# Payments for Marine protected area ecosystem services in the Caribbean (CARIPES)

**Report 4.1 – Valorisation of fishermen's knowledge**

**Report 4.2 - Study of the knowledge of the fishermen relating to the capacity of resilience of the ecosystems of the AMP with respect to the global changes**

**Report 4.3 - Determination of the elements of knowledge having to be integrated into the process of governance of the MPA and being able to be the subject of a gratification**

**Iris Monnereau**

**February 2017**

**Preparatory Action 'BEST' (Voluntary scheme for Biodiversity and Ecosystem Services in Territories of the EU Outermost Regions and Overseas Countries and Territories).**

# WP4: Valorisation of fishermen's knowledge

**Abbreviations**

| | |
|---|---|
| CBD | Convention on Biological Diversity |
| ES | Ecosystem Services |
| FK | Fishers Knowledge |
| MPA | Marine Protected Area |
| NGO | Non-Governmental Organization |
| PES | Payment for Ecosystem Services |
| SNMP | St Eustatius National Marine Park |
| STENAPA | St. Eustatius National Parks Foundation |
| WCCBMPA | Woburn Clarkes Court Bay Marine Protected Area |

## 1 Introduction

Marine Protected Areas (MPAs) are considered to be an essential element in fisheries management and have become increasingly popular as policy instruments. Globally, MPAs have been shown to increase fish size, density, biomass as well as species richness (Starr et al. 2015). These increases can also be seen beyond the boundaries of the protected area, so-called ‘spillover effect’. MPAs are thus considered an important tool in stock replenishment, long-term food security and fishing-related livelihoods (Reuchlin-Hugenholtz and McKenzie, 2015). MPAs are areas of coastal land and water that are specifically designated to protect natural resources and ecosystems. Most MPAs have been restricted to national waters, with MPAs now covering 6.6 percent of delimited EEZ globally. Targets for MPAs have been set through the World Summit on Sustainable Development in 2002 to develop representative networks of MPAs by 2012, and through the Convention on Biological Diversity (CBD) 2006 to protect 10 percent of ecological regions in marine areas under national jurisdiction by 2010. Initiatives such as the Micronesia Challenge, Coral Triangle Initiative and Caribbean Challenge Initiative are attempts to address these conservation targets. In the Caribbean Antigua and Barbuda, the Bahamas, Grenada, Jamaica, Dominican Republic, Saint Lucia, St Kitts and Nevis, and St. Vincent and the Grenadines have signed on to the Caribbean Challenge to effectively conserve 10 percent of marine resources by 2012 and protect 20 percent of their nearshore area by 2020. In 2010, global coverage by about 6,000 MPAs was, however, not yet 1.5 percent (McConney and Pena, 2012). Globally, there is a wave of environmental groups, politicians and ecologists pushing for the large-scale implementation of MPAs, with many calls for protecting 20–30 percent of the oceans. However, although MPAs are a promising tool for fisheries management and conservation of biodiversity, they are not a remedy for all fisheries management problems.

In the Caribbean, MPAs are widely used as a tool for biodiversity conservation and fisheries management. They have proved to be effective in terms of contributing to coral reef rehabilitation, protecting seagrass habitats, and increasing biodiversity and aquatic animal biomass inside their boundaries in numerous locations in the region. For this reason and in response to international commitments, the number of MPAs has increased to approximately 385 within recent years (FAO, 2015). While most MPAs appear to address certain ecological objectives well, their performance in terms of meeting social and economic objectives requires strengthening. Management performance of existing MPAs in the region is considered low (McConney and Pena, 2012) and despite the popularity of this management tool, increasing evidence shows that many fail to achieve conservation objectives in spite of the implementation of rigorous management practices (Rinkevich 2008).

In recent years many protected areas management regimes engage local communities and consciously seek to balance conservation with local livelihoods. Often it is now considered important to incorporate new partnerships for establishing effective and participatory MPAs, for example by establishing partnerships between protected area agencies and scientists which can bridge research and monitoring gaps in a mutually beneficial way. This can not only provide information for managers but also build a supportive community for conservation. Building solid relationships with local communities and fisherfolk can be considered crucial for effective MPA management. In addition, there is growing support for the use of economic incentives to induce people and industries to take account of the environmental externalities linked to their behaviour. One such tool includes the market-like Payment for Ecosystem Service (PES), which have been defined as voluntary and conditional transactions over well-defined ecosystem services (usually divided into a) supporting, b) provisioning, c) regulating, and d) cultural services), between at least one supplier and one buyer. The basic idea behind these mechanisms is that the beneficiaries of an ecosystem service compensate those who either provide or impact the provision of the ecosystem service. The beneficiary of the ecosystem service (ES) is thus dual: both biodiversity itself as well as the direct users of the ES.

PES are a form of market-based incentives (MBI) and can provide a source of income for the management, restoration, conservation, and sustainable use of ecosystems and environmental areas. PES are provided to resource users or owners in exchange of the agreement to implement specific activities, which are aimed at the promotion of sustainable management of the areas taken into account. PES is a tool to buy conservation and generate sustainable funding, where the "user pays" and "provider gets" elements of PES jointly assure a socially efficient resource allocation (Wunder 2008; Corbera, 2012). The establishment of a payment for ecosystem services (PES) scheme within MPAs in Caribbean islands aims to promote such efforts by establishing a fund transfer from the users to the fishers. In Chile, studies have identified possible complementary income streams to scale up and finance MPAs in various forms, including PES schemes (Gelcich et al. 2011), the sustainable harvesting of resources within the protected area (Gelcich et al. 2012), and the creation of additional income sources for the communities and protected area agencies in the surrounding region.

The objective of CARIPES project is to make coastal fishermen playing an active role in the conservation efforts and sustainable use of marine resources in Caribbean MPAs. The implementation of a system of payment for the ecosystem services produced within a MPA (under development in Martinique, St Eustatius and Grenada) aims at promoting such efforts investigating the way traditional Fishers Knowledge (FK) can be used to design PES schemes. Fishers possess wealth of knowledge and experience based on their daily activities that is extremely valuable for research and management of fisheries and MPAs. As a result of their daily fishing practices they possess knowledge in terms of seasonal and annual fluctuations, species behaviour, and local and global changes. The long-term empirical data obtained by fishers are often very important when examining trends in resource abundance, catch size, fish size, fish movements, spawning habits and habitat quality. For example, fishers are often well aware that many species are predictably seasonal in their movements between habitats and/or geographic locations and as a consequence they move their fishing effort between habitat patches as productivity and the species assemblages found vary through the seasons. It can allow these trends to be examined over time and across space. Incorporating FK in various stages of the management process can enhance the effectiveness of fisheries management plans since it is locally owned and managed resources provide efficiency to development process in reaching the local users (Fischeer et al., 2015). FK comprises "the body of experiential knowledge including ecological, resource-based, ecosystem, fishing practices, fishing communities and livelihoods, governance and markets, and their dynamic relationships" (Fischer et al. 2015). This knowledge is developed in a social-cultural and geographical context and will differ per fishing group (scale, gear and technique. While PES has gained popularity in terrestrial environments such as forest and watershed ecosystems, their application in coastal and marine environments is still in its infancy (Mohammed, 2013; Bladon et al. 2014). If well-designed, PES schemes, could play an important role in conserving, restoring, and co-management of marine and coastal resources (Mohammed, 2012, 2014). This report will examine the potential use of FK on the topics of coastal and marine biodiversity, resilience of marine ecosystems towards global changes, and the use of elements of this knowledge to develop appropriate PES schemes in the Caribbean. The CARIPES project, which covers three Caribbean islands (Grenada, St. Eustatius and Martinique) aims to provide pathways for the development of compensation mechanisms (payments for ecosystem services) and support fishers reaping economic benefits of protected areas.

## 2 Pathways for Payment for Ecosystem Services in the fisheries sector

The application of PES in coastal and marine environments is still in its infancy (Mohammed, 2014; Bladon et al. 2014), due to 1) the fact it started with terrestrial and watershed ecosystems and might not have reached marine management yet; 2) marine resources are unlike species from terrestrial ecosystems and highly mobile and difficult to monitor. The fluid, transboundary and often common pool nature of marine ecosystems presents challenges for both PES design and implementation; and 3) ownership and property rights are often ill-defined or only traditionally recognized and thus difficult to implement, monitor, and enforced. Payments of marine ecosystem services (ES) thus raise significant issues related to who holds the rights to ES, more so than in terrestrial systems. However, if well-designed it could play an important role in conserving, restoring, and co-management of marine and coastal resources (Mohammed, 2012, 2014).

PES could potentially be used to address current gaps in fisheries governance (Bladon et al., 2014). PES schemes can also be used for example to address data collection gaps and fishers get rewarded for systematically collecting data. PES schemes can be developed separately or an element of PES can be incorporated in existing regulatory mechanisms (such as data collection initiatives). Used in combination with conventional regulatory approaches, PES may increase private sector engagement and generate more sustainable financing for fisheries management whilst spreading accountability throughout the supply chain. There are opportunities for PES in fisheries, however, the potential for successful application of PES depends on the institutional context and requires creative and innovative approaches to the maintenance of conditionality and additionally. PES projects can be developed in the roam of data collection, fisheries management and monitoring or for example linking the fisheries sector to tourism. In the Data Base of Projects of Payments for Ecosystem Services in Latin America and the Caribbean[1] it shows that most projects have taken place in Central and South-America and only very few have been executed in the Caribbean. Those projects in the database in the Caribbean are mostly in larger Caribbean countries (e.g. Jamaica) but not in the smaller islands. In addition, the projects rarely related to PES in the marine environment but mostly related to terrestrial activities.

However, globally a growing number of examples point to ways in which adding PES to existing 'regulatory' schemes can make them more effective in protecting both environments and livelihoods in the roam of the marine and coastal environment (Mohammed, 2012). One can identify some main reasons for which PES could be (and have been) provided to fishermen in exchange of the contribution to the sustainable management of the marine environments with some examples (see figure 1):

[1] http://www.apps.oas.org/pes/default.aspx

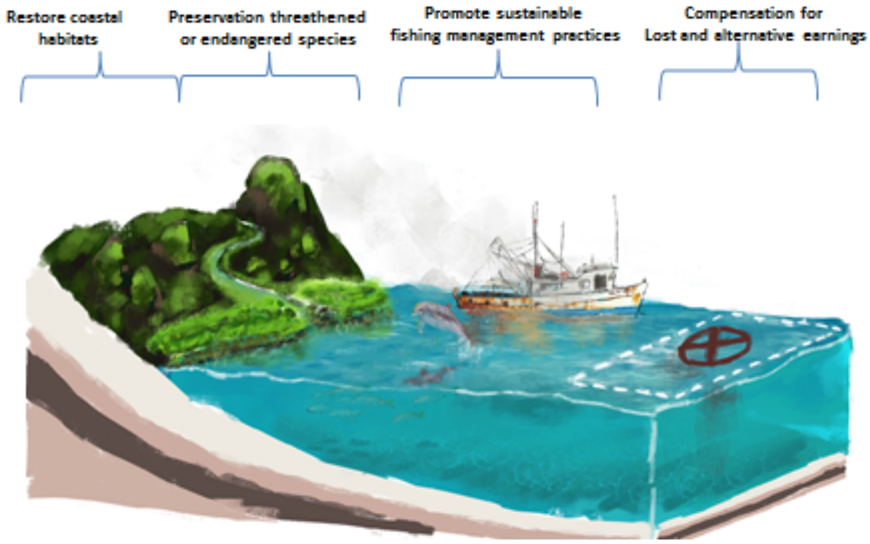


**Figure 1: Various PES options for sustainable in the marine environment**
Source: Noah Monnereau (adapted from Mohammed 2012)

1. Restoring or preserving coastal ecosystems
    - The Manzanar project in Eritrea offers coastal communities small financial and in-kind benefits to plant mangrove trees. In return for their labour, project participants which mostly consisted of poor women receive a free meal and US$1.33 every working day; the poorest households are also given sheep and goats.
    - Mikoko Pamoja is a mangrove restoration and reforestation project currently being implemented in Gazi Bay, Kenya. It is a community-led project financed by voluntary carbon credits whereby part of the money generated is stored in a fund (33 percent) while the remaining funds are used for staff employment and MCS and community projects.
2. Conserving threatened or endangered species
    - The Luis Echeverria community in Mexico agreed to protect about 48,500 hectares of grey whale habitat in exchange for annual payments of US$ 25 000 to support small-scale development projects. Payments have been used to provide training in business skills and launch new income-generating activities.
3. Using sustainable (management) fishing practices
    - In Belize community members receive training and a stipend for involvement in a program for capturing landing data
    - In the Northern Gulf of Mexico the Government engaged in a buyout of fishing nets and a program of reduction of fishing effort for approximately $1 million US. This was done to protect the vaquita (Phocoena sinus) stocks, a rare species of porpoise, in the region.
4. Compensation for lost earnings during closed season and areas, i.e. due to the imposition of MPAs where fishing is restricted (or no-take zones) and provision of alternative livelihoods:

- In Belize and Honduras there are various programs to encourage supplemental livelihoods development, including micro-grants for fishers and their families. Belize also has an example where community members receive training and a stipend for involvement in MPA bio-physical monitoring.
- In 2005 the Kuruwitu Conservation and Welfare Association established a 'no-take zone' in Kenya two $km^2$ no-take zone was established in response to significant declines in fish catches in the area. During the following six months, local fishermen were paid by the International Union for Conservation of Nature (IUCN) for not fishing in the area which had positive ecological effects.

In the CARIPES project we are interested to investigate how TK has been and can be incorporated in the various types of PES schemes (e.g. by means of data collection, management of the fishery or tourism related activities).

**3 Methodology**

This report draws on multiple methods used in fieldwork in the Caribbean islands of St. Eustatius, Grenada and Martinique. In addition, secondary literature was used. The work in St. Eustatius and Grenada is based on fieldwork by Iris Monnereau, the fieldwork in Martinique has been conducted by Myriam Thirot. The comparative case-study approach is valuable for examining the relationship between contextual factors and a specific research topic. During fieldwork in the three countries, informal interviews as well as unstructured and semi-structured in-depth interviews were conducted, and participant observation was carried out by means of fishing trips (lobster and fin fish fishing in St. Eustatius, sea urchin fishing in Grenada). The interviews were carried out with fishers, fisherfolk leaders, government officials, and civil society organizations. The information presented is based on 10 interviews in Statia and 10 interviews in Grenada and 16 in Martinique. Interviews lasted between 30 minutes to 2 hours and were conducted at various places including landing sites, bars and fishers' houses. The interviews were conducted in February 2016 in St. Eustatius, in April and May in Martinique and in June 2016 in Grenada.

The three main topics of Workpackage 4 of the CARIPES project are:

1) *Assessment of the knowledge fishers relating to marine and coastal biodiversity;*
2) *Assessment of the knowledge of fishers regarding the capacity of resilience of the ecosystems of the Marine Protected Area with respect to the global changes;* and
3) *Determination of the elements of traditional knowledge of importance to be integrated into the process of governance of the MPA.*

A set of 29 questions (identical to the three sites surveyed) helped identify and analyze all the elements that can contribute to improving the health conditions of ecosystems and the ability of fishers to mitigate and adapt to global change (including climate change). The interview schedule included several items: socio-demographic characteristics (age, gender, place of residence, nationality, language), the status and career (date and installation procedures, work experience), activity fishing (duration, species, places, techniques), the observations of the state and the development of species and the marine environment over the past decades, the perception of the effects of climate change on the resource, and possible solutions and strategies to deal with

challenges. Fishers were also asked to discuss seafloor areas and habitats (mostly based on already existing maps) to discuss fishing, spawning and nursery areas. The sample of fishers is comprised by a diversity of ownership and crew members, ensuring a wide spectrum of responses and access to various existing categories in the professional group. In addition, possible ways in fisher involvement in PES was discussed. In St. Eustatius and Martinique fishers were generally very opposed to the creation of the MPA whereas in Grenada fishers were more positive (also because the MPA would not restrict fishers access (except for one gear type which was hardly used) but only of other user groups (e.g. yachts).
Some fishers fiercely opposed the creation of the MPA in Martinique and did not wish to participate in the survey. The survey can be found in Appendix 1 and was administered in English (St. Eustatius and Grenada) and French (Martinique).

**4 Case study information**

*4.1 Grenada*

The main island of Grenada, along with Carriacou and Petit Martinique, have a combined land area of 353 km$^{2.}$ The islands have a steep and hilly landscape surrounded by coral reefs, mangroves and seagrasses. There are approximately 2 805 fishers in Grenada working on 770 fishing vessels. The total production is 2 974 Metric Tonnes. Fish makes up a large part of the diet in Grenada with 28% of the animal protein coming from fish.

In Grenada there are three designated MPAs:

1. Molinière/Beauséjour (0.8 km2)
2. Woburn-Clark's Court Bay MPA (4.2 km2)
3. Sandy Island (6.6 km2) (2009)

In 2001 Grenada established two MPAs under the Fisheries Act: Molinière/Beauséjour and Woburn-Clark's Court Bay, while Sandy Island/Oyster Bay on Carriacou has recently been approved by Cabinet in Grenada. No management plan has been prepared, however, for the Woburn Clarkes Court Bay Marine Protected Area (WCCBMPA). There are currently an additional 12 proposed MPAs which have a combined area of 219.3 km$^2$ as Grenada has pledged to effectively conserve 25% of its nearshore marine area (and at least 25% of its terrestrial area) by 2020 as a means to contribute to the sustainable livelihoods for its people and contribute to the protection of the world's biodiversity. Fishers are mostly multi-species fishers whereby they only use one gear type per day. One day they will go to the coral reefs spearfishing, one day they will collect conchs from the seagrass beds and another day they will engage in sea urchin fishing. So even though they are multi-species fishers they mostly do not engage in multiple gears in one day.

The WCCBMPA was initiated by the Fisheries Division of the Ministry of Agriculture, Forestry and Fisheries during the 1990's. The Grenada Fisheries Division developed a MPA programme in 1980, with assistance from an external funding source. Grenada's WCCBMPA extends between Woburn and Calivigny Bays and contains the largest intact mangrove ecosystem in the country. The boundary of the MPA was decided on for merits such as: natural enclosed sea space involving a marine close-to-shore 'basin' adjacent to two small islands (Hog island (80 acres) and Calivigny Island (<75acres); having the three marine ecosystems of mangrove, sea grass beds and shallow water coral reefs; and the presence of the community at Woburn Clarkes Court Bay on the land-side. The mangroves provide critical habitat and erosion protection over three miles of coastline. It acts as a nursery for commercial fish species and as a nesting, roosting and feeding area for resident and migratory bird species. The swamps also provide protected habitat for native iguanas, snakes, and a variety of terrestrial wildlife. There have been mangrove restoration initiatives in the area. These have been hampered, however, by the recent development of the Marina in the harbour of Woburn.


**Figure 2: Sign in the Woburn Clarke's Court Bay MPA**
Source: Iris Monnereau

In addition, there is no actual implementation of the MPA to date and to date there has been no enforcement. However, independent consultants are working with the Fisheries Division to develop the Woburn/Clarke's Court Bay MPA (WCCBMPA) management plan and zoning plans. The Woburn community traditionally maintained livelihoods as farmers on lands surrounding the village, as workers at the local sugar factory, as fishers of conch, lobster, turtles and fin fish and, in recent times, at a variety of other occupations. Woburn is known as a fishing village; it is still very much so but the current commercial fishers, currently fish in a much wider range than previous and fish outside of the WCCBMPA as well. The community has also become less dependent on farming and

**Figure 3 WCCBMPA area**
Source: Iris Monnereau

fishing then previously and now also depend on the services-sector for employment and livelihoods. This is also as the bay is used more and more for yachts. The community (and fishers in particular) as a result have strong economic relationship with the offshore (marina, resort, yacht anchorage) communities mostly as services-providers (e.g. bring yachters to their boats; guard their boats while they are gone; sell them fish; bars and restaurants). The proposed MPA will not prohibit fishing (except for net fishing which is not conducted at a large scale) but will stop use by other user groups (e.g. yachts). Fishers were therefore rather positive on the establishment of the MPA and wished there would be enforcement.

*4.2 St. Eustatius*

Healthy coral reef ecosystems and sustainable fisheries are of utmost importance for the small island economy of St Eustatius. St. Eustatius lies in the North Eastern Caribbean within the Lesser Antilles island group. St. Eustatius (21 $km^2$ in landmass), a special municipality of Kingdom of The Netherlands, is located in the north-eastern Caribbean. St Eustatius National Marine Park (SNMP) was established in 1996 and became actively managed in 1997 and extends around the entire island from the high water line to 30m depth contour. From 1996 the SNMP included two marine reserves, the smaller Northern Reserve (163 ha; rezoned in 2015 as harbour area) and the Southern Reserve (364 ha), in which no fishing or anchoring is allowed. Diving is allowed and dive moorings have been installed to protect the reefs. The reserves, which together cover an area of approximately 5 $km^2$, have led to a tenfold increase in the numbers of several fish species.[2] Other research indicates, however, the positive results have been very limited. The SNMP protects a variety of habitats, including pristine coral reefs (drop off walls, volcanic 'fingers' and 'bombs', spur and groove systems), 18th century shipwrecks and modern-day artificial reefs to promote fishing and dive tourism.

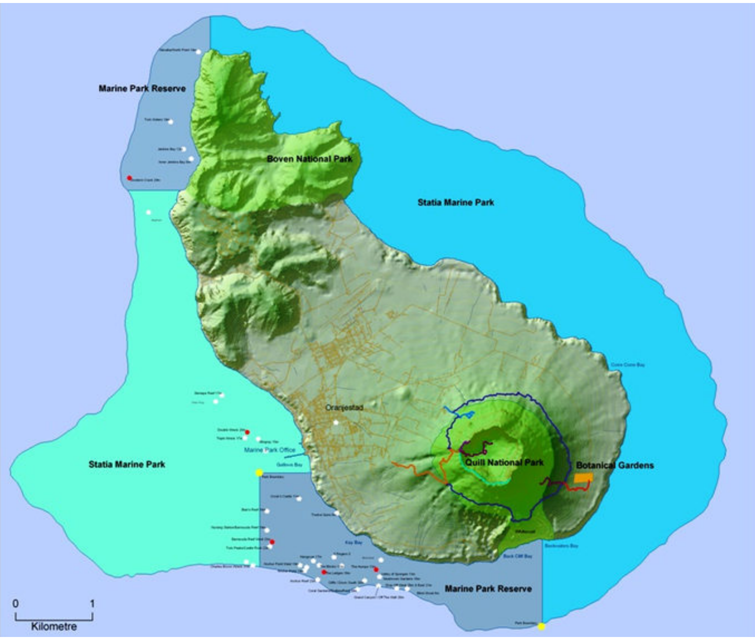


**Figure 4: National parks (including the MPA) in St. Eustatius.[3]**

The marine park falls entirely within the territorial waters and jurisdiction of St. Eustatius and is protected by the Marine Environment Ordinance which was passed in 1996. The SNMP marine environment is a home, migratory stop over or breeding site for 4 IUCN Red List Species, 10 CITES Appendix I species and 98 Appendix II species (Stenapa, 2007). For issues related to international treaties, threatened and endangered species, migratory species and marine pollution the Central Government Department of Nature and the Environment also has jurisdiction although by the EU it is seen as an Overseas Territory. In the current form of

[2] http://www.dcnanature.org/st-eustatius-national-marine-park/.
[3] http://www.dcnanature.org/st-eustatius-national-marine-park/

government the Caribbean Netherlands (Bonaire, Saba, St Eustatius) fall directly under the State and hence the Minister of Economic Affairs is directly responsible for the realisation and implementation of international treaties and conventions regarding the management of fish stock, biodiversity and coral reef habitats in the territorial waters and economic exclusive zone of the three islands (De Graaf et al., 2015).

The Marine Park is managed by a local non-governmental organization (NGO) called St. Eustatius National Parks Foundation (STENAPA). STENAPA has a co-management structure with stakeholders, conservationists and other interested parties on the board. The management of the marine park is carried out by the Parks Manager and the park rangers. Two office administrators also work on the marine park administration and organisation and an education and outreach officer is shared with the nearby Dutch Caribbean islands of Saba and St Maarten. In addition to regular mooring maintenance (dive, snorkel and yacht sites), patrols and research, the Marine Park works closely with three local dive centres to ensure that diving practices minimize impact on the reef. The SNMP attracts around 500 yacht visitors and 2500 diving/snorkeling visitors per year contributing to income for the large majority of the islands population employed in restaurants, hotels and other services. Other uses of SNMP area are for fisheries and use by approximately 1000 tankers a year using the oil storage facility at Statia Terminals NV. Today, the fishery on the island remains very small-scale in nature, with around 20 fishing vessels in operation. Only 15-20 fishers are present whereby only 8-10 fishers are considered fulltime. Principal fishing methods used are traps, hook and line trolling and occasionally nets. Fishers are mostly multi-species fishers using different gears for the different areas. Fishers target a variety of demersal reef fishes (e.g. groupers, squirrelfish, blue tang, cowfish and doctors fish, red hind, snapper) and high catches of lobster and conch between September and December. Fishers also catch pelagic fish including wahoo and dolphin fish but at a smaller scale then reef and reef associated fish. Fishers have a negative attitude towards the establishment of the MPA in the 90s as they were not consulted in the process. Consider the MPA to have taken away the majority of their good fishing grounds and have jeopardized their traditional fishing practices. It has been argued that it has also affected their safety as they now have to fish on the windward side of the island.

### *4.3 Martinique*

The MPA of Le Prêcheur in Martinique was created by a deliberation of the “Conseil Régional de Martinique” on October 14th 2014. The MPA is being promoted by the local institution Collectivité Territoriale de Martinique. The project has faced resistence of fishers. Although the MPA exists on paper since October 2014 it has not been in official operation as many stakeholders (fishers, green movement NGOs, local government and tourism sector actors) are in disagreement on the management and boundaries of the territory of the MPA. The likely effects of the MPA can be expected to have negative economic consequences on the income and livelihoods of fishers (Failler et al, 2013)

## 5 Data results

### *5.1 Knowledge of fishers regarding coastal and marine biodiversity*

In the three cases fishers indicated detailed knowledge of the various habitats and the species that occur in these habitats. The ecosystem knowledge of fisher has derived from daily presence at sea and from information conveyed by peers. The traditional knowledge concerns ethology of species, physical characteristics (height, color) and morphology of the seabed with specific information on the localization of spawning and feeding grounds. Generally fishers explained changes due to a number of factors: 1) changes to the marine environment as a result of changes in the interdependence between species (predators-prey) and between environmental resources and impacts thereon (e.g. pollution, destruction of habitat). Fishers were able to distinguish in this regard between local and global drivers of change (sewage run off versus increase of the temperature of the sea, with resulting coral bleaching) although their ability to do so greatly depended on each individual fishers). They were also able to provide impacts of human practices on marine health (e.g. new techniques, intensification of fishing effort, spatial competition).

In WCCBMPA in Grenada there are three ecosystems: mangrove, sea grass beds and shallow water coral reefs attracting different target species. Fishers indicated in the interviews seagrass beds provide conch and lobster habitat but also fish, and sea turtle and bird hunting areas. Coral reefs provide habitat for lobster and demersal reef fish (e.g. parrot fish, grunts, groupers, triggerfish, snappers). Some reef-associated pelagic species are also caught by fishers e.g. barracuda (Sphyraenidae), various jacks and small tunas and mackerels. Fishers also catch sea turtles (hawksbill turtles) which come to feed. Sea urchins were also caught locally both at reef patches as well as in seagrass bed areas. Fishers were not able to indicate spawning aggregations of particular fish species in this particular area and indicated the spawning areas of the fish species they caught might be outside of their fishing area. However, they considered the mangroves in the WCCBMPA to be an important nursery grounds for certain key coral reef fish so they are well aware that destruction and pollution of mangroves (e.g. paint coming from the yachts) affects the health of the fishery. Fishers believed that mostly different types of parrotfish and grunts depended on the mangroves as their nursery habitats while two fishers also indicated the importance of the mangroves for the nursery habitats of sharks. Mangroves were also recognized as very important in protecting the community from heavy storms and storm surges and protect against coastal erosion.

**Figure 5: Various uses of the WCCBMPA area**
Source: Iris Monnereau

In St. Eustatius fishers also fish in a very traditional and small-scale way with open boats between 5-10 m in length and powered by a single or twin outboard engine (25-600 hp). There are only a very small number of fishers and the average age of fishers is high (+/- 50 years) with only a limited number of younger fishers (but all part-time who only fish every few days to once a week). The full-time fishers do not engage in any other economic activities, the remaining fishers indicate they work alongside (e.g. in the oil terminal). These numbers shows the limited fishing effort currently in place in St. Eustatius. Most fishers use a variety of fishing gears (e.g trap fishing and spear fishing) while a few fishers only engage in line fishing (either handline or trolling). The most commonly used fishing gear are Antillian style arrowhead traps, usually build from chicken wire around a wooden frame (see figure 7). In addition to trapping, speargun fishing is carried out (targeting fin fish) and lobster are also caught by free diving. Only limited commercial SCUBA diving at present is being carried out.

**Figure 6: Fisher in Statia beside an Antillian style trap.**
Source: Iris Monnereau

Fishing effort is concentrated on a relatively small area on the leeward side of the island, limited by the two reserves and area actively used by the tankers of NUSTAR oil terminal. Fishers indicate the rougher windward side of the island is often not accessible to the small fishing vessels due to the weather and wave condition  Fishers indicate the two designated marine reserves within the marine park (see figure 4) contain the main concentrations of coral reef and seagrass habitats of the island. They indicate other valuable habitats lie outside these reserves but that the most productive fishing grounds are inside the marine reserve. Fishers indicate specific knowledge of the various habitats and the species that occur in the various habitats. Fishers describe the various environments and the types of fish that occupy those environments (e.g. the presence of lobster and demersal reef fish (e.g. grunts, triggerfish, snappers and snappers) albeit not very detailed. Their target areas are not determined solely by productivity of the various habitats, however, but also by wind (leewards vs windward side of the island) and the fact the anchoring of the large tankers destroy their traps.

**Figure 7: Hauling traps with a tanker and St. Eustatius in the background.**
Source: Iris Monnereau

The tankers destruct the coral reefs that were present as well as the seagrass beds that were present in these areas. The hundreds of tankers have impacted the seabed to the extent that few fish can be found in those areas according to the fisher as their habitats have been destructed. Fishers indicated lobsters are mostly caught between September-December when the lobsters are migrating through the area and can be easily caught.

The windward side of the island is more produce for pelagic species fishers concluded although in recent years the placed Fish Aggregation Devices (FADs) also attract pelagic fish and include for example sharks. The windward side used to attract large schools of frys but they are not as abundance as in previous years and were rarely fished by fishers. Fishers know it is illegal to fish in the MPA but most indicate they have continued to do so as the abundance of fish is higher. The reason for this according to the fishers is not because there is less fishing effort but because these are the most productive fishing grounds due to the presence of coral reefs and associated habitats and lack of tankers.

In Martinique fishers expressed knowledge of the oceanographic components by observing the links between the direction and the intensity of the current, the temperature of the water and the localization of different species. Finally, they observe the links between climatic data (seasons, force of the wind) and the size and the wealth of species. Fishers knowledge related primarily to the physical characteristics (size, color) and fish habits. Classifications of species are operated according to their breeding and presence from the shoreline (goldfish to the coast, pelagic fish off) and depending on the depth where they live (saury surface, bottom fish at the coast ). The making of different types of bait (plants, fish) and places of presence of juveniles allow callers to identify the food chain by species (seagrass or fry). Large predators are specified (sharks, fish-lions). Depending on the times of plenty of fishing (September to April) or "famine" (May to September), fishers identify the period of breeding and movements of each species of fish. Thus, fisheries venues are increasingly diverse, distant; fishing perimeter (ie observation) extends in size and distance for twenty years. Observation of locations and species displacement is combined with that of oceanographic elements. The direction and intensity of the currents have effects on the presence of surface species (such as flying fish and saury) or to the coast (coulirous, mackerel, red fish). Knowledge of climate such as the temperature of the water, the wind, the size of swell are also mobilized to understand the movement of species but also the impact of these factors on reproduction (eggs hatch, habitat quality ). Finally, the lunar months are considered to intensify or not fishing at the coast. The first type of explanatory factor is the changes of the marine environment. First, fishermen have a knowledge of the interrelationships between species. The accidental appearance of a fearsome predator (lionfish) in the waters of the Caribbean would be the main reason for the decline of the species fished in a traditional manner (nets lagging, lockers, seines). Then the fishers have acquired knowledge of the interactions between fisheries resources and plant species. For example, the Sargassum algae invasions caused changes in sizes and the loss of species (bream, flying fish).

*5.2 Impacts and resilience of the ecosystems of the MPA with respect to local and global changes*

The fisheries sector in the Caribbean has been severely affected over the past decades by several factors including overharvesting, illegal fishing, pollution, coastal developments, tourism development and other maritime space users as well as climate change impacts. We asked fishers in the three countries to express the local and global changes they had witnessed over the past decades and how this affected their fishery.

In Grenada fishers indicate the fishery has been affected by several developments over the past decades: coastal developments by building marinas and houses; increased number of yachts in the bay; destruction and pollution of mangroves; and the incidence of hurricanes and coral bleaching. Fishers explained that the high increase in yachts and boats in the bay over the past 15 years has severely affected the fishery. Coastal developments in the bay have been profound. Clarkes Court Boatyard & Marina (formerly known as Clarkes Court Bay Marina) is sheltered boatyard and marina boasting a 242-tonne boat-lift which is located right inside the MPA. The construction of this Marina has destroyed part of the mangroves which the MPA is meant to protect. They recognized that anchoring

**Figure 8: Sea urchin fisher in Grenada**
**Source: Iris Monnereau**

affects the health of the marine ecosystem in the bay as well as the discharge the development of the marina has brought the bay a high level of pollution that has affected the fishery negatively. According to fishers there used to be only a few yachts anchored in the bay, now there can be up to 100. The fishers indicate that there is clear evidence of active substances used in antifouling products being detrimental to aquatic organisms in the bay. Local fishers indicate declining trends for conch and lobster, yet that the coral reef fishery is considered to be reasonably good according to fishers. Fishers are very aware that all longer-stay vessels mooring within the MPA do not have grey water holding tanks nor are they obligated by law to periodically empty tanks at sea or at on-land sewage disposal facilities. Fishers indicate there is evidence of increasing levels of sewer waste being let out in the MPA zone which destroys marine life by affecting water quality. A major threat beyond overexploitation of fisheries and physical destruction of marine coastal habitats by dredging, is undoubtedly the strong increase in coastal development and discharge of untreated sewage into the near-shore waters, resulting in enormous amounts of nutrients spreading into the sea and coastal zones. This affects the coral reefs and mangroves according to fishers and thus affects the production of reef and reef associated fish species.

According to the fishers a series of hurricanes, Lenny (1999) and Ivan (2004), followed by Hurricanes Dennis and Emily (2005) have all contributed to physical damage of the reefs. especially the elkhorn coral (*Acropora palmate*) as often there are short-lived algal blooms after hurricanes. The hurricanes destroyed parts of the coral reef causing disturbances to the fish habitats. In addition, hurricanes such as hurricane Ivan destroyed large parts of the mangroves. This resulted in destructed of the adult and juvenile feeding grounds as well as spawning grounds affecting the long-term sustainability of the fishery according to fishers. Fishers recognized that the destruction of mangroves as a result of man as well as hurricanes resulted in fewer fish as nursery habitats affecting, for example, the shark fishery. Fishers recalled seeing tons of small sharks in the mangroves when they were young. They would go into the mangroves to feed but now you rarely see them according to fishers.

Fishers indicated that there have been various coral bleaching episodes. They recognized that in 2005, 2008 and 2010 there was strong coral bleaching although in other periods this could be noticed too. Reefs would turn white and green and affect the ability of fishers to catch fish as the health of the coral reef was affected. The fishers noticed less parrotfish, groupers, and snappers and fish would be smaller in size. Fishers recognized there were fewer large parrotfish and as a result less grazing of algae. This lead to less fish for fishers to catch as health of reef is jeopardized.

Fishers in St. Eustatius indicated the fishery is threatened by coastal development, anchoring of tankers, oil spills and tourism expansion as well as sewage and ballast water entering the waters. Fishers indicate coral cover has diminished over the past decades. Anchor damage to the reefs of St. Eustatius reduces marine biodiversity according to fishers as it directly effects fish populations by impacts on the fish habitats. The boats also cut away fish trap markers and cut lines of fishers. The increase in boat traffic, combined with the expansion of the Terminals' own fleet (tugs, barges, response vessels) is furthermore responsible for the increase in traffic between Oranje Baai and the Terminal. The increased traffic gives rise to increased incidences of anchor damage and increased conflict with other users of Oranje Baai. Fishers indicate that corals are broken, fragmented, or overturned as the anchor drops into the reef. Anchors cause further damage occurs by the chain dragging across the substratum or wrapping around reef structures. Reefs are turned into rubble and

leave a 'scar' on the reef. The anchoring causes a lot of rubble and sand, just like a hurricane would. All the cracks (or scars) get filled with sand and rubble and fish cannot use it to hide or breed. This severely affects the habitat of fish species and effects the health of the reef. The coral reef health appear to have been in decline for a number of years according to fishers. Fishers indicated they catch less large reef fishes then before (e.g. groupers and parrot fish). These larger herbivores are important for eating the macroalgae which have now become plentiful and dominate the coral reefs. Fishers also indicate that algea cover is higher than previous which they link to the absence of the herbivorous grazers (e.g. parrot fish). Some of the fishers realized that large herbivores need to be present for a healthy fishery. In addition, fishers indicated that the oil spillage and paint used on the ships affects their fishery as it affects the water quality and will thus in turn affect fish production.
Fishers indicate a decline in abundance of fish and fish species composition in the fishery around Statia. "*You don't see the fry [juveniles] like you used to. You used to see them all around here. Now you see none at all. It would attract jack benito and crevalli*". Another fisher indicated "*We used to have schools of jacks but these cavallis are gone. You used to set nets, you would get 200/300 cavalli's in one time. It's been about 10 years since we last saw these big schools of fish. Jacks come close to shore to lay their eggs, so that's why you have a chance to catch them. Now these chances are gone as they don't come to shore anymore*". As a result, fishers have stopped fishing with nets. According to fishers there used to be four fishers with nets, but now there is only one left but he barely sets the nets as the fish are gone and the yachts and diving boats have come in the way of the purse seine nets. Hauling nets is heavy work and used to require the help of approximately 20-30 people. In rumination the boat owner always gets half, whereas all pullers share the rest. Now the tradition of net fishing is disappearing from St. Eustatius.

Hazel is the oldest practicing fisher on St. Eustatius who is 81 years old and he has been fishing since he was 12 years old. He started fishing after his father died when he was 12 and he had to take care of his mother and all his 11 siblings as he was the oldest. When he started fishing 69 years ago he fished with wooden rods (just a sick) and the rope was made of twine or cotton. As there was a lot more fish back then he indicated you would catch fish even with these simple gears using soldier crab or lobster as bait.

**Figure 8: Hazel in front of his house with the wall he build of conch shells**
Source: Iris Monnereau

Later he tried spear gun fishing and made a speargun himself when some fishers from abroad showed him how to make it. He had a donkey which would wait by the shore so he could store his catch. "In those days the donkey was all the car you had'. He made his own speargun and his own mask. He used the rubber from car tires to make the outing of the mask. As fish and lobster were plentiful it wasn't difficult to catch them even with these simple gears. At present he only uses hand-line as he is too old to use any other gear. Has always continued fishing in the marine park despite the implementation of the MPA. He indicated they cannot stop him from going into the park but he is not afraid of the consequences as there are none.

Fishers indicate that 30 years ago they would go out fishing in the morning and catch 100 lbs. In the afternoon they would go out fishing again and catch another 100 lbs. Now fishers count themselves lucky if they catch 50 lbs. of fish for the whole day. Only a very small number of young fishers are active in the fishery. Two young fishers operate from a very small dinghy and are free-lung divers but also have a small number of fish pots. These young fishers can make a living from the fishery (although one also holds a job outside of fishing) and indicate they catch 50-80 lbs. of fish per day and regard the fishery as healthy. Only one other fisher indicated the fishery is doing well and indicated the reef is very healthy whereby the fishery is more healthy than the inshore areas of Saba. Generally speaking the fishers indicated that with regards to fin fish in St. Eustatius there was a decline in catches due to the inability to fish in the marine reserves, anchor damage from ships, oil spills from the terminal, impacts of paint on the hulls on the marine ecosystems and seasonal fluctuations. Fishers also indicate the loss of sea grass beds over the past 20 years have impacted the fishery. Lobsters appeared to be doing well with exceptional good catches over the past few years. This fishery mostly faced coordination and market problems rather than production or abundance problems. Fishers generally agreed that the conch population has remained constant yet only very few fishers catch it.

Interviewees indicate there was a period in 2005 and after where coral reef bleaching was taking place. The corals lost the algae upon which it depends for food and turns white. The bleaching appeared to be more severe in the more shallow areas of the sea. Since then, more recent coral bleaching events and possible water quality issues have affected the reefs. The loss of these corals could have negative effects on different ecosystems and marine biodiversity. Coral reefs form a natural protective buffer against storms, so a loss in coral cover will lead to an increase in negative impact from storms on e.g. housing and infrastructure and landing sites along the coast. However, fishers indicated they had noted that the reef recuperated and coral bleaching is currently not severe.

In Martinique fishers have witnessed increases in the level and temperature of the sea and their consequences such as a reduction of plankton and coral bleaching. They also observe climate change impacts in terms of changes to seasonal cycles of one year to the next with effects on reproduction, and the presence and abundance of fish. Fishers have also observed the observed trends concerning human activities. Some recognize that change and improvement techniques, intensification of fishing activity, geographic competition (between different fishers and fishing groups) have implications for fisheries production, reinforcing the need for early intervention and the introduction of sustainable and responsible fishing.

### *5.3 The elements of knowledge having to be integrated into the process of governance of the MPA and PES*

The previous sections have showed extreme in-depth knowledge of fishers in terms of coastal and marine biodiversity as well as the impacts and resilience of the ecosystems of the MPA with respect to local and global changes. We have seen that different types of fishers have different knowledge bases (e.g. pelagic fishers do not possess in-depth knowledge on the state of the reef yet they have indepth knowledge on changes in season and size of specific pelagic fishes). The results of the study have demonstrated knowledge of fishers on the state of marine resources and ecosystem health, interactions between climate conditions and the state of the marine habitats and soruces of pollution. This TK is important to be integrated into the process of governance of the MPAs and into PES schemes such as coral reef gardening, Blue Carbon Projects, alternative livelihoods by improving linkages with the tourism sector and data collection by fishers.

Proposed MPAs need to consist of crucial habitats that fishers indicate as consisting of important nursery habitats and feeding grounds including for example fringing reef, reef patches and seagrass beds and mangrove areas. The inclusion of this diverse set of habitats promises to strengthen the proposed MPA, as it accounts for development changes in habitat used by many species. And while small reserves (<1 $km^2$) can be effective, more recent research (Edger et al. 2014) suggests that large size is a strong indicator of MPA success which can explain the large MPAs which have been implemented in St. Eustatius and Martinique.

Some of the main PES schemes could center around coral reef gardening projects (e.g. in Grenada and Bonaire) and mangrove rehabilitation projects.Reef restoration projects have been considered an option to link market-based initiatives with improving coral reef health. Coral reef gardening can serve as an efficient way to perform long-lasting reef restoration, either on small or large-scales. It can be executed as a large-scale operation, financed by international bodies (i.e., the World Bank), or carried out as a small-scale operation by local communities and thus provide benefits to local users such as fishers. Fishers could use their knowledge on the reefs to optimize coral reef gardening projects while being paid to take care of the coral reef gardening projects. Achieving optimality would require more scientific work, but recent results on reef restoration in some areas in the Caribbean region have been promising, for example in Grenada and Bonaire.

There are options for Blue Carbon Projects which will support mangrove rehabilitation processes. Blue Carbon' is the carbon stored and sequestered in Blue Forest habitats such as mangroves, seagrass meadows, intertidal saltmarshes and kelp forests and beds. Restoring and protecting Blue Carbon can thus improve the sustainability of the fisheries sector and provide training and possinble remuneration for fishers. In the Caribbean region there is currently only one project which is being planned in the Dominican Republic. Mangrove area and health have greatly declined over the past decades in the Dominican Republic. The Dominican Republic can be regarded as taking the regional lead as it is the first country in the region to include Blue Carbon in the Nationally Appropriate Mitigation Actions (NAMA) proposed to the UNFCCC at the COP 21 in December in 2015. The Blue Carbon project of the Dominican Republic has the objective of enabling national climate mitigation through the conservation and restoration of mangroves, and includes capacity-building, technical assistance, and financing and sustainability activities. This could provide an example in some areas in Grenada.

Several MPAs have been created in the Caribbean region with the tourism sector in mind, and Statian and Grenadian fishers used the tourism sector to enhance their income (by supplying boat trips to tourists and by protecting the marine habitats that attract dive tourism). The tourism sector could thus be used as a way to monetize the implemented or proposed MPA. Even short-term MPAs are known to increase abundance and biomass of fish species, leading to increased recruitment and migration of fish into neighboring reefs, and thus improve the benefits for the tourism sector. The ability to reap benefits from these developments depends on the capacity of fishers in the three communities. A potential opportunity could lie in having the fishers benefit from increased marine park fee’s as they would act as guardians to the park. This is difficult however in terms of limited use of the national park by visitors and the potential for remuneration of fishers. For example, in St. Estatius, only 2500 park visitors (divers/snorklers) are registered. An increase in user fees of 1 dollar would only generate 2500 USD and thus only 250 per fisher which is minimal.

Fishers can support collecting data in terms of catch and effort. This information can feed into more systematized national data collection methods. Fishers can provide information about changes in reef health over time, the socioeconomic uses of marine resources, and the population dynamics of at-risk reef species. This data that can be difficult and time-consuming to gather using more conventional methods. The necessity of gathering such information is highlighted by the fact that species can be captured by both methods of data collection. By combining these two methods, researchers can construct a clearer and more complete picture of the reef ecosystem and fishers' needs. Based on this information, researchers can then tailor their recommendations for proposed or already implemented MPAs to the habitat needs of targeted species, while taking into account the subsistence needs of local fishing communities. Fishers could be compensated by means of training or monetary remuneration.

In some cases, fishers indicate they do not wish to change their fishing practices as fishing is their way of life. Even if they gain monetary gains from giving up their traditional practices it must be worthwhile for fishers do so. Their job satisfaction is considered to be very high and changes to their lifestyle might be difficult to pursue. It is therefore important to develop PES schemes that improve the current lifestyle of fishes but not radically change it. Younger fishers might be more inclined to change activities and for example expand into alternative livelihoods, as well as those better organized and with higher levels of capacity (e.g. in terms of organization of fisherfolk).

**6 Conclusions**

Fishers have a wide range of traditional and local knowledge. In recent years there has been a growing interest in the value of traditional knowledge, particularly in the way that fishers organize themselves to manage their livelihoods, their daily fishing practices and the natural resources on which they depend, and as a mutually acceptable basis on which to build their participation in improved governance. It is important to note the inequalities of resource use and technological advance within the fisheries sector and between various types of fishers. Recent international meetings and organizations have reinforced concerns that traditional knowledge must be taken into account in development and fishers and coastal communities should contribute to development in a participatory manner. Harnessing the TK of fishers has the potential to enhance conservation planning in developing regions. MPAs that incorporate traditional knowledge about reef ecosystems for example are generally more successful in reaching conservation goals and ensuring the participation of local fishermen on vulnerable tropical reef systems. They can provide information about changes in reef health over time, the socioeconomic uses of marine resources, and the population dynamics of at-risk reef species—data that can be difficult and time-consuming to gather using more traditional means.

In the three islands fishers showed detailed knowledge of the various fish habitats and the species abundance and dynamics that occur in these habitats. The ecosystem knowledge of fisher has derived from daily presence at sea and from information transferred by peers. The traditional knowledge is concerned with ethology of species, physical characteristics (height, color) and morphology of the seabed with specific information on the localization of spawning and feeding grounds. Generally fishers explained changes due to a number of factors: 1) changes to the marine environment as a result of changes in the interdependence between species (predators-prey) and between environmental resources and impacts thereon (e.g. pollution, destruction of habitat). Fishers were able to distinguish in this regard between local and global drivers of change (sewage run off versus increase of the temperature of the sea, with resulting coral bleaching) although their ability to do so greatly depended on each individual fishers. climatologic changes). They were also able to provide impacts of human practices (e.g. new techniques, intensification of fishing effort, spatial competition). In the three cases fishers indicated detailed knowledge of the various habitats and the species that occur in these habitats. The ecosystem knowledge of fisher has derived from daily presence at sea and from information conveyed by peers. The traditional knowledge is concerned with ethology of species, physical characteristics (height, color) and morphology of the seabed with specific information on the localization of spawning and feeding grounds. Generally fishers explained changes due to changes intrinsic to the marine ecosystem, environmental resources and impacts thereon (e.g. pollution, destruction of habitat) and local and global drivers of change (sewage run off versus increase of the temperature of the sea, with resulting coral bleaching). The second explanation as explained by fishers directly related to human practices (new techniques, intensification of fishing effort, spatial competition, establishment of MPAs).

The fisheries sector in the Caribbean has been severely affected over the past decades by several factors including overharvesting, illegal fishing, pollution, coastal developments, tourism development and other maritime space users as well as climate change impacts. In the three islands fishers expressed in depth knowledge of the sources of change and the impacts thereof on marine ecosystem health (e.g. mangrove destruction, coral bleaching, anchoring of oil tankers). It is difficult to correlate fishers perceptions of reef change with quantitative measures of reef fish population dynamics because such data is scarce and patchy, however, regional- and national-level fisheries reports bear out fishers' perception that finfish abundance and biomass are in decline in the various countries.

This TK is important to be integrated into the process of governance of the MPAs and into PES schemes. PES schemes can involve restoring or preserving coastal ecosystems; conserving threatened or endangered species; using sustainable (management) fishing practices; compensation for lost earnings during closed season and areas, i.e. due to the imposition of MPAs where fishing is restricted (or no-take zones) and provision of alternative livelihoods. In line with these schemes the three countries can start PES schemes such as coral reef gardening, Blue Carbon Projects, alternative livelihoods by improving linkages with the tourism sector and data collection by fishers could supporting fishers with training or remuneration while incorporating TK will improve the effectiveness of these PES schemes.

Although many advances have been made in the last few years, there are still several constraints associated with unlocking the values PES schemes and converting them into options for improved revenues for fishers. For one, there are very few ‘proof of concept’ on-the-ground examples around, and the international community still does not fully recognize the value of using TK for improving

marine ecosystem health and more particular in terms of PES schemes in relation to MPA management.
Our study has shown the crucial role of fishers as guardians of the sea. Often regarded as harmful and exploiters they can also be considered as guardians of the sea. Fishers draw their income from the exploitation of fishery resources while exposing themselves to hazardous working conditions. Their role thus goes beyond being economic actors but can be considered as natural history experts that have a distinct role to play in biodiversity conservation. This often requires a change in practice and a commitment to protect the marine ecosystem benefiting the whole of society. Solutions may require a range of long-term measures including education and employment schemes, community support, microfinance and development of non-marine enterprises. Issues such as governance failures, lack of human capacity, and political uncertainty are less perhaps less appealing yet their improvement will be vital for the success of PES schemes in the long term. To ensure social benefits, food security, long-term sustainable economic growth, a healthy ocean, while enhancing climate change resilience, we must develop dynamic solutions that integrate locally sensitive approaches tailored to particular socio-ecological systems incorporating the most successful PES schemes.

This report has shown the Workpackage objectives of Workpackage 4 have been reached as this report has covered the following components:

1) Assessment of the knowledge fishers relating to marine and coastal biodiversity;
2) Assessment of the knowledge of fishers regarding the capacity of resilience of the ecosystems of the MPAs with respect to the global changes; and
3) Determination of the elements of traditional knowledge of importance to be integrated into the process of governance of MPAs.

## References

Bladon, A., K. Short, E. Mohammed and E. Milner-Gulland. 2014. Payments for ecosystem services in developing world fisheries. Fish and Fisheries DOI: 10.1111/faf.12095

Brander, L., Baulcomb, C., van der Lelij, J. A. C., Eppink, F., McVittie, A., Nijsten, L. and P. van Beukering. 2015. The benefits to people of expanding Marine Protected Areas. VU University, Amsterdam, The Netherlands.. VU University, Amsterdam, The Netherlands

Corbera, E. 2012. Problematizing REDD+ as an experiment in payments for ecosystem services. Current Opinion in Environmental Sustainability, http://dx.doi.org/10.1016/j.bbr.2011.03.031

Daw, T., K. Brown, S. Rosendo, and R. Pomeroy. 2011. Applying the ecosystem services concept to poverty alleviation: the need to disaggregate human well-being. Environmental Conservation 38:370-379. http://dx.doi.org/10.1017/S0376892911000506

Edgar GJ, Stuart-Smith RD, Willis TJ, Kininmonth S, Baker SC, et al. (2014) Global conservation outcomes depend on marine protected areas with five key features. Nature 506: 216–220

Failler, p., Borot de Battisti, A, Binet, t., and L.Violas, 2013. Conséquences de la création de l'aire marine régionale du Prêcheur (Martinique) sur la pêche martiniquaise. *Études caribéennes*. DOI : 10.4000/etudescaribeennes.6644

Fischer, J., Jorgensen, J., Josupeit, H., Kalikoski, D. & Lucas, C.M., eds. 2015. Fishers' knowledge and the ecosystem approach to fisheries: applications, experiences and lessons in Latin America. FAO Fisheries and Aquaculture Technical Paper No. 591. Rome, FAO. 278 pp.

Gelcich, S, L Peralta, C Gonzalez, A Camano, M Fernandez, and JC Castilla. 2011. Scaling-up marine coastal biodiversity conservation in Chile: A call to support and develop ancillary measures and innovative financing approaches. In Successful and Failed Experiences in Biodiversity Conservation: Lessons and policy recommendations from the American continent, ed. E Figueroa, 199–220. Santiago: Editorial Universitaria.

Gelcich, S, M Fernandez, N Godoy, A Canepa, L Prado, and JC Castilla. 2012. Territorial user rights for fisheries as ancillary instruments for marine coastal conservation in Chile. Conservation Biology 26: 1005–1015.

McConney, P and M. Pena 2012 Capacity for (Co)Management of Marine Protected Areas in the Caribbean, Coastal Management, 40:3, 268-278, DOI:10.1080/08920753.2012.677632

Mohammed E. 2012. "Payments for coastal and marine ecosystem services: prospects and principles." IIEED Briefing. http://pubs.iied.org/pdfs/17132IIED.pdfIIED, 2012.

Mohammed, E. 2012. Payments for coastal and marine ecosystem services: prospects and principles. IIEED Briefing. http://pubs.iied.org/pdfs/17132IIED.pdfIIED, 2012.

Reuchlin-Hugenholtz, E., and E. McKenzie. 2015. Marine protected areas: Smart investments in ocean health. WWF, Gland, Switzerland.

Starr et al. 2015. Variation in Responses of Fishes across Multiple Reserves within a Network of Marine Protected Areas in Temperate Waters. PLoS One. 2015; 10(3): e0118502.

Wunder, S. 2008. Payments for environmental services and the poor: concepts and preliminary evidence. *Environment and Development Economics* 13(3):279–297. http://dx.doi.org/10.1017/S1355770X08004282

**Appendix A: survey**

**<u>CARIPES Survey</u>**

| | | |
|---|---|---|
| Interview ID: | Interviewer: | |
| Country: | Site: | Date: |
| Name: | Nickname: | Gender: M ☐ F☐ |
| **Fisher**:<br>Captain ☐<br>Boatowner ☐<br>Captain and boatowner ☐<br>Crew ☐<br>Fish from shore ☐<br>Other:__________________ | Vessel name:<br><br>Owners name: | Any additional info: |
| Community of residence: | | |
| Nationality: | | Age |
| Language: English ☐ French ☐ Dutch ☐ | | |

**Fishing activities**

1. How long have you been a fisher? (years)
2. Can you tell me a little bit about how and why you became a fisher?
3. How often do you go fishing? (x per week)
4. How long do you usually spend fishing (hours or days)?
5. Gear type and species you use?
6. Identify the 10-15 most important fish species you catch (taking into consideration the anticipated price at sale, the perceived abundance and the proportional importance of the species to their daily catch)
7. Out of these 10-15, which 5 species do you judge to be the most important (based on anticipated price at sale, the perceived abundance and the proportional importance of the species to their daily catch) for you?
8. Could you explain to me how the catch changes over the course of the year, from season to season, affect each of these five species?
9. For each of the 5 species:

   a) Where do you catch it? At what time/season? Why?

   b) Are they adults?

   c) What about when they are young, where can you find them? Why there?

   d) What do these fish eat at different stages of their life?

MAP: Look at a rough map and draw characteristics (spawning grounds, juvenile habitats, mangroves, seagrass, reefs etc) together with the interviewer map. Specific sites and characteristic features on the map are discussed to ensure that the interviewer's perception of the area map agreed with the one held by the fisher. The map can then be used to indicate primary target areas for the five species identified in the previous questions.

10. Identify 3 species of (shell)fish that you associate primarily with A) mangroves B) sea grass beds C) reefs.
11. Do you engage in other economic activities? [tourism, diving industry, farming etc]
    List and describe:
12. % of fisher's income approximately fishing/other economic activities
    % fishing activities= % other activities
13. Have you noticed any changes over the past 10 years?
    (probe for e.g. a) fish abundance; b) seasonal changes; c) changes in species composition; d) reef health)
14. What are the reasons for this change?
    a) fish abundance;
    b) seasonal changes;
    c) changes in species composition;
    d) reef health.
    (probe for underlying causes such as cutting down mangroves, pollution, pollution, overfishing or use of small mesh sizes, illegal fishing, habitat changes, coastal erosion as well as global causes such as sea level rise, coral bleaching, increase of hurricanes)
15. Can you specify particular fisheries that have been most affected by change? (probe for different target species as well as different techniques or fishing areas)
16. Why these fisheries? What do you think makes them particularly vulnerable?
17. What do you think of the overall health of the fishery?
18. Have you perceived any change in catches over the past 10 years? Identify any changes in fish catches over time by drawing a time line (with assistance from the interviewee) and indicating patterns of increasing and decreasing catches over time.
19. What are your predictions for the future of the fishery? What changes do you expect over the next 10 years?
20. What solutions/actions can you suggest to improve the sustainability of the fishery?
21. Do you think the establishment of MPAs has negative or positive impacts? How?
22. If positive consequences do you think MPAs:
    a) lead to an increase in fisheries productivity,
    b) support maintenance of biodiversity and stock structure
    c) protect habitats;

d) support livelihoods of fishers due to improved catches?

23. Do you think the locations of MPAs in your country are the appropriate locations for MPAs (do it per MPA in the country) from:
    a) an ecological perspective (for example breeding grounds/spawning grounds or coral reefs);
    b) tourism perspective;
    c) fisherfolk wellbeing perspective?
24. Did the implementation of the MPA(s) affect your fishing activities? How?
25. If another MPA were to be proposed, do you think that your knowledge and expertise can be used for design and management of the MPA? If so, how?
    (probe for designing MPAs in areas with spawning aggregation, nursery grounds etc)
26. Are you currently involved in data collection? How could your knowledge be used in future data collection?
27. Are you involved in MPA monitoring, control and surveillance?
28. If you are involved in these activities, are you being rewarded? Discuss various options: e.g. compensating for lost earnings from the imposition of MPAs (no-take zones or different); coastal habitat restoration activities; rewarding for the conservation of threatened marine and coastal species (e.g turtles); rewarding of sustainable fishing practices
29. How can we improve the benefits fishers receive from these three areas? (give examples of how you envision the rewards and what should be done)
    a) Tourism
    b) Research and data collection
    c) Monitoring and Management