five large rebar structures filled with empty conch shells have been deployed in the Bay of Pointe Milou. By the end of 2017, a total of 32 structures will be deployed, connected to the current structure, and propagated with corals.

Reef of Life

The endowment fund "Reef of Life" started a reef restoration project in 2015 in St-Jean Bay using the BIOROCK technology. Two grids of $20m^2$ (200 sq ft) were installed on the reef in a location where all corals previously died. *A. palamata*, *A. prolifera*, and *Porites sp*. (main endogenous corals) were propagated by cutting. After a white plague[6] event in 2015, 75% of the corals have recovered and an average of 13 cm (5 in) of linear growth has been recorded after just one year on the structure.

[6] White plague is a coral disease caused by a virus. It develops often in corals that have recently bleached, a process in which some stressor, typically heat, causes coral to expel the symbiotic algae that provides the coral with food.

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Lionfish hunt organized by Coral Restoration St-Barth

STAKEHOLDERS

Regional Environmental NGOs

BIOS

BIOS is an organization based in Guadeloupe and it has focused on conducting several surveys of nesting birds in St-Barthélemy and its satellites islands. Their work has led to the identification of four Important Bird Areas (IBA) recognized by BirdLife. The association also works with the ATE for bird banding projects.

Kap Natriel

The Shark Network of French Antilles works to increase knowledge of the sharks and rays found in the region and promote public awareness about these species. The association recently started a program on St-Barthélemy to record shark observations made by SCUBA divers. In addition, observations from shore and sharks caught by fishermen are also recorded. In November 2016, a new program started to record elasmobranchs species diversity, abundance, and repartition in waters of St-Barthélemy using baited underwater video cameras deployed at strategic locations.

Marine Turtles Network of Guadeloupe (RTMG)

The Marine Turtles Network of Guadeloupe (*le Réseau Tortue Marine de Guadeloupe* - RTMG) coordinates a program for the preservation of marine turtles and their habitats in the Guadeloupe archipelago and northern islands including St-Barthélemy. Volunteers monitor nesting turtle activities on the beaches and record turtles seen at dive sites. As a local relay, ATE officers carry out educational awareness programs and provide technical expertise for the preservation of the turtle nesting beaches.


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ENVIRONMENTAL GOVERNANCE

Between 1947 and 2007, St-Barthélemy was attached administratively to Guadeloupe as a county of this French department. In 2007, St-Barthélemy became an Overseas Collectivity (COM) and on January 1, 2012, St-Barthélemy changed its status once again to an Overseas Countries and Territories (OCT)[7]. As an OCT, St-Barthélemy is the competent authority for the environment, as well as for energy, tourism, and town planning.[8] The French State remains the competent authority for criminal proceedings and law, commercial law, and monetary banking, and financial law (de Bettencourt & Imminga-Berends, 2015).

The environmental code of St-Barthélemy was adopted in June 2009 and is easily accessible online (**http://www.comstbarth.fr/iso_album/cde_au_13-05-2016.pdf**). It revokes and replaces the French National Code of the Environment and covers all sectors of its development.The island uses separate sorting, recycling, and incineration for energy production, which is then used in the desalination plant to produce drinking water. In addition, a new treatment and sanitation network for waste water was recently put into service for the area of Gustavia. The majority of the hotels have wastewater treatment plants. The Overseas Collectivity regularly invests in upgrading and expanding the stormwater collection network. In 2012, the Collectivity allocated €8.1 million to renovate the water and sanitation sectors (de Bettencourt & Imminga-Berends, 2015). A Plan for the Prevention of Natural Hazards (PPRN) was initiated in the Collectivity of St-Barthélemy but has not been approved yet. The Collectivity is continuing to work towards the final adoption of zoning and town planning regulations to protect natural habitats. After consulting with St-Barthélemy's fishermen, the Collectivity updated its Fishing Regulations in 2015 (see Fishing Regulations).

Marine Protected Areas

In 1996, the St-Barthélemy National Nature Reserve was founded (decree nº 96-885 from October 10, 1996) to protect marine areas around the island. The marine reserve covers a total of 1,200 ha (~3000 acres) and is composed of five zones located in the north and north west of the main island (see Figure 4). Two areas are adjacent to the main island and three areas surround islets. The Nature Reserve includes the Maritime Public Domain (from the high seas to 300 m offshore) and part of Territorial Waters. The Marine Reserve includes two zones with enhanced protection in which it is prohibited to fish, anchor, and scuba dive.

French Designations

Natural Zones of Interest for the Ecology, Fauna and Flora - ZNIEFF

Thirty-seven ha (116 acres) of land has been designated as Zones of Interest for the Ecology, Fauna, and Flora (*Zone naturelle d'intérêt écologique, faunistique et floristique* - ZNIEFF). These zones encompass the five ponds and the unique xerophytic vegetation at Pointe à Toiny, however, these designations have no legal status.

Agoa Sanctuary

Agoa Sanctuary was established in 2010 on the EEZ (Exclusive Economic Zone) of the French Antilles (143,256 km² / 143,256 sq mi) to protect marine mammals. The ATE represents the Collectivity of St-Barthélemy in the Agoa Sanctuary.

[7]In addition to a derogation from European standards, OCT status allows the Collectivity to benefit from having customs jurisdiction.

[8]Furthermore, it handles among others things: road traffic, public services, and institutions of the Collectivity, taxation, land registry, state law and property of the Collectivity, and foreigners' access to employment, construction, accommodation, etc.


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Fort Karl

Fort Karl site (1.3 ha / 3.2 acres) is protected following the land acquisition of the French Coastal Protection Agency (*Conservatoire du Littoral*). The management of this site was entrusted to the ATE.

Prefectoral Order of Biotope Protection

Biotope Protection Orders cover 5.5 ha (13.6 acres) around St-Jean and 16 ha (34.5 acres) of Grand and Petit Cul-de-Sac. Today, it is not clear if these biotope protections are still in force since St-Barthélemy's new OCT status.

International Conservation Treaties

The current environmental code does not include any international environmental conventions signed by France, however, some important environmental conventions ratified by France include:

- ***CITES*** (Washington 1973) - the Convention on International Trade in Endangered Species of Wild Fauna and Flora,
- ***Cartagena Convention*** (Cartagena, 1983) - for the protection and development of the marine environment in the wider Caribbean region, including the **Protocol SPAW** - Specially Protected Areas and Wildlife (1990), on marine and coastal biodiversity of the Caribbean,
- ***Law of the Sea Convention*** (Montego Bay, 1982) - on the rights and responsibilities of nations with respect to their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources,
- ***Ramsar Convention*** (Ramsar, 1971) - for the conservation and sustainable use of wetlands,
- ***Convention on Biological Diversity*** (Rio de Janeiro, 1992) - for the conservation of the biodiversity, the sustainable use of its components, and a fair and equitable sharing of benefits arising from genetic resources,
- ***United Nations Framework Convention on Climate Change*** (New York, 1992)
- ***Bonn Convention*** (Bonn, 1979) - for the Conservation of Migratory Species of Wild Animals, and
- ***Aarhus Convention*** (Denmark, 1998) - on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters.

Key Biodiversity Areas (KBAs)

In addition, a recent European initiative identified Key Biodiversity Areas (KBAs) on St-Barthélemy (RNSM and SPAW-RAC, 2016). KBAs constitute sites of global significance for biodiversity conservation. These sites are identified using global standard criteria and thresholds, based on the needs of biodiversity requiring safeguards at the site scale. These benchmarks used in systematic conservation planning are based on the framework of vulnerability and irreplaceability (Figure 24) (Langhammer et al., 2007).

Conservation Corridors

A corridor is a link between wildlife habitats, which joins two or more larger areas of similar habitats. Corridors are critical for the maintenance of ecological processes such as allowing for the movement of animals and the continuation of viable populations. Only one marine ecological corridor between KBAs has been identified in St-Barthélemy's waters (RNSM and SPAW-RAC, 2016). It has a total area of 69.8 km^2 (26.9 sq mi) and assures the connectivity between seagrass beds and coral reefs areas (Figure 25). These corridors have been extensively explored during island-wide mapping efforts (Chauvaud, 2001, 2013; Delord, 2004) but very few efforts studied the functionality of these ecosystems.

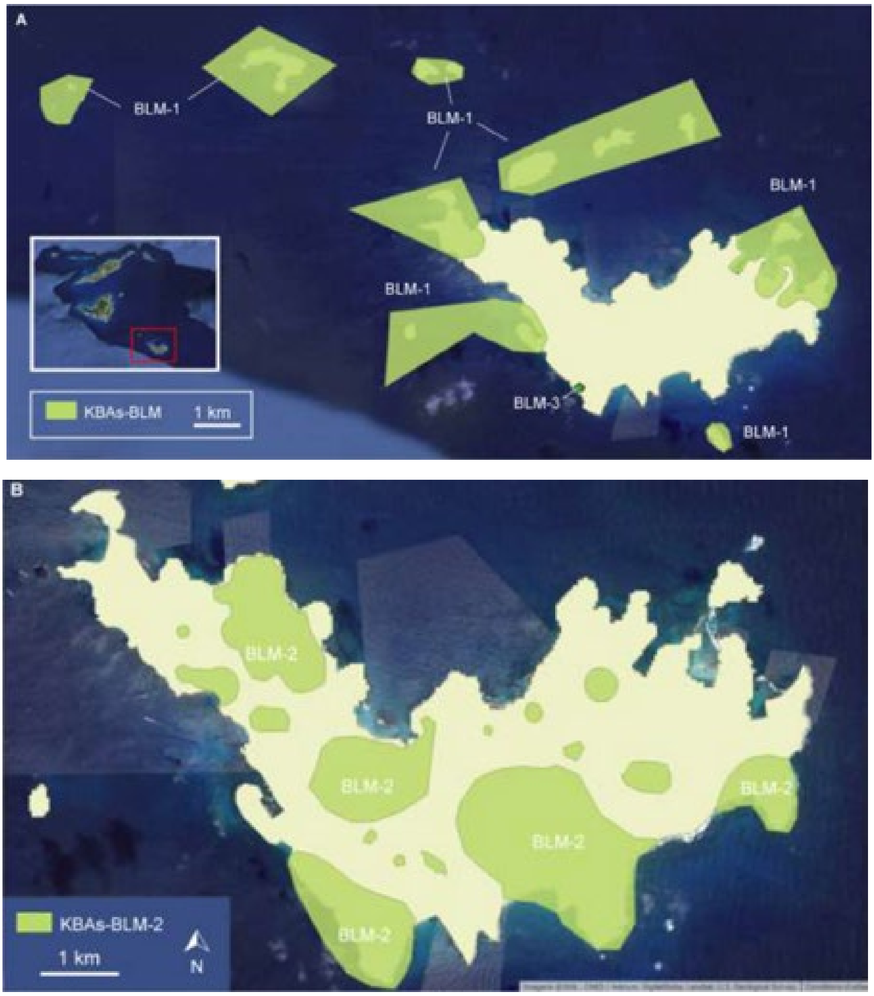

Figure 24. Map of Terrestrial Key Biodiversity Areas in Saint-Barthélemy (Source: RNSM and SPAW-RAC, 2016)

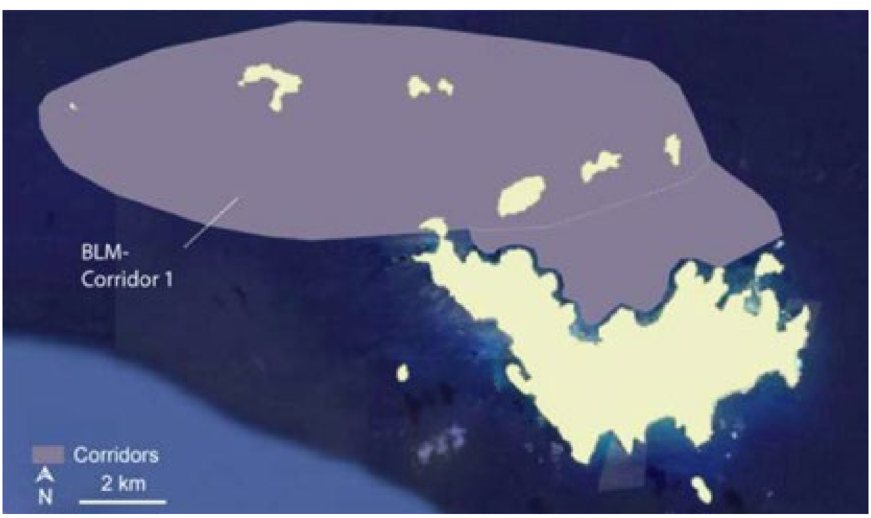

Figure 25. Marine corridor in Saint Barthélemy (Source: RNSM and SPAW-RAC, 2016)

THREATS AND ISSUES

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As a part of this report, various meetings and a stakeholder workshop were held in order to identify the main threats to the environment of the island and define priority actions to mitigate them. Attendees of the September 9, 2016 workshop are listed in Appendix E. The results are incorporated here and in the recommendations section. We have also included two issues that were not identified by the stakeholders but, based on the bibliography review and our knowledge of the Caribbean, are relevant for the island: climate change and coastal erosion.

Pollution

Workshop attendees listed pollution as one of the three main threats on the island (together with urbanization and invasive species). “Pollution” was then detailed as wastewater pollution, land runoff, plants pollution, ship pollution, atmospheric pollution, organic pollution, noise pollution, and light pollution. In St-Barthélemy, the single largest source of pollution for the marine environment is domestic sewage and the main non-point source of pollution is runoff from land.

Land Runoff Pollution

After heavy storm events, the water that can not be absorbed by the soil will move over the ground towards the coast. On its way, the water carries sediments in addition to natural and human-made pollutants that will be deposited in the bays around the island. With the very steep and irregular relief of the island, watersheds have very short response times, which generate substantial flows during heavy rains and can lead to a significant drop in salinity of the bays around the island. The release of sediment-, nutrient-, and pollutant-rich water into the bays stimulates growth of harmful fleshy algae and phytoplankton. This eutrophication phenomenon can disrupt the delicate balance of the coral reef and the seagrass bed ecosystems. The sediments contained in the runoff also reduce the amount of light reaching the shallow benthic ecosystems and can smother corals and seagrasses. In addition, runoff water can carry macro-wastes, a risk even more important when open dump sites are close to the ocean (Figure 26). Moreover, urbanization, land clearance, and intensive grazing by feral goats further increase runoff pollution, intensifying the eutrophication, sedimentation, and erosion problems.

Wastewater

The majority of sewerage systems on the island of St-Barthélemy are non-collective. Only Gustavia has a collective sewage system, where an updated sanitation station was built in 2012. Traditionally, houses are equipped with septic tanks or cesspools that can be sources of pollution when leaking, overflowing, or simply due to improper maintenance. In 2002, a studied showed that 71% of these installations were not compliant with French regulations (Safège Caraïbes, 2002). In addition, biosolids (or sludge) resulting from sewage treatment plants are pumped away and either spread on the hill tops of the island or brought to the collective sewage treatment plant. Today, several houses and hotels have private wastewater treatment installations discharging the treated wastewater into the sea. Workshop participants highlighted that many of these individual treatment plants were dysfunctional.

Phytosanitary Pollution

A very large number of containers are imported every year to St-Barthélemy containing ornamental plants for villas around the island. Live plant import is a known major pathway for insects and pathogens. Today no quarantine or phytosanitary regulations are in place to protect the island.

Figure 26. Open illegal dump site in Toiny, Saint Barthélemy (Source: St Barth Essentiel)

Ship Pollution

At the height of the tourism season, a large number of yachts and other ships gather in the harbor of Gustavia. Some of these boats release grey water and bilge water in the harbor and the bays around the island. These waters are charged with nutrients, pollutants, and oil that impact the environment. Collisions with turtles are also reported every year due to the non-compliance with the speed limits.

Atmospheric Pollution

Attendees to the workshop mentioned that the number of vehicles (especially SUVs) had greatly increased over the last years, impacting the air quality of the island. The only study conducted in 2007 to evaluate the air quality in St-Barthélemy concluded that the overall air quality of the island was good, however; high level of nitrogen monoxide emissions (up to 27 mg/m^3) were observed during the high season in the the harbor of Gustavia. This is explained by the increased presence of vehicles and yachts during that time of the year.

Light Pollution

Stakeholders present also highlighted the increased pressure of light pollution on the critically endangered population of nesting turtles combing the beaches.

Urbanization

Historically, the spatial distribution of the population was concentrated around the capital of Gustavia and its harbor, the main center of activity. The inhabitants now tend to spread throughout the island's territory. The main dense residential areas are located on the coastline in Gustavia, Colombier, Flamand, St-Jean, Anse des Cayes, Lorient, and Grand Cul-de-Sac.

The significant demographic growth had an important impact on housing construction. Fifty-five years ago (in 1961), the total number of main houses on the island was only 600. In 2007, that number rose to 4,400 (INSEE, 2015, Saint Barths Online, 2016) - an explosion of 633% in just over 50 years, creating several urbanization problems.

The attendees to the workshop highlighted the following issues due to the rapid urbanization of the island and the lack of long-term sustainable planning regulations:

- Land clearing and back filling causing loss of natural habitat (biotic homogenization),
- Loss of connections between wetlands and sea, and disruption of other ecological corridors (habitat fragmentation),

- Construction sites' stormwater runoff increasing water pollution,
- Loss of biodiversity, and
- Lack of sustainable urban planning.

In addition, urbanization increases hard surfaces that do not allow water to penetrate the soil (parking lots, roads, etc.), increasing the volume of water runoff and peak flows, worsening land runoff pollutants, and erosion problems.

The Collectivity of St-Barthélemy is currently reviewing a new Urbanization Map that will divide the island into sectors of different zones, either "urban" where development is allowed under certain regulations, with four levels of urbanization:

1. Gustavia,
2. Urban areas with medium density development,
3. Residential areas with low density development, and
4. Zoned for economic activities, or "natural" where new development would be proscribed (Collectivité de St-Barthélemy, 2016).

Notably, participants of the workshop indicated that in some instances, houses or other structures were built in "natural" zones that had been recently reclassified as "urban" zones.

Invasive Species

Goats

Currently goats roam freely on St-Barthélemy. The population size is unknown and is estimated anywhere between 2,000 to 5,000 individuals according to various sources on the island. Goats have an important influence on the vegetation and soil of the island by trampling and grazing. **Trampling** increases soil bulk density and this in turn, changes the water infiltration rate. In addition, goats **grazing** on the island's vegetation decrease its overall cover, which can lead to increased wind and water erosion due to the vulnerability of bare soil. In fact, animal predation (including goats, milokoï, *Cactoblastis cactorum*, etc.) had been identified as one of the three main factors of deterioration for the vegetation in St-Barthélemy together with invasive flora (*Scaevola taccada*, *Antigonon leptopus*, etc.) and anthropic impacts (land clearing, backfilling) (Breuil, 2000; Sastre et al., 2014). Finally, feral goats have been identified as a major threat to nesting birds. Feral goats have been completely removed from the satellites islands.

Iguanas

The common iguana (*Iguana iguana*) is an invasive species that was first observed on St-Barthélemy in 2004 (Caraïbes Aqua Conseil, 2010). The common iguana is in direct competition with the endemic Lesser Antillean iguana (*I. delicatissima*). Hybridization between the two species has been observed and may lead to the disappearance of the endemic Lesser Antillean guana (Breuil, 2002; Breuil and Vuillaume, 2012). The common iguana populations are monitored by agents of the ATE. In addition to threats of displacement and hybridization, gravid females of the Lesser Antillean iguana are highly vulnerable to vehicular collisions when undertaking their long-distance migrations from island interiors to coastal nesting areas. The slow population growth, delayed sexual maturity, and low levels of recruitment further increase the demographic impacts of this endangered species (Knapp et al., 2000).

Invasive Ornamental Plants

A very large number of ornamental plants are imported every year to St-Barthélemy during the high season to cater for landscaping needs around the island. Today, there is no record keeping of the imported plants as they are un-

loaded from shipping containers. A number of invasive ornamental plants have already escaped the gardens of high-end villas and hotels, and were found colonizing new territories. In addition, several other exotic species (insects, snakes, etc.) have been introduced on the island through this media.

Lionfish

Lionfish (*Pterois* spp.) are present around the island, however the size of the population today is unknown. A local NGO (Coral Restoration St Barth) organizes bi-monthly "hunts" and, to date, has removed slightly fewer than 1,000 lionfish from the environment. Lionfish is not consumed on island, as there is a risk of ciguatoxin toxicity. Indeed, a recent study showed that, in St-Barthélemy, toxic lionfish were identified from all locations sampled around the island and that approximately 49% of lionfish collected presented ciguatoxin-like activity (Soliño et al., 2015).

Other Invasive Species

Feral cats and cochineals have been also cited by the participants of the workshop as "invasive." In only 30 years, the number of species of cochineal went from 3 to 60. The new species are now on the island without their auxiliary plants and could create an ecological imbalance. A prime example is the cactus moth (*Cactoblastis cactorum*) - a parasitic species, the moth feeds directly on the host cactus such as the endemic *Melocactus intortus*. The wild cat population (and domestic dogs) are predatory threats for the endemic iguanas. Other invasive species on the island include frogs, toads, the red-eared slider (*Trachemys scripta elegans*), and the red-footed tortoise (*Chelonoidis carbonaria*).

Inadequate Policies and Laws

The relatively new environmental code helps steer the country towards better conservation of natural habitats, biological diversity, and sustainable use, however; the code is viewed by stakeholders as weak and in need of strengthening. This point of view was backed by a recent analysis of the St-Barthélemy's environmental code by experts in French Environmental Law (Cans & Touret, 2016). The analysis highlighted that St-Barthélemy's environmental code lacked consistency and was oversimplified. The code's foundation does not include the general principles of environmental law which includes the precautionary principle, the prevention principle, the "polluter pays" principle, the integration principle, and the public participation principle; hence, these basic principles cannot be referred to in case of litigation.

In France, a particular agreement is recognized for Approved Environmental Protection Associations (*Associations Agrées de Protection de l'Environnement* - AAPE). This status confers special faculties to AAPE such as the ability to bring civil actions to defend general interest. This administrative agreement, promoting a balanced dialogue between government and civil society, was in effect before the creation of the new environment code of 2009 but is not included in the code now.

In addition, there is no "Water Law" to regulate the discharge of pollutants into the waters of St-Barthélemy or control surface runoffs from construction sites and urban environments. Therefore, anything can be legally released into the salt ponds or sea.

Minimal legal framework is given for the introduction of chemicals and biocides on the island, the commerce of fauna and flora, the introduction of alien species, air quality, renewable energy, GMOs, etc.

No guidelines for coastal developments setback are provided to ensure that new development does not cause beach erosion or that new projects are impacted by beach erosion.

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The lack of enforcement was also viewed by the attendees of the workshop as a major impediment to the conservation of the natural habitats, the conservation of biodiversity, and the promotion of sustainable use practices.

Research Gaps

The sustainability of St-Barthélemy's environment rests on our base knowledge of its ecosystems. Research is central to increasing the understanding of the current state of these systems and for providing key information to formulate effective conservation and management plans, in addition to identifying the risks that threaten these fragile ecosystems. Until recently (2007), the island was a region of Guadeloupe and the vast majority of studies did not focus on the distant commune of St-Barthélemy. Today, the undermanned ATE and weak on-island research capacity have limited the extent of studies undertaken.

Stakeholders have highlighted the lack of studies to establish the carrying capacity of St-Barthélemy in general and for key sensitive areas. The steady increase in tourism is accompanied with a growing number of divers on the reefs and boats anchoring on seagrass beds. Small islands often quickly reach a threshold level beyond which natural ecosystems will not recover and suffer from irreversible damage (Briguglio et al., 1996). Defining the carrying capacity of St-Barthélemy will be a key piece of information that policymakers can use to harmoniously balance economic development and protection of the island's rich biodiversity.

Attendees to the workshop highlighted several research gaps including:

- Lack of water quality surveys,
- Lack of data on fisheries and stocks, and
- Lack of data on key ecosystems and their health, including the reefs, seagrass, and mangrove.

This lack of information prevents stakeholders' ability to monitor the efficiency of conservation and management plans in place and precludes these systems from yielding their maximum sustainable socio-economic returns.

Illegal Fishing Activities

Stakeholders have identified illegal fishing activities as a threat to the marine environment. The main illegal fishing activities on the island are:

- Poaching in the MPA, mainly for burgos (*C. pica*) and yellowtail snapper (*O. chrysurus*),
- Recreational fishermen selling pelagic fish to restaurants without a license,
- Undersized catch, and
- Poachers from nearby islands fishing in St-Barthélemy's water.

Overfishing

Overharvesting the marine resources of St-Barthélemy's water has been mentioned as an area of concern by the participants of the workshop. Today, fishing pressure on resources extracted (mainly conch, lobster, burgos, and reef and pelagic fish) is not monitored. In addition, the current state of their stock is unknown, yet the increased pressure combined with the degradation of their habitats place these populations at risk. Moreover, FADs deployed off-shore are also a cause of concern among stakeholders. It is believed that the high number of FADs deployed, along with a common misunderstanding of their correct use by artisanal fishermen, has reduced their effectiveness and poses a threat to the sustainability of the FAD fishery.

St-Barthélemy is already experiencing the primary impacts of climate change. The unprecedented invasion of sargassum is being attributed to factors that include ocean warming, eutrophication, and the deposition of iron and nutrient-rich Saharan dust on the ocean.

Climate Change

Due to its small size and location, St-Barthélemy is, like many other small nations in the Caribbean, particularly susceptible to the impacts of climate change. With the gradual sea level rise, and the increased frequency and strength of storms, low lying areas are especially susceptible to inundation. A recent study showed that over 7% of the island's most populated surface is exposed, including the port area and beaches, where a large number of buildings (328) and roads (4 km / 2.5 mi) are present (CETMEF-CETE Méditerranée, 2012, Figure 27). Additionally, increasing water temperature and ocean acidification will negatively impact the reefs around the island. Rising seas coupled with projected augmentations in the intensity and frequency of storms and hurricanes which further affect wave energy, are expected to accelerate coastal erosion. The hospitality sector, a principal economic driver for the island, is predicted to also be at particular risk due to the erosion of the beaches, increased storms, and inundation of low lying areas (Sage et al., 2015).

The measures already taken by the Collectivity to adapt to climate change (such as the construction of an embankment to protect the purification plant in Gustavia against hurricanes) might not be sufficient to balance environmental pressures. St-Barthélemy is already experiencing the primary impacts of climate change in several ways. Since 2011, St-Barthélemy and many other parts of the Caribbean have experienced an explosion in the quantities of sargassum reaching island shores. This unprecedented invasion is being attributed to factors that include ocean warming, eutrophication, and the deposition of iron and nutrient-rich Saharan dust on the ocean. Secondary impacts of climate change can already be observed such as increased coastal erosion on certain beaches, especially St-Jean. Additionally, the island has suffered extended drought periods in the past few years.

Erosion

Similarly to other islands of the Caribbean, two types of erosion are observed on St-Barthélemy: **soil erosion** and **coastline erosion**. The steep and irregular relief of the island combined with heavy rains and the impact of goats have worsened the problem of soil erosion on the island. Today, large ravines and

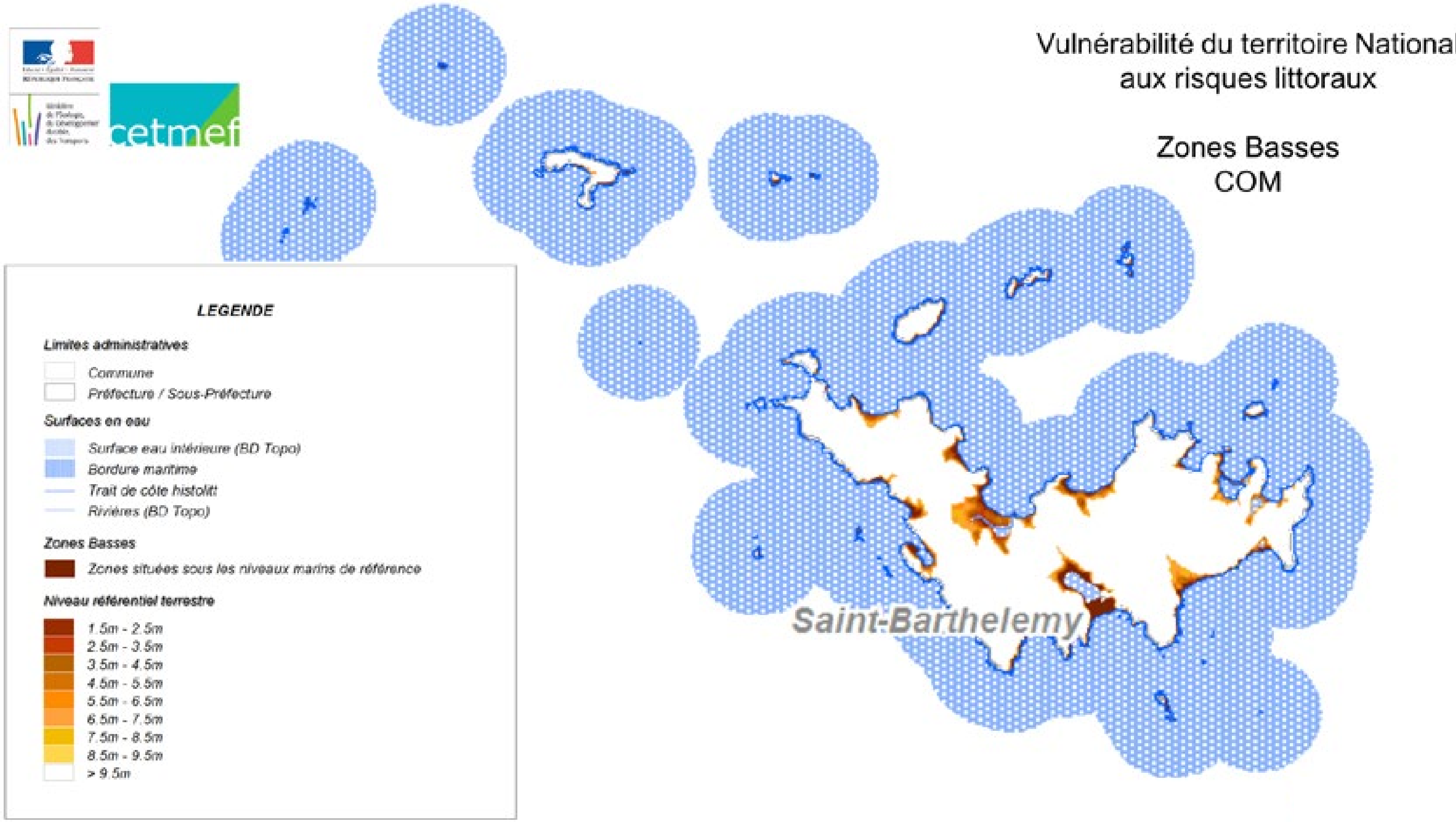

Figure 27. Vulnerability area of Saint-Barthélemy to coastal risks (Source: CETMEF-CETE Méditerranée, 2012 - scale 1/250,000)

gullies flank the steep terrain. In a very short period of time, these ravines are able to channel large quantities of water during the rainy season. These intermittently flowing streams can carry large amount of sediments, exacerbating runoff pollution and leading to a significant drop in salinity of the bays around the island (Assor, 1993; Scalley 2012). In addition, natural and anthropogenic factors have led to coastal erosion around the island, including severe erosion of popular beaches. To address this, several beach renourishment projects took place. Despite best efforts, some of these projects have actually exacerbated erosion problems (BOX 5).

Overall, the compounding effects of erosion may lead to ecological detriment and losses in revenue caused by impacts on tourism, fishing industries, and coastal development.

BOX 5 - **Beach Erosion**

Currently, there are no guidelines, regulations, or laws to guide beach renourishment projects. No impact studies have to be done, and no mitigation measures have to be taken in order to avoid, reduce, or remedy the impact of the renourishment on the nearby and far ecosystems. Since 2000, a total of 13 beaches have been renourished on St-Barthélemy. Four of them were carried out at one of the most popular beach on island – St-Jean Beach (Le Nagard, 2016).

In 2007, an emergency beach renourishment was carried out in October and November to mitigate the impact of erosion on St-Jean Beach (Brosnan, 2008a). Brosnan (2008b) reported that: "*As it is often the case in urgent responses, minimal attention was given to advanced planning or consequences. Cost concerns, intuitive guesses, time constraints, and perceived urgency were the driving forces. Sand dredging took place in a somewhat opportunistic way. Sand borrows were identified by proximity to shore and ease of access. Once dredging started weather conditions overrode concerns of substrate or location suitability.*" This lead to dredging of the sand needed only a few meters offshore, between the beach and coral reef, drastically disrupting the sediment balance of the system. Depressions caused by the dredging have led sand landslides in the northern part of the beach creating important erosion problems for beachfront properties and trees along the shoreline, thus, creating more damages than if no action was taken (Le Nagard, 2016).

Several environmental impacts of beach nourishment have been reported, including rapid smothering and / or siltation of sandy & hard bottom communities - including coral reefs and seagrass beds. In addition, it can lead to dramatic increases in turbidity and reduced light penetration, stressing coral and other light dependent organisms, which in turn, further the erosion problems in the area (Green, 2002; Le Nagard, 2016).

For the sand to stay on the beach after a renourishment, the geological characteristics of sand compatibility (such as granulometry, composition, and hardness) and an understanding of currents in the area are crucial. Today, experts agree that if a beach nourishment is not realized correctly, long-term, and cumulative environmental impacts may be the most problematic issues surrounding beach replenishment (Green, 2002).

The negative impacts caused to the entire ecosystem of St-Jean Bay following the 2007 beach nourishment, might have been avoided if stricter environmental regulations had been in place.


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RECOMMENDATIONS AND KEY PRIORITIES

Within the last 50 years, St-Barthélemy has transitioned into a successful high-end tourism economy; however, the island now faces new challenges which are hindering sustainable development (Figure 28). A severe degradation of natural conditions is shown in many ecosystems, which hinder the resilience and adaptive capacity of the island. Despite inherent disadvantages, these vulnerabilities can serve as a catalyst for innovation and progress. This chapter recommends eight key priority areas of action in order to steer the island towards sustainable development and the mitigation of environmental threats.

Research

With increased anthropogenic pressures, the state of the marine and terrestrial environments of St-Barthélemy has already started to decline. The sustainability of its environment rests on a comprehensive knowledge of the various ecosystems and the ability to design effective conservation and management plans. However, recent changes in the legal status of the island along with the developing environmental code, led to fragmented information regarding the island's natural environment. This significantly reduces the ability of policy- and decision-makers to accurately evaluate the health and resilience of the systems, and impedes the sustainable development of the island.

Therefore, this review recommends that a long term monitoring program be designed which will follow key indicators and monitor essential trends of the unique ecosystems of the island. Indicators are designed to translate complex information into simple measurable units that can be evaluated against a threshold or benchmark describing a healthy or degraded state. Based on WCS's experience in designing environmental dashboards (Jupiter et al., 2009; Gurney & Darling, 2016) and the work of Nobel Prize winner Elinor Ostrom (Ostrom, 2007, 2009), combined with the input of stakeholders present during the workshop, key social-ecological indicators were selected:

- ***Context system*** - This set of indicators describes the underlying context of the island and include indicators such as pollution, development, urbanization, and climate change,
- ***Actors*** - Number of actors, socio-economic attributes, social networks, importance of resource, and technology used,
- ***Governance*** - Network structure, operational rules, collective-choice rules, monitoring, and sanctioning process,
- ***Resources systems*** - Productivity of the systems (including reef, seagrass and mangrove ecosystems, and bird population), water quality, and urbanization.
- ***Resources units*** - Number of resource units, i.e., fishable biomass of targeted fish, density of targeted invertebrates (lobster, conch, top snail),
- ***Interactions*** - Harvesting levels of the different targeted species, conflicts, and
- ***Outcomes*** - Social performance, ecological performance (e.g. overharvested, resilience, bio-diversity, sustainability).

Moreover, it is crucial that research outputs are connected at every level of the community to have a real impact, including property owners, resources managers, decision-makers, fishermen, and the entire population of the island (Johnson et al., 2013).

Figure 28.

Threats to St-Barthélemy's Environment

Causes, Impacts, and Possible Actions

Threats

Urbanization
Poorly-planned urban growth causes loss of natural habitat and bio-diversity, results in habitat fragmentation, and increases runoff pollution and erosion.

Invasive Species
Invasive species (such as goats) have negative effects on the vegetation and increase erosion problems.

Pollution
Wastewater and land runoff are the largest sources of pollution, increasing nutrients and sediments loads in the ocean and damaging reefs and seagrass beds.

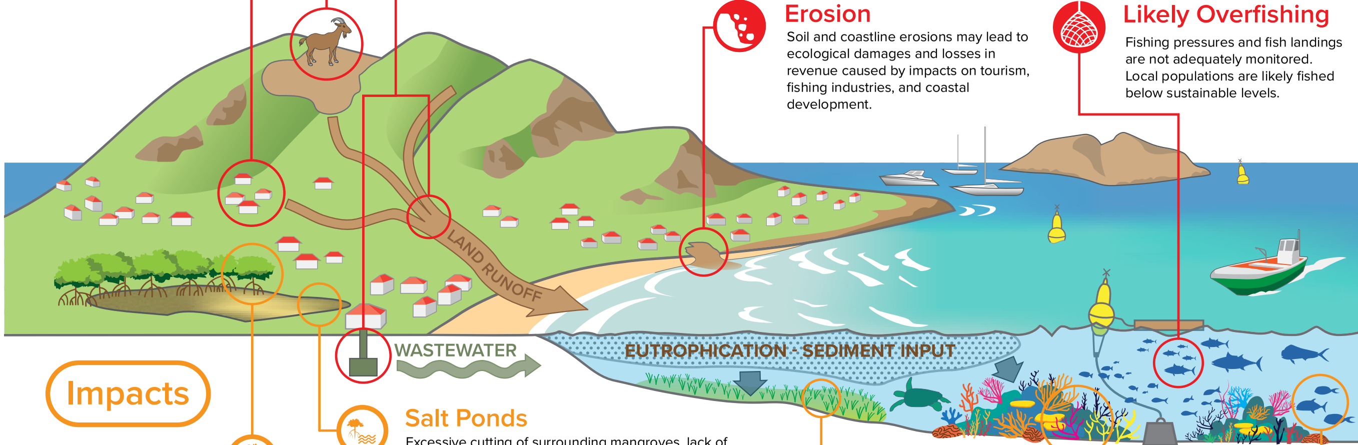
Climate Change
The degradation of marine and terrestrial habitats reduces the resilience and adaptive capacity for the island to handle the anticipated effects of climate change. These include sea level rise and increased frequency and strength of storms.

Inadequate Policies and Laws
Poor or weak environmental regulations and lack of enforcement deepen the challenges faced by the island.

Research Gaps
Lack of information about critical components of the island resources hinders the assessment of their health and precludes the design of effective conservation plans.

Erosion
Soil and coastline erosions may lead to ecological damages and losses in revenue caused by impacts on tourism, fishing industries, and coastal development.

Likely Overfishing
Fishing pressures and fish landings are not adequately monitored. Local populations are likely fished below sustainable levels.



Impacts

Mangroves
Most mangroves on island have disappeared or are in a dire state due to land reclamation and pollution.

Salt Ponds
Excessive cutting of surrounding mangroves, lack of water aeration and circulation, and excessive input of pollutants coming from point and non-point sources have severely damaged these ecosystems.

Terrestrial Vegetation
Pollution, urbanization, invasive species, and soil erosion threaten the rich flora biodiversity of the island.

Seagrass Beds
Pronounced hypersedimentation and eutrophication have led to seagrass bed deterioration and increased the presence of macroalgae in the bays.

Coral Reefs
The reefs around the island are in critical condition and have been severely impacted by overfishing, disease, coastal development, and pollution.

Reef Fish
Reef fish populations have dropped below the benchmark for recovery established for the region, even inside the protected areas.

WCS ES CARIBBEAN

Source: Jadot C., 2016 - Infographic: Hendrik Gheerardyn

Recommendations and Key Priorities

Research
Long-term monitoring of key indicators will allow decision-makers to accurately evaluate the health and/or resilience of the systems of the island and design effective conservation plans.

Legal Framework
Strengthening the legal framework and enforcement capacities is recommended to increase the resilience and adaptive capacity of the island.

Sustainable Development
A long-term sustainable development strategy, supported by institutional coordinated mechanisms to integrate economic and social development with conservation efforts, is needed.

Carrying Capacity
To prevent irreversible damages, it is recommended to determine and monitor the carrying capacity of key sensitive areas, including seagrass beds and coral reefs.

Climate Change
Climate change adaptation strategies need to be implemented to limit primary and secondary impacts of climate change on the island.

Capacity Building Programs
Strengthening on-island capacity will allow for updating of surveying tools and protocols and foster ongoing professional skills and competence.

Communications Strategy
Stronger communication and coordination is needed to increase awareness of the decision makers and civil society, and to enhance collaboration between environmental NGOs.

Tourism
Developing and implementing tourism development plans to maintain quality of life, natural esthetics, tranquility, and safety will be key to maintaining a market share of luxury tourism.

Updated Legal Framework

Today, St-Barthélemy civil society is not legally empowered to participate in the decision-making process for the management of the natural resources of the island[9]. The current environmental code is derived from the French code and several shortcomings were underscored.

The legal framework is further undermined by lack of enforcement and weak institutional strength.

Recommendations to update and adjust the legal and institutional framework include:

- Consulting with legal experts to adapt and extend the environmental code to the specificity of the island,
- Develop and adopt a "Water Law" to regulate discharges of pollutants into the waters,
- Develop and implement a land use plan,
- Legislate to strengthen enforcement by environmental agents or the police in case of infraction to the existing environmental code, and
- Develop and adopt a law to limit phytosanitary risks, e.g. regulate the sanitization of ornamental plants cargo from Florida shipped to the island.

Island-wide Sustainable Development Strategy

The first call for National Sustainable Development Strategies (NSDS) was made at the United Nation Earth Summit in Rio de Janeiro in 1992. NSDS should: "*build upon and harmonise the various sectoral economic, social, and environmental policies and plans that are operating in the country. Its goal is to ensure socially responsible economic development while protecting the resource base and the environment for the benefit of future generations*" (United Nation, 1992).

Today there is no institutional coordinating mechanism for sustainable development in St-Barthélemy. A growing concern among stakeholders is that the three pillars of sustainable development: economic, social, and environmental, are not harmoniously integrated. A 2014 study conducted by UAG, identified that the attractiveness of St-Barthélemy is linked to the intrinsic quality of the island (sceneries, quality of life, tranquility & safety, etc.) (Theng, 2014).

A main challenge for St-Barthélemy is to ensure that its rapid urbanization does not impede the realization of the island sustainability & development goals.

RECOMMENDATIONS

[9] However, it is important to note that town meetings with fishermen were held in 2015 to help draft the new fishing regulations.

A holistic, **long-term vision for sustainable development** supported by institutional coordinating mechanisms emerges as an important step for St-Barthélemy. The island-wide sustainable development plan should have for goals:

- Long-run environmental sustainability,
- Improved economic well-being,
- Sustainable competitive advantage,
- Limit economic and social vulnerability,
- Enhance culture and heritage,
- Sustainable urban development, and
- Foster public private cooperation.

Experience shows that for a NSDS to be successful and effective it requires a conducive political and social climate, high-level political support, and adequate funding (Bass et al., 1995; Mycoo et al., 2016).

Carrying Capacity of the Island and Sensitive Areas

Models have shown that economic growth is beneficial to the environment in its early stages of development, an empirical relationship between per capita income and some environmental data exists. Indeed, when a country reaches a sufficient standard of living, its constituents have the abilities and opportunities to give better attention to environmental amenities (Arrow, 1995a, 1995b, Commonwealth Secretariat, 2010). This notion has led to economy-wide policies designed to promote economical growth and liberalization, yet the natural resources on which economic activities ultimately rely on are finite. Unwise use of environmental resources can lead to detrimental and irreversible changes when a certain threshold level is exceeded (United Nation, 1992). This threshold is called the carrying capacity of a system. The carrying capacity is not static, but can be fluid and adapt to reflect improvements made to the management of the resource systems.

Determining the carrying capacity in St-Barthélemy under various development assumptions and resource constraints is the crucial point for the future of sustainable development, i.e., prevent irreversible damages to occur and maintain. Recent studies have recommended that St-Barthélemy capitalize on high-end visitors instead of engaging in mass tourism so as to limit the impact on its small territory, without providing a threshold value (Theng, 2014).

This report recommends **determining and monitoring the carrying capacity** of St-Barthélemy and its sensitive areas, including seagrass beds and coral reefs. The carrying capacity of an area is estimated using a range of development indicators such as tourism infrastructure, traffic, urban coverage, number of beds, waste management, noise nuisance, and conservation measures of the landscape, among other factors.

Climate Change

Primary and secondary climate change impacts will affect St-Barthélemy as well as the rest of the Caribbean in various ways. Experts agree that if no mitigation or adaptation measures are taken, impacts of climate change could "*lead to a profound environmental-economic crisis in the CLME[10] region by mid-century, if not earlier*" (UNDP; 2015). The FAO of the United Nations and the Caribbean Community Climate Change Centre (CCCC) developed roadmaps for responding to climate change (McConney et al., 2015; CCCC, 2015). The framework is comprised of four main strategies:

- Develop mainstream climate change adaptation strategies into sustainable development agendas,
- Promote actions to reduce greenhouse gas emissions through energy efficiency, conservation, and switching to renewable energy sources,

[10] Caribbean Large Marine Ecosystems

RECOMMENDATIONS

- Encourage actions to reduce the vulnerability of both natural and human systems to the impacts of a changing climate, and
- Promote actions to derive social, economic, and environmental benefits through the prudent management of standing forests (including mangrove forests).

Detailed information for implantation is provided by the two organizations who highlight that climate change adaptation will come at a cost, but the financial and human costs of inaction will be much greater.

Develop and Implement Capacity Building Programs

Capacity on small islands is often limited as the territory can not maintain all necessary specializations. Strengthening the on-island capacity building programs will allow for updating and sharpening concepts, tools and protocols used, and foster professional skills and competence.

This strengthening can be implemented by:

- Promoting collaboration and agreement between research institutions of the neighboring islands (St-Martin, Guadeloupe, etc.),
- Providing an on-island research environment that reduces intellectual isolation while stimulating learnings (access to online scientific libraries, off-island trainings opportunities, participation to workshops, congresses, etc.), and
- Providing supportive mechanisms to encourage cooperation with international researchers from universities, international NGOs and supranational organizations (WCS, UNEP, GCRMN, etc.).

Moreover, new technologies can increase the output and range of capability of the limited human resources and should be employed whenever possible.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Strong Communications Strategy

The development and implementation of stronger communications strategies is also recommended for three target groups. Firstly, communication strategies should be developed in order to increase awareness of the **people in power** and the **civil society**. Communications should be focused on St-Barthélemy vulnerabilities associated to climate change and other environmental threats and implementation strategies should use a variety of tools including posters, flyers, informative and engaging nature centers, public events, nature and underwater trails, and guided tours. In addition, well structured citizen science programs should be organized and consistent. Communication empowers decision-makers and the civil society to greater understand strategies that can be implemented at the island level to increase the adaptive capacity of St-Barthélemy and advance the sustainable development of the island.

Secondly, several **environmental NGOs** present on the island, are helping to protect and restore the environment, indicating a strong desire from the civil society to take action. We believe better communication and coordination between the separate efforts would lead to compounding effects, resulting in a greater overall benefit to the environment. In order to strengthen communication between a quite diverse group of people and foster collaboration, joint projects between NGO's could be organized, such as joint awareness campaigns, fundraising events, etc. In addition, joint training sessions to increase NGO members' capacity could be organized and strengthen a wide range of skills such as fundraising skills, project management, environmental management, administrative and financial capacity, and other relevant skills.

Finally, as part of a complete communication strategy, it is also recommended to update **ATE's website** to provide accurate information about the management of the MPA and to better engage and inform civil society and tourists. The design of the website should focus on improving user experience and drive engagement. An increase in website retention rates will help expand environmental awareness of tourists and civil society, alike. In addition, the website could host an up-to-date e-library featuring research papers, theses, and reports related to St-Barthélemy, which users could access remotely. Today, some research documents are held at the offices of the ATE, but the vast majority only exist only as hard copies (no electronic version is available). This paper format greatly reduces their availability for scientists, policy-makers, and the civil society and is liable to loss.

Tourism

In general, small islands are constrained by the narrow resource base of their economies and are more susceptible to environmental dangers (Briguglio, 1996). St-Barthélemy has positioned itself as the epicenter of luxury tourism in the Caribbean, yet other luxury destinations are emerging in the region. Decision makers are aware that innovation and diversification of the tourism offerings will be key to maintaining St-Barthélemy's attractiveness in this competitive market. A 2014 report by UAG, pinpointed that the attractiveness of St-Barthélemy is linked to the intrinsic quality of the island (sceneries, quality of life, tranquility, safety, etc.) (Theng, 2014). Therefore, maintaining its quality of life, natural esthetics, tranquility, and safety will be important for St-Barthélemy to maintain market share of the luxury tourism throughout the Caribbean.
Consequently, we recommend to:

- Elaborate and implement tourism development plans that (1) take into considerations the carrying capacity of the island and (2) can be weaved into the island-wide sustainable development strategy,
- Develop coherent urban planning designed to maintain the high attractiveness of the territory and prevent the physical saturation of the territory, and
- Analyze and model the Green / Blue Economy principles.

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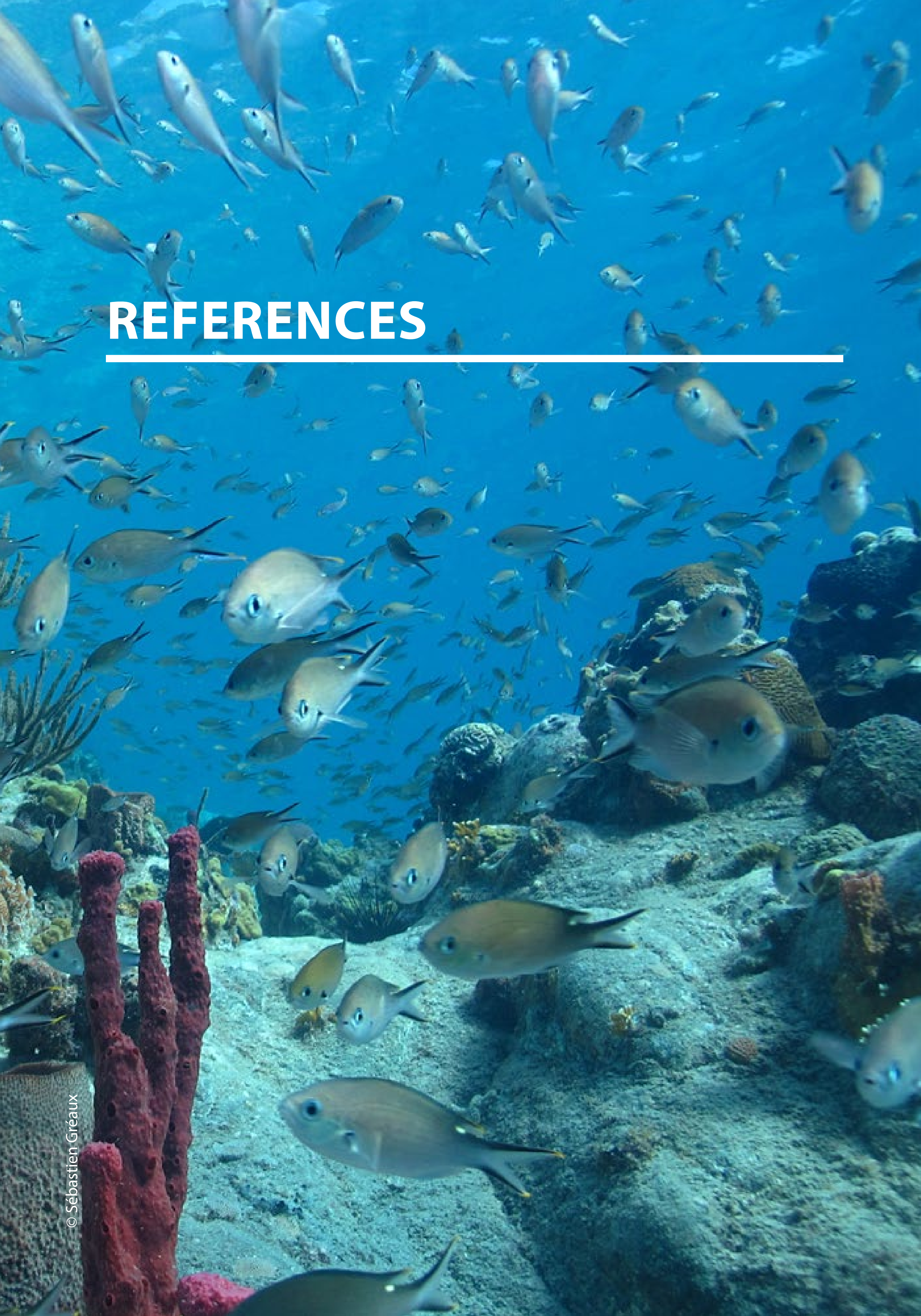

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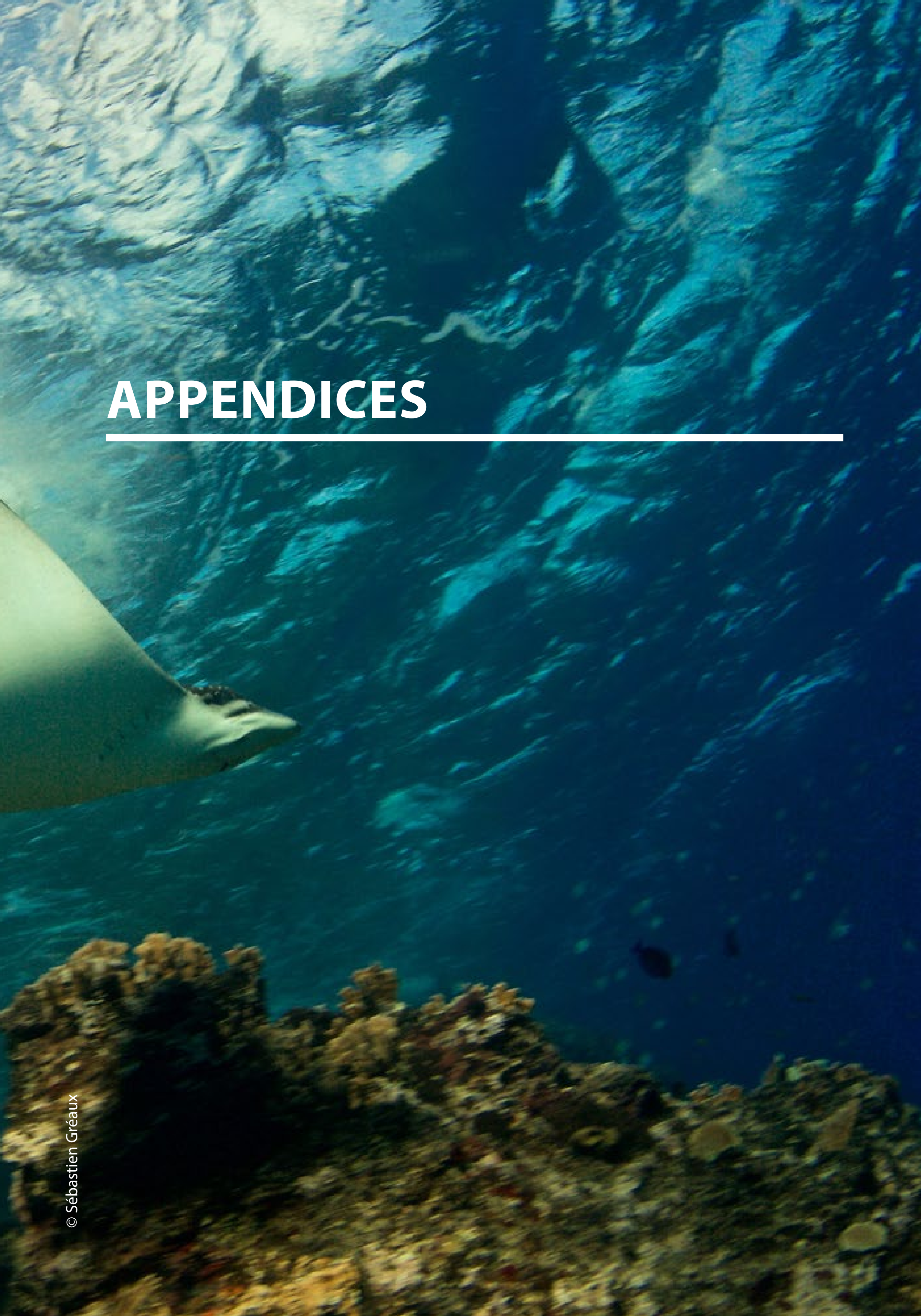
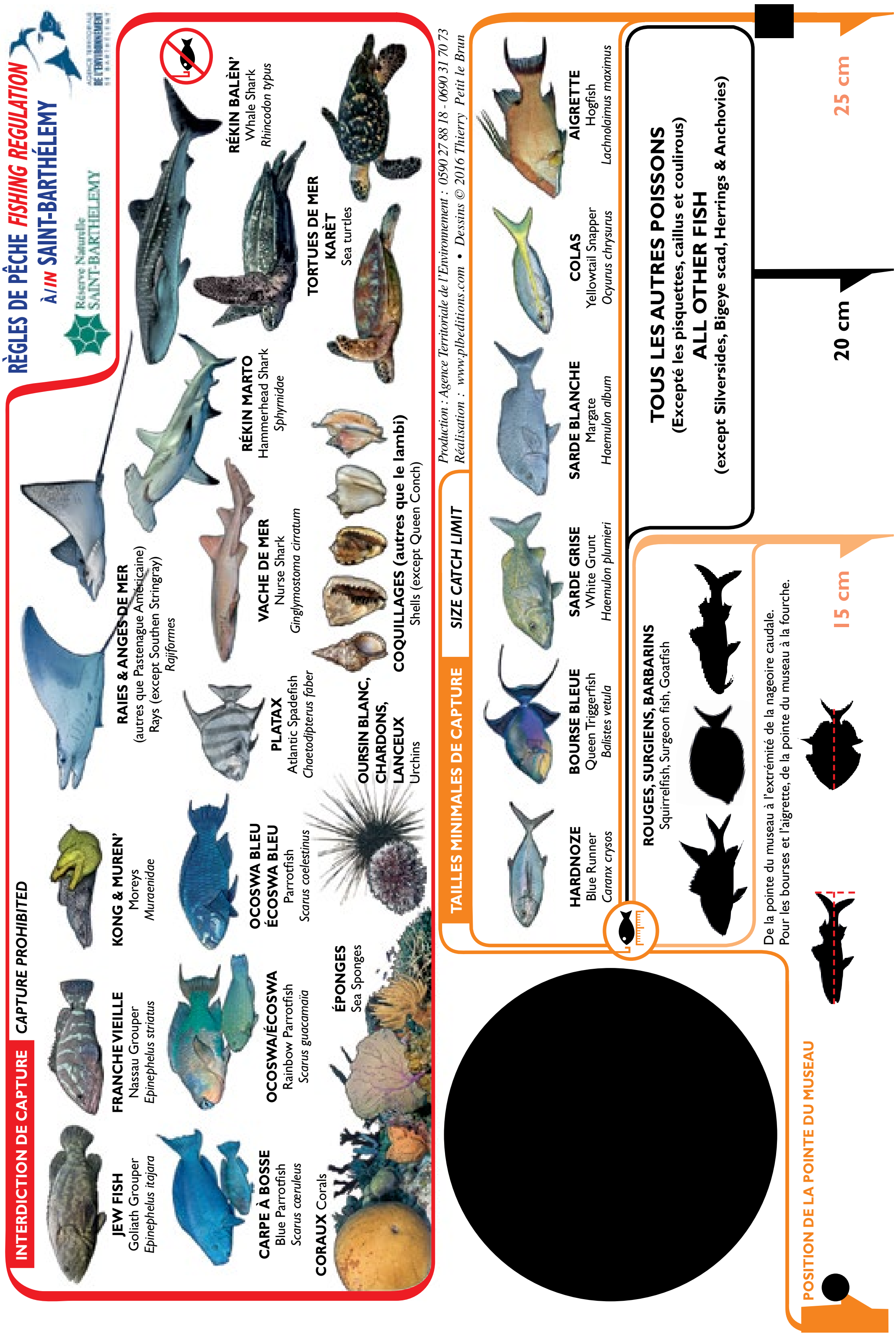
APPENDICES



APPENDIX A. SAINT BARTHÉLEMY FISHERIES REGULATIONS CARD



LIMITATION DES CAPTURES POUR LES PLAISANCIERS *CATCH LIMIT FOR RECREATIONAL FISHERMEN*

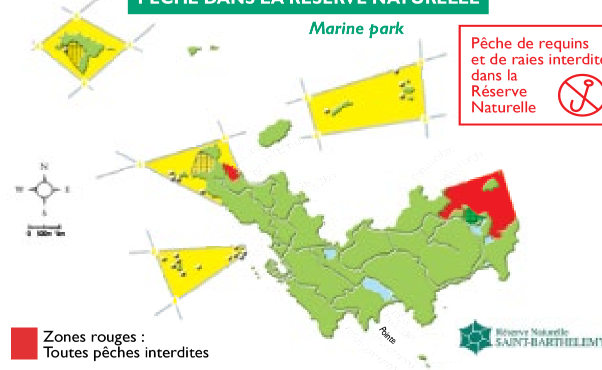
Permis obligatoire (sauf pour la pêche à la ligne depuis la côte).

	PÊCHE EMBARQUÉE		CHASSE SOUS-MARINE	ÉPERVIER	PÊCHE SOUS-MARINE
ESPÈCES CONCERNÉES	**CATÉGORIE 1** - Marlins - Espadon - Voilier	**CATÉGORIE 2** - Thons - Daurades - Wahoo - Finot	**CATÉGORIE 3** - Carpes et boutou (perroquets) - Aigrette, parokèt et pie (labres) - Surgiens (chirurgiens)	**CATÉGORIE 4** - Piskèts - Caillus	- Roumar (langouste royale)
CAPTURES JOURNALIÈRES MAXIMALES	1 poisson de CATÉGORIE 1 par bateau	5 poissons de CATÉGORIE 2 par titulaire de permis et par personne encadrée avec un maximum de 3 poissons de plus de 5 kg par bateau	3 poissons de CATÉGORIE 3 par titulaire de permis et par personne encadrée	10 kg de poissons de CATÉGORIE 4 par titulaire de permis	5 langoustes par titulaire de permis et par personne encadrée

Les poissons pélagiques et les colas doivent obligatoirement avoir un lobe de la queue coupé.
Les langoustes doivent obligatoirement avoir un morceau de la queue coupé.

PÊCHE DANS LA RÉSERVE NATURELLE

Marine park

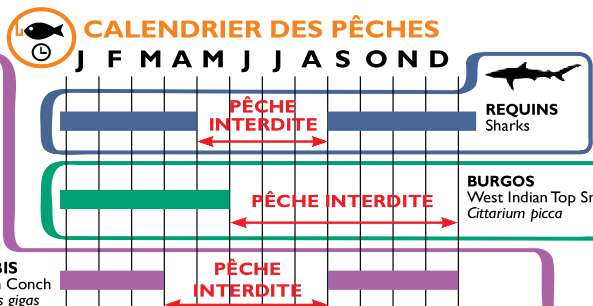


Pêche de requins et de raies interdite dans la Réserve Naturelle

Zones rouges : Toutes pêches interdites

Zones jaunes :
* Non professionnels ; pêche à la ligne uniquement, en dérive ou depuis la côte.
* Professionnels ; pêche aux burgos, à la senne ou aux appâts selon périodes en vigueur avec demande d'autorisation et déclaration de captures.

CALENDRIER DES PÊCHES



LAMBI : Pêche interdite aux non professionnels

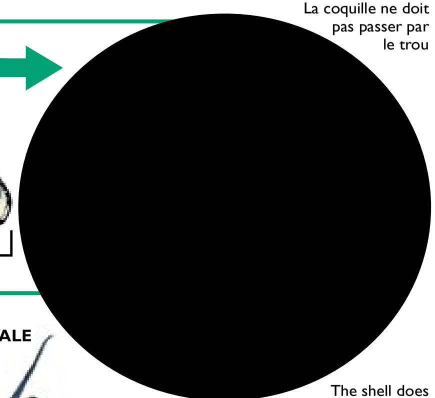
Le poids de la chair doit être supérieur ou égal à 250 grammes.

Le pavillon doit être formé et épais d'au moins 7 mm (non cassable à la main)

7 mm

6 cm minimum

La coquille ne doit pas passer par le trou



The shell does not pass through the hole

POSITION DE LA POINTE DU ROSTRE

Taille: de la pointe du rostre à l'extrémité de la queue

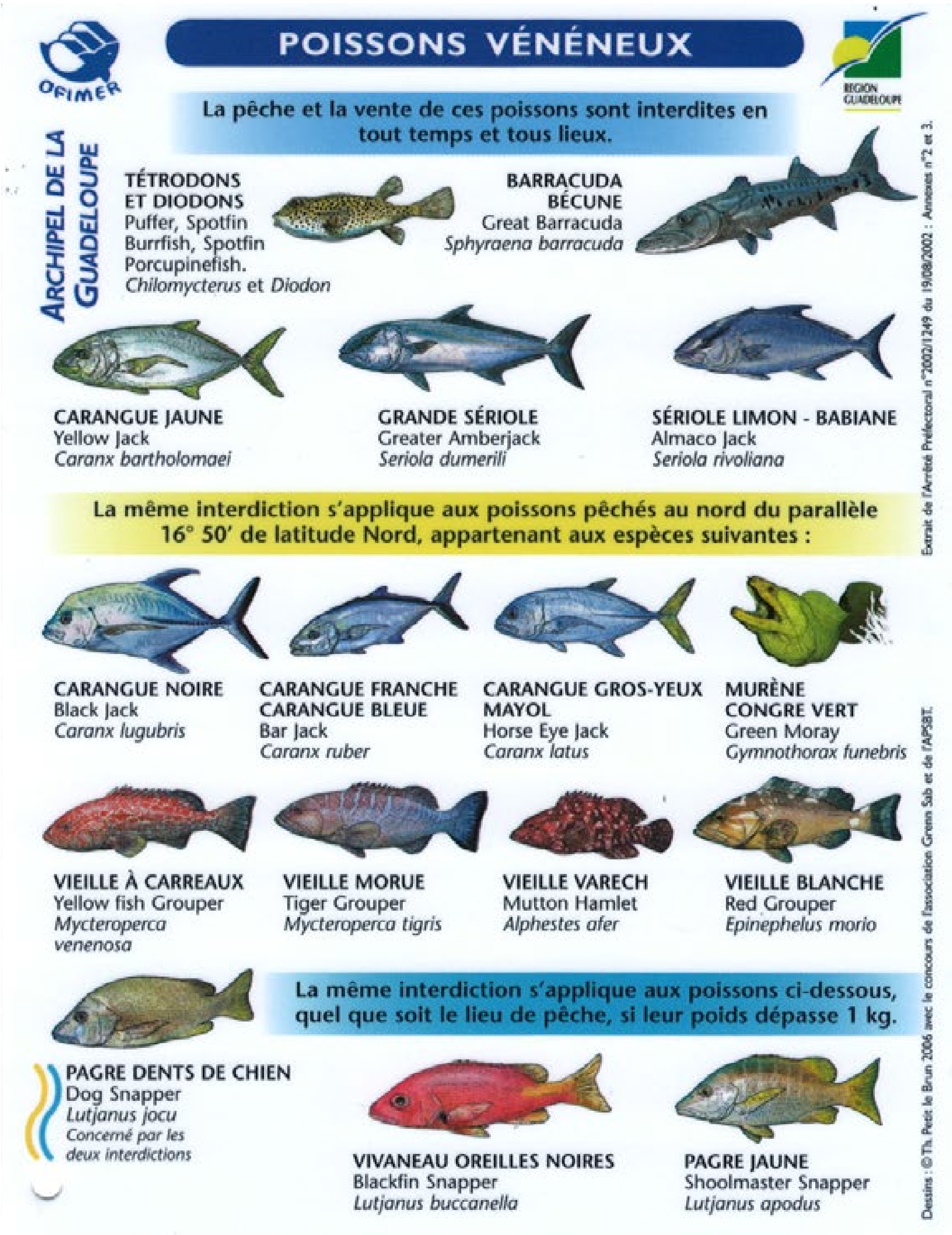
KRIKÈT, LANGOUSTE BRÉSILIENNE
Spotted Spiny Lobster
Panulirus guttatus

14 cm

ROUMAR, LANGOUSTE ROYALE
Caribbean Spiny Lobster
Panulirus argus

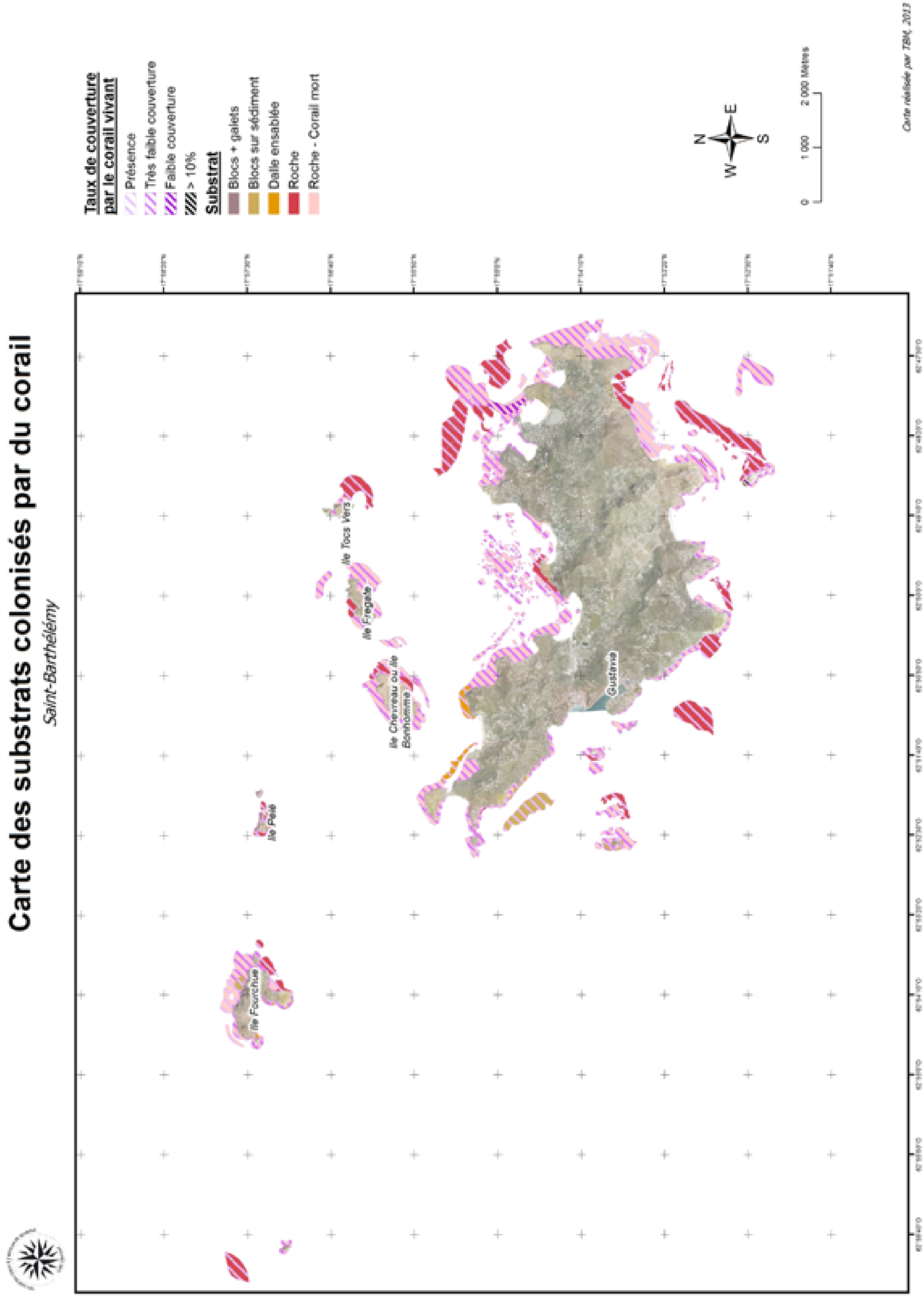
21 cm

APPENDIX B. FISH THAT CAN NOT BE CAUGHT OR SOLD IN SAINT BARTHÉLEMY DUE TO HIGH CIGUATERA RISKS

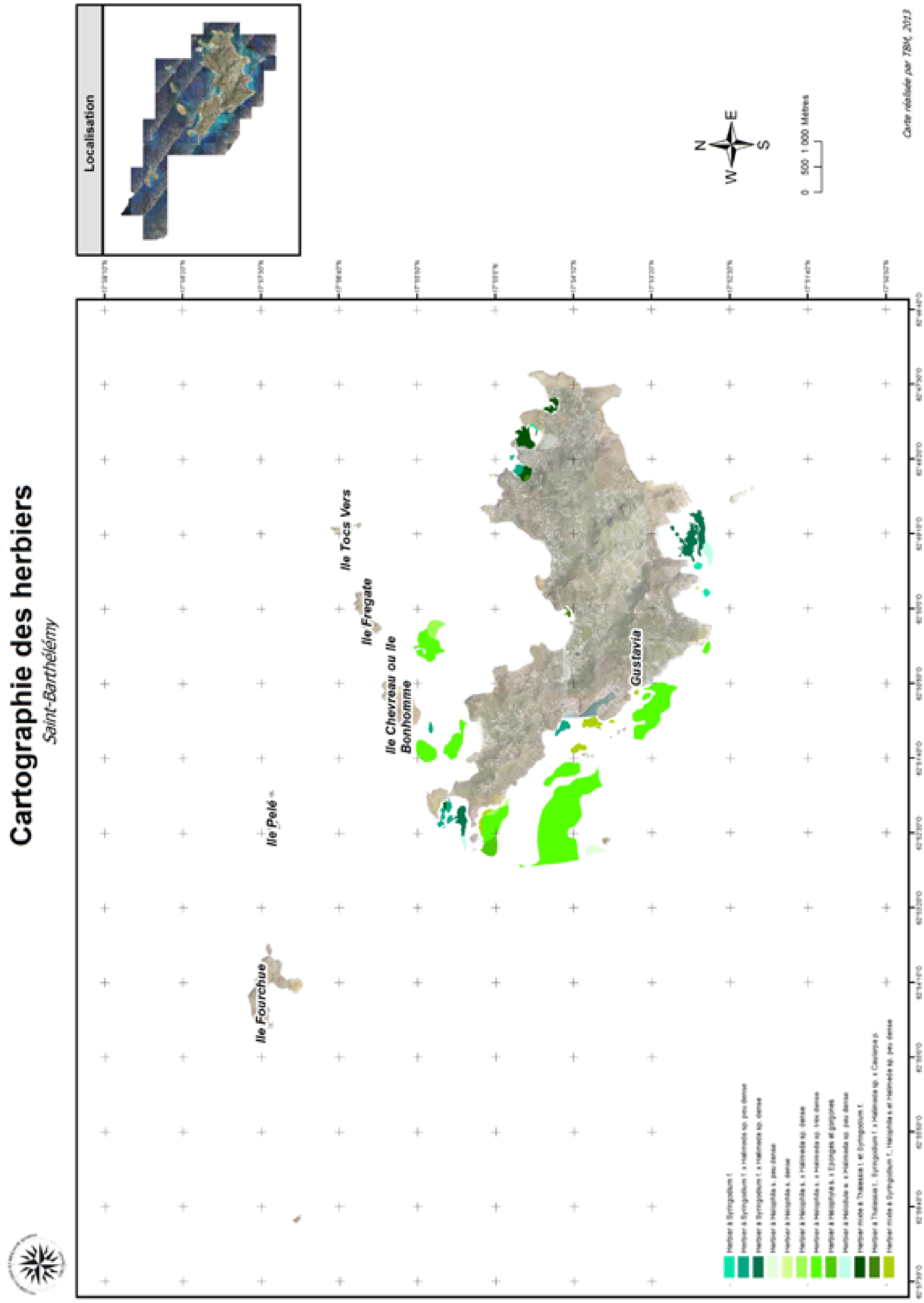


APPENDIX C. DETAILED GIS MAPS OF SAINT BARTHÉLEMY'S MARINE ENVIRONMENT (CHAUVAUD, 2013)

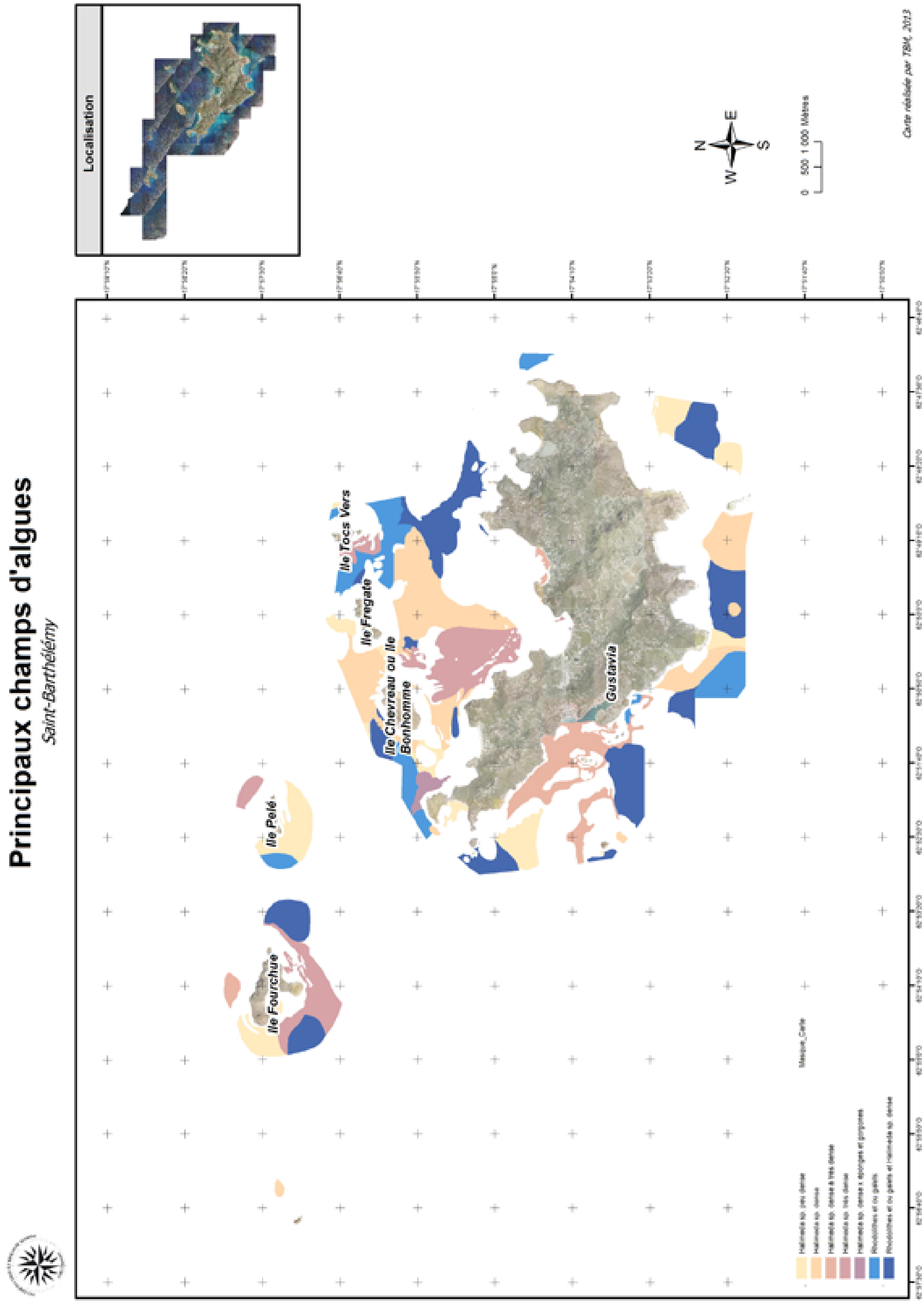
1. Substrate colonized by life corals.



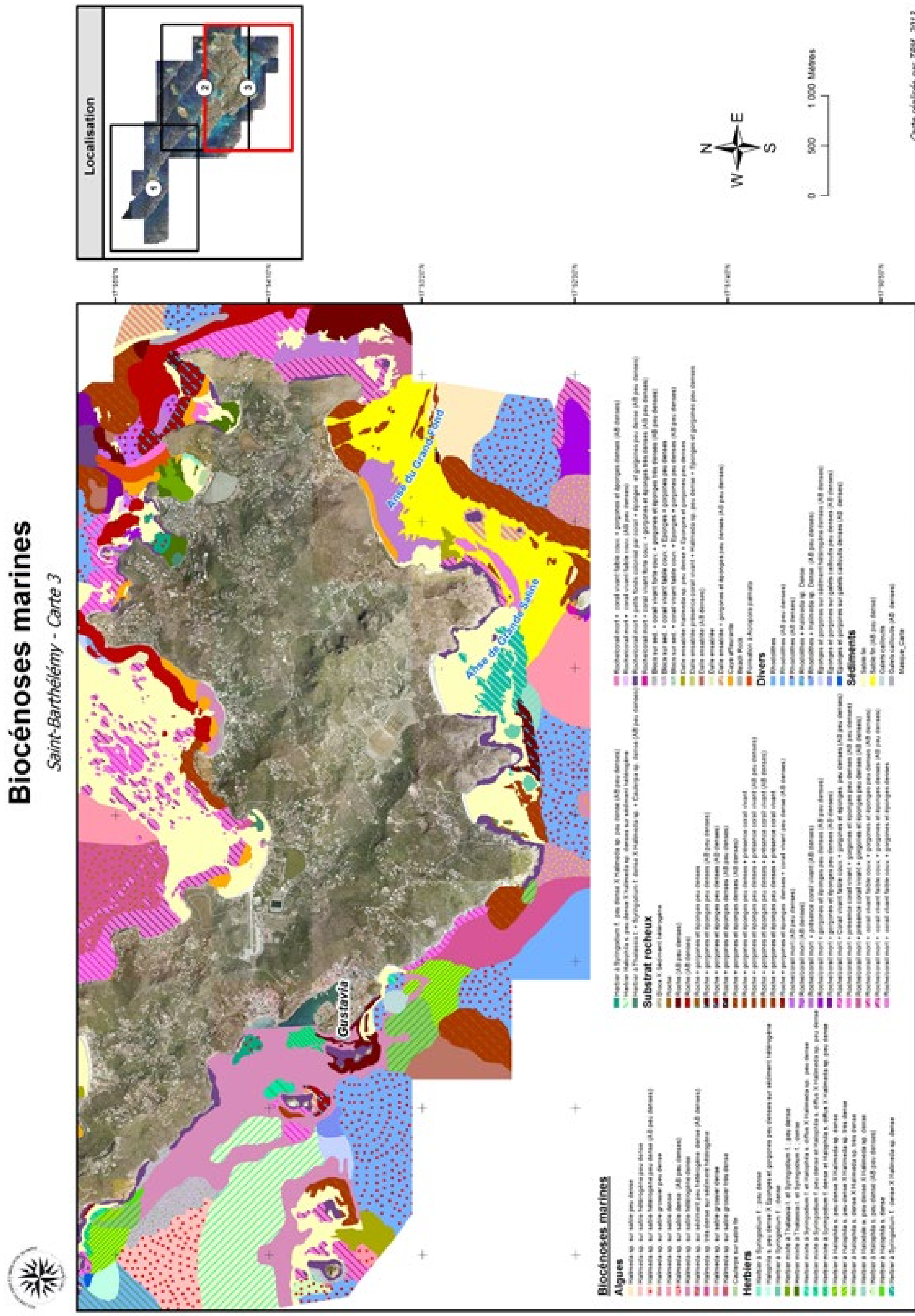
2. Seagrass beds around Saint Barthélemy



3. Algae around around Saint Barthélemy



4. Main biocenosis around Saint Barthélemy



APPENDIX D. LIST OF PROTECTED SPECIES IN THE ENVIRONMENTAL CODE OF ST-BARTHÉLEMY (2016)

NE - Not Evaluated, DD - Data Deficient, LC - Least Concern, NT - Near Threatened, VU - Vulnerable, EN - Endangered, CR - Critically Endangered, EW - Extinct in the Wild, EX - Exctinct, NA - Not available

Species	Common Name		IUCN Red List Status
Scientific Name	French	English	
Marine Turtles	**Tortues de mer**	**Marine Turtles**	
Dermochelys coriacea	Tortue luth	Leatherback Sea Turtle	VU
Caretta caretta	Tortue caouanne	Loggerhead Turtle	VU
Lepidochelys olivacea	Tortue olivâtre	Olive Ridley	VU
Lepidochelys kempii	Tortue de Kemp	Kemp's Ridley	CR
Eretmochelys imbricata	Tortue imbriquée	Hawksbill Turtle	CR
Cetaceans	**Cétacés**	**Cetaceans**	
Suborder Mysticeti: All species	À fanons : toutes les espèces	Baleen whales: all species	
Suborder Odontoceti: All species	À dents : toutes les espèces	Toothed whales: all species	
Sirenia	**Siréniens**	**Sirenia**	
Dugong dugon	Dugong	Dugong	VU
Trichechus manatus	Lamantin d'Amérique	American Manatee	VU
Pinnipedae	**Pinnipèdes**	**Pinniped**	
All species	Toutes les espèces	All species	
Reptiles	**Reptiles**	**Reptiles**	
Iguana delicatissima	Iguane des Petites Antilles	Lesser Antillean green iguana	EN
Thecadactylus rapicauda	Thécadactyle à queue épineuse	Turniptail gecko	NA
Thecadactylus oskrobapreinorum	Thécadactyle de Saint-Martin		NA
Anolis gingivinus	Anolis d'Anguilla	Anguilla anole	NA
Mabuya sloanii [Spondylurus magnacruzae]	Scinque sloanien	Greater Saint Croix skink	CR
Ameiva plei plei	Ameive de Plée	Plee's ameiva	NA
Sphaerodactylus sputator	Sphérodactyle d'Anguilla	Island least gecko	NA
Sphaerodactylus parvus	Petit sphérodactyle à grosse écailles		NA
Alsophis rijgersmaei	Couresse d'Anguilla	Anguilla racer	EN
Typhlis annae	Typhlops de Saint-Barthélemy	Saint Barts blindsnake	NA
Chelonoidis carbonaria	Tortue charbonnière	Red-footed tortoise	VU

Mammal	Mammifères	Mammal	
Tadarida brasiliensis	Tadaride du Brésil	Brazilian free-tailed bat	LC
Molossus molossus	Molosse commun	Pallas's mastiff bat	LC
Noctilio leporinus	Noctilion pêcheur	Greater bulldog bat	LC
Artibeus jamaicensis	Artibéus de la Jamaïque	Jamaican fruit-eating bat	LC
Brachyphylla cavernarum	Brachyphylle des cav-ernes	Antillean fruit-eating bat	LC
Monophyllus plethodon	Monophylle des Petites Antilles	Insular single-leaf bat	LC
Birds	**Oiseaux**	**Birds**	
Podilymbus podiceps (antillarum)	Grèbe à bec bigarré	Pied-billed grebe	LC
Puffinus lherminieri	Puffin d'Audubon	Audubon's shearwater	LC
Puffinus gravis [Ardenna gravis]	Puffin majeur	Great shearwater	LC
Phaethon artherus (mesonauta)	Phaéton à bec rouge	Red-billed tropicbird (mesonauta)	LC
Phaethon lepturus (catesby)	Phaéton à bec jaune	White-tailed tropicbird	LC
Pelecanus occidentalis	Pélican brun	Brown pelican	LC
Sula leucogaster	Fou brun	Brown booby	LC
Sula dactylatra	Fou masqué	Masked booby	LC
Sula sula	Fou à pieds rouges	Red-footed booby	LC
Phalacrocorax auritus	Cormoran à aigrettes	Double-crested Cormo-rant	LC
Fregata magnificens	Frégate superbe	Magnificent Frigatebird	LC
Butorides striatus [Butorides striata]	Héron strié	Striated heron	LC
Egretta caerulea	Aigrette bleue	Little blue heron	LC
Egretta thula thula	Aigrette neigeuse	Snowy egret	LC
Bubulcus ibis	Héron garde-boeufs	Cattle egret	LC
Nyctanassa violacea (bancrofti)	Bihoreau violacé	Yellow-crowned night-heron (Bancroft's)	LC
Ardea alba egretta	Grande aigrette	Great white egret	LC
Ixobrychus exilis	Petit bonglios	Least Bittern	LC
Nomonyx dominicus	Erismature routoutou	Masked duck	LC
Oxyura jamaicensis	Erismature rousse	Ruddy duck	LC
***Anas* ssp.**	**Espèces canard**	**Duck species**	
Aix sponsa	Canard branchu	Wood duck	LC
Aythya collaris	Fulligule à bec cerclé	Ring-necked duck	LC
Aythya affinis	Fulligule à tête noire	Lesser scaup	LC

Lophodytes cucullatus	Harle couronné	Hooded merganser	LC
***Dendrocygna* ssp.**	**Espèces dendrocygne**	**Dendrocygnidae species**	
Pandion haliaetus (carolinensis)	Balbuzard pêcheur	Osprey	LC
Falco sparverius (caribaerum)	Crécerelle d'Amérique	American kestrel	LC
Falco peregrinus	Faucon pèlerin	Peregrine falcon	LC
Falco columbarius	Faucon émerillon	Merlin	LC
Gallinula chloropus	Gallinule poule-d'eau	Common moorhen	LC
Porphyrio martinicus	Talève violacée	Purple gallinule	LC
Fulica caribaea	Foulque à cachet blanc	Caribbean coot	NA
Fulica a. Americana	Foulque d'Amérique	American coot	LC
Rallus longirostris (caribaeus)	Râle gris	Mangrove rail	LC
Porzana Carolina	Marouette de Caroline	Sora	LC
Haematopus palliatus	Huîtrier pie	American oystercatcher	LC
Himantopus mexicanus	Échasse d'Amérique	Black-necked stilt	LC
Charadrius semipalmatus	Pluvier semiplamé	Semipalmated plover	LC
Charadrius wilsonia	Pluvier de Wilson	Wilson's plover	LC
Charadrius vociferus	Pluvier kildir	Killdeer	LC
Actitis macularius	Chevalier grivelé	Spotted sandpiper	LC
Calidris alba	Bécasseau sanderling	Sanderling	LC
Calidris minutilla	Bécasseau minuscule	Least sandpiper	LC
Calidris pusilla	Bécasseau semipalmé	Semipalmated sandpiper	LC
Calidris mauri	Bécasseau d'Alaska	Western sandpiper	LC
Calidris fuscicollis	Bécasseau à croupion blanc	White-rumped sandpiper	LC
Tryngites subruficollis	Bécasseau roussâtre	Buff-breasted sandpiper	NT
Phalaropus tricolor [Steganopus tricolor]	Phalarope de Wilson	Wilson's phalarope	LC
Stercorarius longicaudus	Labbe à longue queue	Long-tailed jaeger	LC
Stercorarius parasiticus	Labbe parasite	Arctic jaeger	LC
Stercorarius pomarinus	Labbe pomarin	Pomarine jaeger	LC
Leucophaeus atricilla atricilla [Larus atricilla]	Mouette atricille	Laughing gull	LC
Sternula antillarum	Petite sterne	Least tern	LC
Onychoprion fuscatus	Sterne fuligineuse	Sooty tern	LC
Onychoprion anaethetus (recognitus)	Sterne bridée	Bridled tern	LC
Sterna hirundo	Sterne pierregarin	Common tern	LC

Sterna dougallii	Sterne de Dougall	Roseate tern	LC
Thalasseus maximus	Sterne royale	Royal tern	LC
Anous stolidus	Noddi brun	Brown noddy	LC
Columbina passerina (nigrirostris)	Colombe à queue noire	Common ground-dove	LC
Coccyzus americanus	Coulicou à bec jaune	Yellow-billed cuckoo	LC
Coccyzus minor	Coulicou manioc	Mangrove cuckoo	LC
Crotophaga ani	Ani à bec lisse	Smooth-billed ani	LC
Chaetura martinica	Martinet chiquesol	Lesser antillean swift	LC
Cypseloides niger	Gros martinet noir	Black swift	LC
Orthorhyncus cristatus (exilis)	Colibri huppé	Antillean crested hummingbird	LC
Eulampis jugularis	Colibri madère	Purple-throated carib	LC
Eulampis holosericeus	Falle vert	Green-throated carib	LC
Megaceryle torquata (stictipennis)	Martin-pêcheur à ventre roux	Ringed kingfisher	LC
Megaceryle alcyon	Martin-pêcheur d'Amérique	Belted kingfisher	LC
Tyrannus dominicensis (vorax)	Tyran gris	Grey kingbird	LC
Myiarchus oberi	Tyran à grosse tête	Lesser antillean flycatcher	LC
Elaenia martinica	Élénie siffleuse	Caribbean elaenia	LC
Contopus latirostris (brunneicapillus)	Moucherolle gobe-mouche	Lesser antillean pewee	LC
Progne dominicensis	Hirondelle à ventre blanc	Caribbean martin	LC
Hirundo rustica erythrogaster	Hirondelle rustique	Barn swallow	LC
Riparia riparia	Hirondelle de rivage	Sand martin	LC
Cinclocerthia ruficauda (tremula)	Trembleur brun	Brown trembler	LC
Mimus gilvus (antillarum)	Moqueur des savanes	Tropical mockingbird	LC
Setophaga petechia (melanoptera)	Paruline jaune	Yellow warbler	LC
Setophaga discolor	Paruline des prés	Prairie warbler	LC
Setophaga virens	Parulineà gorge noire	Black-throated green warbler	LC
Setophaga striata	Paruline rayée	Blackpoll warbler	LC
Setophaga coronata coronata	Paruline à croupion jaune	Yellow-rumped warbler	LC

Setophaga dominica	Paruline à gorge jaune	Yellow-throated warbler	LC
Setophaga fusca	Paruline à gorge or-angée	Blackburnian warbler	LC
Setophaga plumbea	Paruline caféiette	Plumbeous warbler	LC
Setophaga Americana	Paruline à collier	Northern parula	LC
Cardellina Canadensis	Paruline du Canada	Canada warbler	LC
Setophaga citrina	Paruline à capuchon	Hooded warbler	LC
Protonotaria citrea	Paruline orangée	Prothonotary warbler	LC
Mniotilta varia	Paruline noir et blanc	Black-and-white warbler	LC
Setophaga ruticilla	Paruline flamboyante	American redstart	LC
Parkesia noveboracensis	Paruline des ruisseaux	Northern waterthrush	LC
Parkesta motacilla	Paruline hochequeue	Louisiana waterthrush	LC
Seiurus aurocapillus [Seiurus aurocapilla]	Paruline couronnée	Ovenbird	LC
Coereba flaveola (bartholemica)	Sucrier à ventre jaune	Bananaquit	LC
Saltator albicollis (guadeloupensis)	Saltator gros bec	Lesser antillean saltator	LC
Euphonia musica flavifrons	Organiste louis d'or	Antillean euphonia	LC
Loxigilla noctis	Pèrenoir rougegorge	Lesser antillean bullfinch	LC
Tiaris bicolor	Cici verdinère	Black-faced grassquit	LC
Piranga rubra	Tangara vermillon	Summer tanager	LC
Piranga olivacea	Tangara écarlate	Scarlet tanager	LC
Scorpions	**Scorpions**	**Scorpions**	
Oiclus questeli	Petit scorpion (endém-ique)	Small scorpion (endemic)	NA
Fish	**Poissons**	**Plants**	
Epinephelus itajara	Mérou goliath	Atlantic goliath grouper	CR
Epinephelus striatus	Mérou rayé	Nassau grouper	EN
Chaetodipterus faber	Disque portugais	Atlantic spadefish	LC
Muraenidae	Murènes (famille)	Moray eels (family)	LC
Scarus coeruleus	Poisson-perroquet bleu	Blue parrotfish	LC
Scarus guacamaïa	Perroquet arc-en-ciel	Rainbow parrotfish	NT
Scarus coelestinus	Zawag bleu/Perroquet noir	Midnight parrotfish	DD
Sea urchins	**Oursins**	**Sea urchins**	
All species	Toutes les espèces	All species	
Sea Shells	**Coquillages**	**Sea Shells**	
All species (Except Lobatus gigas)	Toutes les espèces (sauf le lambi)	All species (Except Lobatus gigas)	

Rays and Sharks	Raies et requins	Rays and Sharks	
Rajiformes (Except Dasyatis Americana)	Toutes les raies (sauf la raie pastenague)	Rajiformes (Except southern stingray)	
Ginglymostoma cirratum	Requin nourrice	Nurse shark	DD
Sphyrnidae	Requins marteaux (les 10 espèces)	Hammer shark (all species)	EN
Rhincodon Typus	Requin-baleine	Whale Shark	EN
Plants	**Plantes**	**Plants**	
Coccothrinax barbadensis	Palmier à balai	Latanier balai	NA
Agave karatto	-	-	NA
Tillandsia recurvata	-	small ballmoss	NA
Tillandsia usneoides	Mousse espagnole	Spanish moss	NA
Brassavola cucullata	-	Daddy long-legs orchid	NA
Epidendrum ciliare	-	Fringed star orchid	LC
Ionopsis utricularioides	-	Delicate violet orchid	NA
Sacoila lanceolata	-	Scarlet ladies' tresses	NA
Trichocentrum cebolleta	-	-	NA
Psychilis correllii	-	-	NA
Tetramicra elegans	-	Elegant wallflower orchid	NA
Tolumnia urophylla	-	-	NA
Avicennia germinans	Palétuvier noir / mangrove noire	Black mangrove	LC
Alternanthera geniculata	-	-	NA
Chamissoa altissima	-	False chaff flower	NA
Pentalinon luteum	-	Hammock viper's-tail	NA
Batis maritima	Herbe à crabes	Turtleweed/Saltwort	NA
Heliotropium elegans	-	-	NA
Rochefortia acanthophora	Bois d'ébène	Greenheart ebony	NA
Mammillaria nivosa	-	Woolly nipple cactus	LC
Melocactus intortus	Tête à l'anglais	Turk's cap	LC
Opuntia dillenii	Raquette à fleurs jaune	Sweet prickly-pear	LC
Opuntia rubescens	Raquette arborescente	Sour pricklypear	LC
Opuntia triacantha	Raquette volante	Spanish lady	NT
Opuntia tuna	-	Tuna/Elephant ear pricklypear	NA
Conocarpus erectus	Chêne Guadeloupe/ Palétuvier gris	Silver-leaved buttonwood	LC
Laguncularia racemosa	Palétuvier blanc	White mangrove	LC

Borrichia arborescens	-	Tree seaside tansy	NA
Quamoclit repanda	-	-	NA
Haematoxylum campechianum	Campêche	Logwood	NA
Scaevola plumieri	Manioc marron du bord de mer	Beachberry	NA
Forestiera segregata	-	Florida swampprivet	NA
Peperomia baerthelemyana	-	-	NA
Peperomia questeliana	-	-	NA
Rhizophora mangle	Palétuvier rouge	Red mangrove	LC
Catesbaea melanocarpa	-	Tropical lilythorn	NA
Guaiacum officinale	Gaïac	Guaiac tree/Ligum vitae	EN

APPENDIX E. LIST OF STAKEHOLDER MEETING — ATTENDEES

	INSTITUTION	NAME
Government	*President of the Environmental Commission/ President of the Territorial Environmental Agency*	Benoit Chauvin
Government	*Conseiller territorial*	Maxime Desouches
Government	*Territorial Environmental Agency (ATE)*	Olivier Raynaud
Government	*Territorial Environmental Agency (ATE)*	Karl Questel
Government	*Territorial Environmental Agency (ATE)*	Jonas Hochart
Government	*Territorial Environmental Agency (ATE)*	Sébastien Gréaux
Government	*Territorial Environmental Agency (ATE)*	Cécile Breton
Government	*Economic, Social, Cultura,l and Environmental Council (CESCE)*	Rudi Laplace
Regional Bodies	*IFRECOR/DEAL*	Fabien Barthelat
Regional Bodies	*Shark Network of French Antilles*	Oceane Beaufort
Regional Bodies	*Marine Turtles Network of Guadeloupe*	Antoine Chabrolle
Regional Bodies	*INRA*	Eric Francius
Environmental NGOs	*St Barth Essentiel*	Helene Bernier
Environmental NGOs	*St Barth Essentiel*	Pierrette Guiraute
Environmental NGOs	*St Barth Essentiel*	Nancy Marty
Environmental NGOs	*St Barth Essentiel*	Michel Chevaly
Environmental NGOs	*St Barth Essentiel*	Brigitte Feillet
Environmental NGOs	*Association for Bird Protection*	Jean Jacques Rigaud
Environmental NGOs	*Coral restoration St-Barth*	Didier Laplace
Environmental NGOs	*ARTIREEF / Dive clubs*	Turenne Laplace
Environmental NGOs	*BIOS*	Gilles Leblond
Users	*Dive Clubs*	Bertrand Caizergues
Users	*Technical director / Hotels and villas of St Barth*	Jean-Baptiste Gasquet
Users	*Hotels and villas of St Barth*	Nathalie Soubira
Users	*Hotels and villas of St Barth*	Mariangela Dalla Longa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