

Summary of project activities and preliminary results – March 2019



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INTRODUCTION

The project "**Umuen vida no / Omali vida nón**" was created to jointly try to solve current challenges in the artisanal fishing sector in Príncipe (São Tomé and Príncipe). Therefore, this project aimed to promote better management of marine resources through the participation of those who are primarily affected – fishers and fish traders. This project was designed to test and implement ways of producing benefits for both fishing communities and marine resources, focusing on participatory management of resources and having strong research and community engagement components.

Our general action plan included:

- Understanding how, where and why marine resources are used and their importance for local communities in Príncipe;
- Together with fishers and fish traders, identifying and testing strategies in order to promote sustainable artisanal fishing;
- Promoting capacity building of fishers, fish traders and staff involved in the management and conservation of natural resources;
- Facilitating improved management of marine resources that is inclusive and participatory.

Our project started in July 2016 and ends March 2019. We focused on the six resident fishing communities in Príncipe: Campanha, Lapa, Hospital Velho, Praia Abade, Praia Burra e Santo António.

This document presents preliminary results resulting from the main project activities and aims to inform discussions about project impacts and upcoming initiatives; results will be summarized during the months of April-June 2019 and shared with all stakeholders. For each activity, we describe its goal and implementation approach, some preliminary results and some considerations in terms of lessons learned (both positive and negative aspects of the activity) and recommendations for the future.

This project is the result of a partnership between institutions in Príncipe (Príncipe Foundation, the Regional Directorate for Fisheries and the Biosphere Reserve) and the University of Exeter, UK. It is funded by the [Darwin Initiative](#), a UK government grants scheme that helps to protect biodiversity and the natural environment through locally based projects worldwide. Other funders include: [Forever Príncipe](#) (a collaborative conservation alliance that finances conservation through tourism activities) and the [Halpin Trust](#).

The work described in this document results from the effort and dedication of a team composed of fishers, fish traders, government representatives, environmental organizations, researchers, students, among others. Thank you, all!

Questions, suggestions and comments are welcome! Contact: Dr. Ana Nuno (project coordinator: a.m.g.nuno@exeter.ac.uk). Additional information about our project can be found at: <https://omaliprincipeen.weebly.com>.

1. Fisheries landing surveys

A. What was the goal of this activity?

In order to characterize artisanal fisheries in Principe and develop a database that allows the monitoring of impacts from management and marine conservation interventions, our team gathered information on fish catch and fisheries' practices in the communities targeted by our project, promoting a better management of the resources in a participatory way (directly involving the local population).

B. What has been done in this activity?

Fisheries landing surveys in the six fishing communities were carried out from the 16th of December 2016 to the 28th of December 2018 (total sampling period). When the project started, a network of focal points was created: a team of six local residents (fishers or fish traders), each from a different community. After the application, selection and training phases (October to December 2016), information was collected twice a week (every Tuesday and Friday of the sampling period) by these focal points. On each sampling day, focal points had the task of collecting data from fishers that returned to the landing sites after a fishing day. Using standardized forms to collect information, they registered data on:

- fishers and their fishing gear;
- fishing practices (including fishing effort and areas);
- types and quantity of fish catch;
- individual size and weight for some selected species.

C. What did we find?

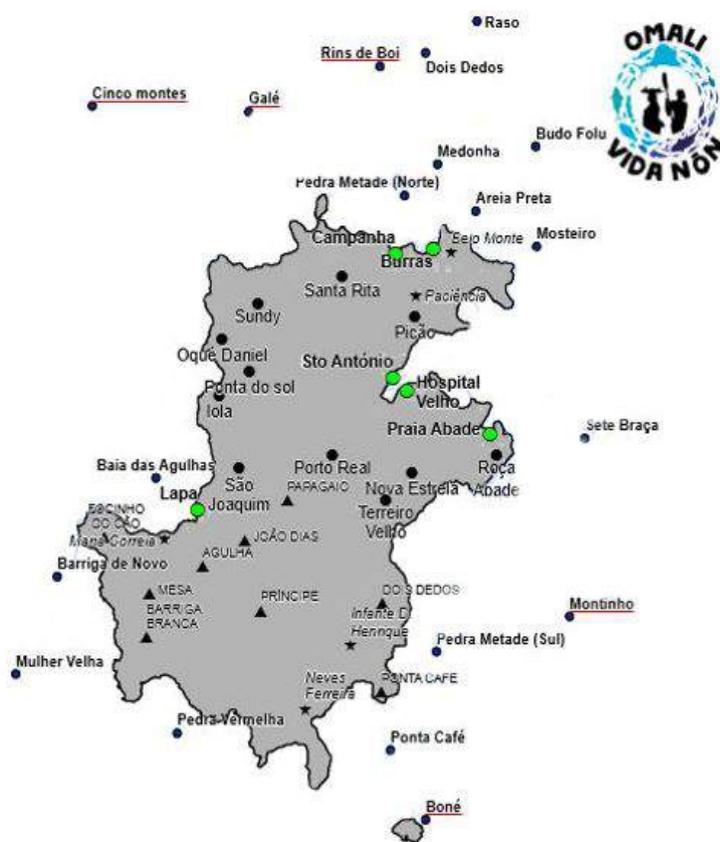


Figure 1. Communities are marked in green and main fishing zones are underlined in red.

During the total sampling period, our team's focal points collected information regarding 1879 fishing trips in the six communities. Our results refer to the information registered about these fishing trips.

The five main fishing zones mentioned were: Raso, Cinco montes, Boné, Montinho e Rins de Boi. We can observe (Figure 1) that fishers moved preferentially to the north/northwest of the island.

Eight different fishing techniques were recorded among the six communities. The three most frequent fishing techniques were: long-line, vertical long-line and mid-water trawl (Figure 2). Different communities used mainly certain fishing techniques. For example, demersal longline was the most common in Abade, mid-water trawl in Burras and Campanha, vertical long-line in Hospital Velho and long-line in Lapa and Santo António.

Fishers generally used more than one technique each time they went fishing. On average, we recorded 1.3 fishing techniques used per fishing trip.

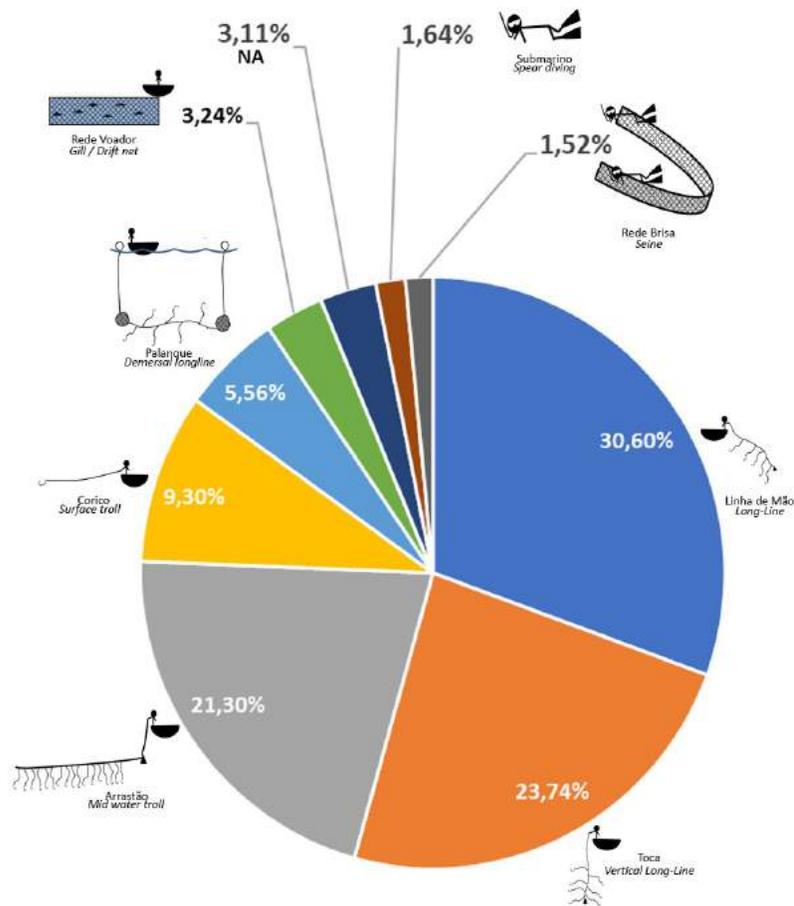


Figure 2. Frequency (%) of each fishing technique relative to the number of times they were mentioned during the sampling period (N total =2376 mentions of different fishing techniques). “NA” means “Not Available”, that is, records with no technique specified.

Overall, we registered 79694 individual fish (which corresponds to 53575 Kg in total) captured by fishers during our data collection, and 90% of the captured biomass refers to pelagic species (i.e. fish that can be found in the water column which is not affected by the ocean shore or sea floor). Fishers caught more than 77 different species, being Blue runner, Bluespotted seabream, Frigate tuna, Atlantic sailfish and Gorean snapper (Figure 3) the most important in terms of total captured weight.

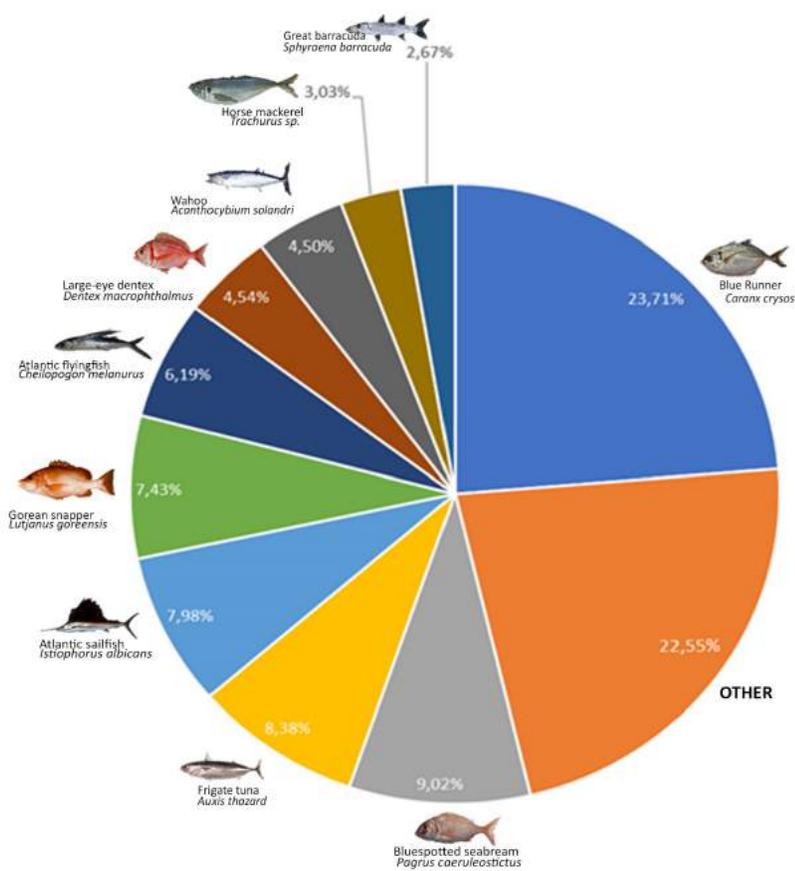


Figure 3. Biomass (%) of the most captured species in the total of the six communities. “OTHER” corresponds to 67 species with relatively low captures, that together make a significant biomass percentage.

D. What have we learnt?

We were able to obtain information that allows us to characterize fishing activities in Principe and assess what are the most exploited species. Thanks to the involvement of focal points and fishers in each of the communities, it was possible to obtain very valuable information that can be used to inform management and conservation of marine resources.

However, there were some challenges as well, mainly in terms of: information representativeness (i.e. some fishers prefer not sharing information and the focal points wouldn't always collect information following the sampling protocol previously defined); loss of records (some data were not submitted by the focal points or were potentially lost after submission); inconsistency and possible errors (for example, errors when entering information in database, spelling and grammar uncertainties about some terms, local slang); uncertainties about species identification (for example, several designations used to identify the same type of fish) and location of fishing areas.

E. Next steps and recommendations

- The information collected by our team and initial database development must be considered in order to inform next initiatives planning to conduct fisheries landing surveys in Principe.
- In the future, it would be important to extend use of local knowledge about the information recorded by further working together with local communities. This way, we should be able to better understand some locally used designations (example: fishing grounds and fish names).
- To collect similar information, we suggest using tools for digital data collection. These tools are available for Android systems (Tablets, smartphones), and would require specific training for focal points as users and responsible for the electronic devices. This would potentially avoid errors whilst entering information and would allow for easier data organization and analysis.
- Lastly, we recommend making all this information available in order to create a national database for monitoring over time.

2. Collection of socioeconomic information

A. What was the goal of this activity?

The collection of social and economic information is essential to assess the living conditions of the several communities (especially fishers and fish traders) where the project takes place and their dependence on natural resources. This allows us to better consider their needs and priorities, as well as informing the design of interventions that benefit (and do not harm!) fishing communities. This information is also important for monitoring the impact of marine management and conservation initiatives in Principe.

B. What has been done in this activity?

During the initial months of the project (October / November 2016), our team visited the multiple fishing communities and invited all fish traders and fishers for group discussions. We organized 14 discussions (we split fishers and fish traders from each community) and learned about their lives, challenges and ideas on how to improve artisanal fishing in Principe in order to benefit fishing communities. 142 people (73 fishers and 69 fish traders) participated in these discussions.

In February and March 2017, we interviewed 869 adult residents of the island, in a total of 6 fishing communities and 5 other rural communities, including 202 fishers and 153 fish traders. These questionnaires included questions on:

- individual and family characteristics (e.g., age, schooling, type and number of occupations);
- gear, practices, revenue and costs related to fishing and sale of fish;
- use of other natural resources (both marine and terrestrial, such as rays, sea turtles and bats);
- perceptions of threats, changes and opportunities in artisanal fisheries as a means of subsistence;
- opinions on marine resource management and decision-making.

In January and February 2019, we repeated these questionnaires in the six project communities, including questions on:

- perceptions about impacts of our project;
- opinions and suggestions on future marine management and conservation interventions in Principe.

During this second phase of questionnaires, we interviewed 516 residents of fishing communities, including 200 fishers and 158 fish traders.

C. What did we find?

The majority (71%) of fishers and fish traders in Principe said that the amount of fish being caught has declined over time and about one third of people (35%) think that the amount of fish at sea has also decreased. Very few people think it has increased or not changed (Table 1).

Table 1. Perceptions of fishers and fish traders (number of people interviewed in Jan/Feb 2019 = 358) on changes during the last 10 years.

	Increased	Decreased	No change	Don't know/ No answer
Total amount of fish catch	25 (7.0%)	253 (70.7%)	14 (3.9%)	66 (18.4%)
Amount of fish available at sea	23 (6.4%)	124 (34.6%)	16 (4.5%)	195 (54.5%)

According to the fishers and fish traders surveyed, the main factors affecting the quantity of fish at sea in Principe are (in descending order of importance):

- | | |
|--------------------|-------------------------|
| 1° Small-mesh nets | 4° Industrial fisheries |
| 2° Too many hooks | 5° Number of fishers |
| 3° Bay fishing | 6° Climate change |

According to the fishers and fish traders, the three main actions that must be taken to improve their living conditions are (in descending order of importance):

- | | |
|--|--------------------------------------|
| • livelihoods of fish traders: | • livelihoods of fishers: |
| 1° Provide fishing gear and repair equipment | 1° Strengthen fisheries associations |

- 2° Strengthen fisheries associations
- 3° Provide credit to fish traders

- 2° Provide fishing gear and repair equipment
- 3° Create other employment opportunities/
Increase quantity of fish at sea

Regarding our several project goals, residents of fishing communities feel that the project has had a positive impact mainly on improving the living conditions of fish traders and fishers. The percentage of surveyed residents who thinks the project has had a positive impact on each of our goals is (in descending order of percentage):

- improvement of the living conditions of fish traders: 63%
- improving the living conditions of fishers: 59%
- access to opportunities to improve living conditions of fishing communities: 54%
- use and management of marine resources: 50%
- involvement of fishing communities in fisheries decision-making: 42%.

Approximately 8% of respondents believe the project has had some negative impacts. The remaining people feel that the project did not produce positive or negative impacts.

For each community where the project took place, the intervention issue that had the most positive impacts according to its residents is:

- Campanha: access to opportunities to improve living conditions of fishing communities (72%)
- Hospital Velho: improvement of the living conditions of fish traders (62%)
- Lapa: involvement of fishing communities in fisheries decision-making (87%)
- Praia Abade: improvement of the living conditions of the fish traders (73%)
- Praia Burra: improving the living conditions of fishers (62%)
- Santo António: improving the living conditions of fishers (65%)

In general, the communities of Lapa and Campanha showed higher levels of satisfaction (i.e., higher percentage of their residents described positive impacts of our project).

When asked about possible marine conservation interventions in Principe, residents of fishing communities demonstrated greater support for the creation of protected marine areas with community and government involvement compared to other options (Table 2). For example, 71% of people interviewed said they agreed with this measure and only 13% of people said they disagree.

The measures that generated the most discontent (i.e., highest percentage of people disagreeing with the option) were: closed seasons (i.e. not catching some species during a few months of the year) and creating areas permanently without fishing (i.e. areas where you can never fish).

Table 2. Perceptions of residents of fishing communities on possible interventions if they were used in Principe (number of people interviewed in Jan/Feb 2019 = 516)

Possible interventions	Disagree/ Completely disagree	Don't agree nor disagree/ Don't know	Agree/ Completely agree
Prevent the use of some fishing gear in certain areas	150 (29.1%)	60 (11.6%)	306 (59.3%)
During some months of the year, not catching some species	263 (51.0%)	56 (10.9%)	197 (38.2%)
During some months of the year, not fishing in some places	224 (43.4%)	53 (10.3%)	239 (46.3%)
Create some areas where we can never fish	257 (49.8%)	61 (11.8%)	198 (38.4%)
Protected marine area with involvement of communities and government	65 (12.6%)	83 (16.1%)	368 (71.3%)

D. What have we learnt?

- During the administration of questionnaires in fishing communities, we collaborated with a team of enumerators (i.e. interviewers) composed of local youth (usually high school finalist students). These young people were regularly trained and followed up and did an excellent job, resulting in a very successful data collection in terms of number of participants and correct recording of information. Because they are local residents unrelated to any environmental, fisheries or governmental

organizations, it is easier to maintain neutrality and promote community participation (almost no one refused to participate in the interviews). There is, therefore, very good local capacity for collecting social and economic information.

- As the occupations of fishers and fish traders are usually performed by men and women, respectively, we decided to make several group discussions separated by gender. This was important to give voice to different concerns and topics that might not have been discussed with everyone present. Ideally, these group discussions should have a maximum of 10-12 participants so that we can encourage the participation of all those present. However, at times, too many people were interested in the meeting (usually in open spaces), which undermines the dynamics of the discussion. For next approaches using group discussions, it is recommended, for example, to divide stakeholders into smaller groups (requiring discussions at different times or using more discussion facilitators).
- Our questionnaires were administrated in paper format, which required costs in terms of: paper, printing and staff time responsible for recording data on the computer and checking data quality. The use of questionnaires in digital format (use of tablets) avoids these costs, although possible consequences in terms of interviewees' perceptions and robustness of the equipment to fieldwork conditions should be considered.

E. Next steps and recommendations

- The information gathered from this project activity should be used to assess possible changes in fishing communities over time (e.g.: increase or decrease in poverty levels and consumption of species of conservation interest). These questionnaires should be repeated (for example, every 2 years) and a database should be maintained for recording and comparing the information obtained over time. This information can also be complemented by, for example, facilitated group discussions, which generally provide very informative qualitative data.
- In order to facilitate robust comparisons, it is recommended to develop standardized tools for use by multiple projects and, if possible, at national level. These tools should be flexible in order to incorporate specific indicators relevant to local context and project objectives, but should include core issues that are maintained and used for comparisons.
- Due to the small size of the island and relatively small numbers of communities, efforts should be made to coordinate and minimize the number of different questionnaires used by various projects in order to avoid repetition and survey fatigue among respondents.
- All interventions must be accompanied by monitoring and evaluation measures to monitor progress and learn from what works or does not work. This is especially important when working with local communities: it is necessary to design fisheries management and marine conservation interventions that do not harm them. Therefore, it is essential to work with communities and gather information that allows us to inform our decisions and evaluate the impacts of our projects.

3. Mapping artisanal fishing areas

A. What was the goal of this activity?

For improving management of marine resources, fishing practices and fisher knowledge must be considered. Information on the spatial and temporal distribution of fishing effort (i.e. where and when fishing occurs) is useful for identifying the most important areas for fishing communities and, for example, identifying possible conflicts with industrial fishing. This activity aimed to produce maps of artisanal fishing areas in Principe.

B. What has been done in this activity?

To conduct this project activity, we used relatively inexpensive and easy-to-use technology and a participatory approach in which fishers themselves were involved in collecting data. We distributed GPS trackers (Figure 4) among 41 fishers from the six communities where the project occurs. These fishers demonstrated interest in participating voluntarily in this activity and producing maps of their fishing areas. From February 2017 to February 2018, participating fishers took with them a GPS locator that recorded their location (every 5 mins) each time they went fishing. For each fisher, we also registered their main fishing gear.



Figure 4. GPS tracker used for collecting location information during fishing trips.

Monthly (due to the battery of the GPS tracker), these devices were collected by a member of our team and replaced by another similar device. Upon arriving at the office, the information of each GPS tracker was transferred to the computer so that it could be viewed and analyzed. During the course of this activity, preliminary fishing maps were produced (separated by individual and community) in order to show results to the fishers involved and to explain how the information was being used.

C. What did we find?

The final information is currently being analyzed to produce artisanal fisheries maps throughout the island (for example, which areas are most frequented by fishers) and at the community level (e.g.: which are the most important areas for fishers from each community?).

Figure 5 shows the level of fishing activity by different fishing communities (yellow and red tones represent higher numbers of fishing trips in these areas). For example, these maps illustrate the use of different areas by various communities (e.g.: north of the island is used by all communities), while some zones (e.g.: Bay of Agulhas and Tinhosas) are preferably used only by some communities.

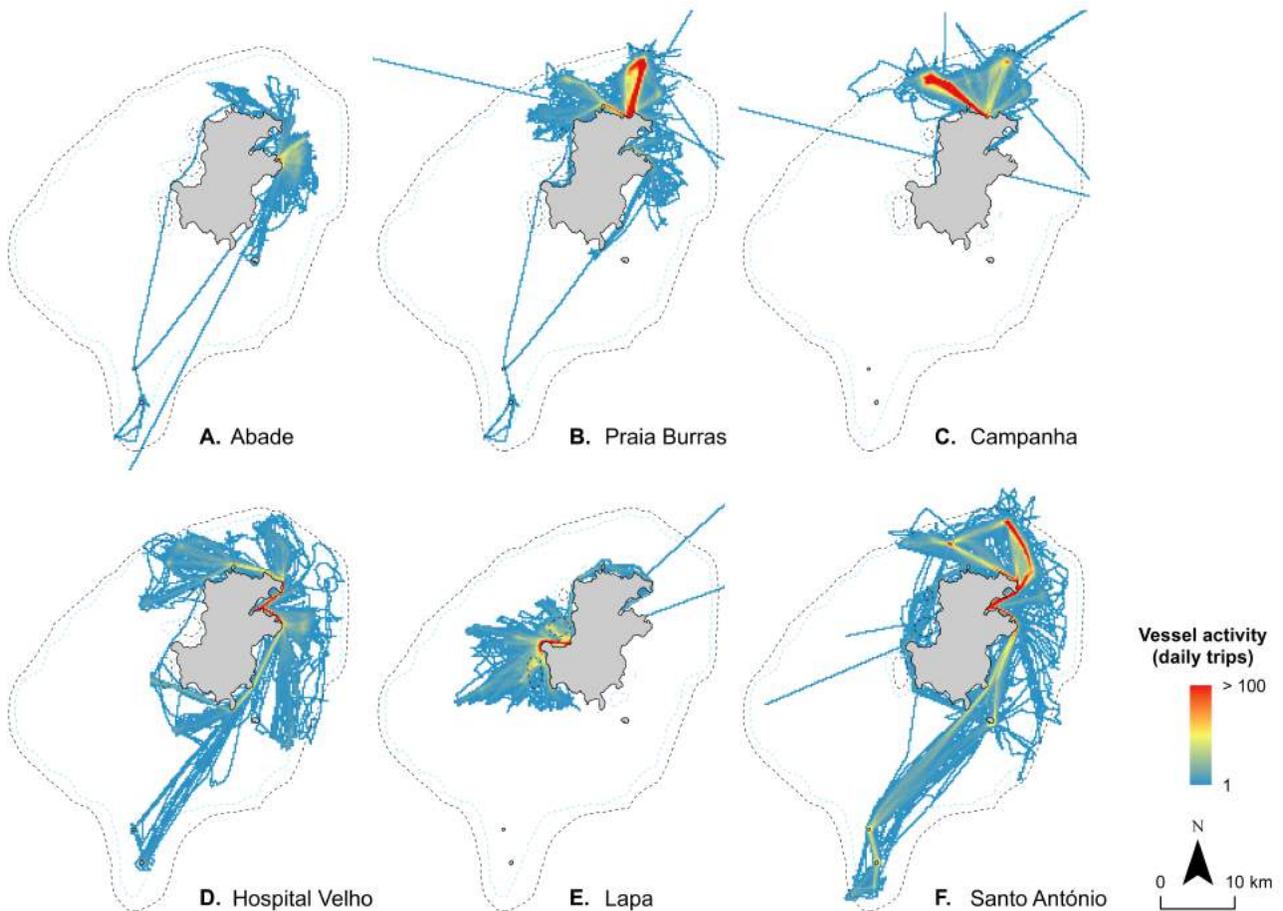


Figure 5. Maps of artisanal fishing representing activity level of vessels (i.e. number of fishing trips) for each community.

D. What have we learnt?

- The activity received plenty of interest from fishers who were receptive to the use of this technology. We believe that because it is very easy to use (the device is activated automatically when it detects movement and it does not need to be switched on or off), it does not represent a barrier and greatly simplifies the task (fishers only have to remember to carry device with them on the boat).
- When we started this project activity, some fishers expressed concerns about this information showing individual fishing areas (information they did not want to share with other fishers). However, the scale of the map can be selected so as to respect the privacy of the fishers and not provide too detailed information. When we showed the preliminary maps produced, the fishers did not mention any more concerns and even suggested we should include more details (e.g., names of landmarks).
- Fishers volunteered to participate in this activity, so this was not a representative sample of the entire fishing population (ideally, we should have included representatives of all fishing gear). In any case, we have been able to obtain enough information to produce maps of the main fishing gears and this information can be complemented by discussions with fishers and/or further data collection with more fishers.
- After training, the collection and basic visualization of this information was processed in Príncipe, and there is capacity to use this tool locally.

E. Next steps and recommendations

- By mapping the most important fishing areas for each community, we can facilitate discussions on management of fishing areas and conservation measures (for example, we can identify areas that might generate more conflict in case of fishing restrictions). These maps can therefore be a way of giving voice to the interests of artisanal fishers, as well as informing the design of marine conservation strategies (e.g., which communities use priority conservation areas?).
- In case this data collection activity is continued, fishers using less frequent gears should be encouraged to participate so that we can more robustly represent their practices and interests. In addition, it would be interesting to consider the use of this tool as a means of monitoring in order to identify possible

changes in fishing practices in the case of new interventions (e.g., what areas are most commonly used in the case of restrictions in certain locations in Principe?).

4. Community ideas

A. What was the goal of this activity?

This activity was implemented at the fishing communities targeted by our project with the objective of promoting community dynamism and supporting the implementation of interventions with a positive impact on the sustainability of artisanal fisheries, through improved management of marine resources and community advantages for fishers and fish traders.

B. What has been done in this activity?

This activity had three distinct phases: i) planning; (ii) applications and selection; iii) implementation and monitoring. Below we briefly describe the multiple steps of each of these phases.

i) Planning

A fund of approximately 15,000 euros was created by our project to implement this activity. All project partners, together with close collaborators (e.g. MARAPA), have defined the strategy to be followed for approaching communities. It was defined that:

- Ideas could be presented by formal (i.e., associations) or non-formal groups of fish traders and fishers (including spearfishers).
- Winning ideas should present interventions that belong to one or more of these categories:
 - reduction of costs and/or increase in fishing revenues or sales of fish;
 - income diversification;
 - increase the quantity of fish in their fishing areas;
 - capacity building of fish traders and fishers;
 - improving the functioning of fisheries associations and involvement in the management of marine resources.
- Winning proposals would have to meet multiple criteria: financial sustainability (investment should generate more money to carry on activity or maintain infrastructure), environmental sustainability (proposal could not increase fishing effort) and have the support of the community. The maximum cost of each proposal should be 100 million STD (about 4000 euros) and the community should support implementation providing 2% of funds (money or in-kind).

ii) Applications and selection

Several documents were produced (guidelines for presenting initiative in the communities, proposal sheet and evaluation sheet) and the launching and discussion phase in the communities began. This activity was announced at a project event at the Centro Cultural Santo António (September 8, 2017), followed by multiple discussions in all project communities to publicize the initiative and support the drafting of proposals.

After receiving 7 proposals, a public meeting was held on October 23, 2017, where the community committees responsible for each proposal were present, as well as all partners of the project and representatives of the President of the Regional Government and the General Directorate of Fisheries - São Tomé. Each participating team had to present its idea and was evaluated by a jury composed of representatives of all project partners: Mr. Damião Matos (Regional Fisheries Department), Mr. Jaconias Pereira (Principe Foundation), Ms Plácida Lopes (Biosphere Reserve) and Dr Ana Nuno (University of Exeter - United Kingdom). Of the 7 proposals submitted, 6 were selected for funding (only the proposal by Hospital Velho - motorcycle purchase - was not selected for funding).

iii) Implementation and monitoring

For each of the six selected community ideas (see Table 3), a document defining management model was developed together with the communities involved, in order to delineate everyone's responsibilities and, in particular, the way in which support and revenues should be managed. All community initiatives were regularly monitored by our team members to facilitate community discussions and decisions and to support registration of sales and use of community centres. Depending on the needs of each initiative, the project provided support in terms of: infrastructure; purchase of materials; and/or training.

Table 3. Types of main support provided by the project "Omali Vida Nón" to the implementation of each selected community idea.

Community idea	Comunity	Infrastructure	Training	Acquisition of materials	Follow-up
Community centre	Lapa	Construction of centre	----	----	Elaboration of management model and regular visits (monthly)
Community centre	Campanha	Construction of centre	----	----	Elaboration of management model and regular visits (monthly)
Production and sale of handcraft	Praia Burra	Construction of workshop and shop	Training in handcraft production	Purchase of materials (e.g. scissors, yarn)	Elaboration of management model and regular visits (2-4 per month)
Community shop	Santo António	Repair available infrastructure	----	Purchase of materials (e.g. fishing cables, salt, basins, resin)	Elaboration of management model and regular visits (1-2 per month)
Salting fish	Praia Abade	Repair available infrastructure	Training in business management (with MARAPA)	Solar fish dryer	Elaboration of management model and regular visits (2-3 per month)
Production and sale of artisanal soap	Praia Abade	Repair available infrastructure	Training in production of handmade soap	Purchase of materials (e.g., magic wand, pot, caustic soda)	Elaboration of management model and regular visits (2-4 per month)

C. What did we find?

The monitoring and evaluation phase of community ideas is still ongoing during the month of March 2019. Some preliminary results are described in Table 4.

Table 4. Some indicators and preliminary results used to monitor progress and evaluate success of each implemented community idea.

Community ideia (Comunity)	Some indicators and preliminary results	Comments
Community centre (Lapa)	Number (and reasons) of uses of space: 8 (leisure, for example: watching TV) 1 (occupational: fishing) 2 (tourism) 1 (overnight stay)	During rainy seasons, tourist visits to this area of the island is quite low and no uses of space by people outside the community were registered.
	Income: 300 STN	
Community centre (Campanha)	Number (and reasons) of uses of space: 7 (leisure) 1 (occupational: fishing) 7 (meetings with community)	Notwithstanding the management model defined by the community, space managers preferred not to charge for its use
Production and sale of handcraft (Praia Burra)	Number of people trained: 7 women 7 men	
	Income (sales - expenses) 3730 STN	
	Income received by each committee beneficiary 10 people x 200 STN each	
Community shop (Santo António)	Income (sales - expenses) 65000 STN	
Salting fish (Praia Abade)	Number of people trained: 15 women	Unfortunately, this initiative only had a single sales event, not having any

	Income: 2400 STN for sale of salted fish	other involvement of the people responsible
Production and sale of artisanal soap (Praia Abade)	Number of people trained: 2 women 6 men	
	Income (sales - expenses) 2620 STN	
	Income received by each committee beneficiary 8 people x 50 STN each	

D. What have we learnt?

- Although the initiative has attempted to promote multiple types of proposals, communities are very much concerned only with fishing gear (e.g. vessels and engines, wires, hooks, salt). It is necessary to promote discussions about possible alternatives using examples of contexts similar to Príncipe.
- From the dissemination of this activity to the presentation of proposals by the communities, it was important to have a minimum period of 2 - 3 months to inform and discuss with the communities in order to better understand their interests and their level of involvement. It is also necessary to allow sufficient time for the implementation of the winning ideas and it is fundamental to clearly define the responsibilities and tasks of those involved, following up these initiatives for at least 1 - 2 years.
- In order to strengthen those involved in this type of activity, especially in income-generating initiatives, it is necessary to: have a conflict mediator who is knowledgeable about the local situation, and be regularly with the people involved (about 3 times a week) (for example: to keep in touch and better understand their day-day related to fishing, salting and sale of fish).
- It is essential to maintain transparency and neutrality of all team members. For example, by promoting public discussions, such as event organized for announcing winning proposals, we aim to demonstrate inclusiveness and transparency for all involved in the process and making the selection process more transparent to everyone and promoting learning.

E. Next steps and recommendations

Recommendations on possible next steps for each intervention at community level, as well as general recommendations on involvement of fishing communities, are described in Table 5.

Table 5. Recommendations on possible next steps for each community intervention

Community ideia (Comunity)	Recommendations
Community centre (Lapa)	<ul style="list-style-type: none"> • Equip the space (chairs, tables) • Work not only with the residents of Lapa, but also with all those who go there quite often to develop fishing activities (e.g., São Joaquim, Monte Alegre) • Promote the development of the area as a tourist point in collaboration with government and tour guides (e.g., improve access, create services based on the abilities of residents including sport fishing, visits to attractive sites)
Community centre (Campanha)	<ul style="list-style-type: none"> • Equip the space (chairs, tables) • Being a very small community, work with them as an association/cooperative • Seek more female involvement • Search business opportunities (e.g., with tour guides)
Production and sale of handcraft (Praia Burra)	<ul style="list-style-type: none"> • Training in other crafts and business management • Focus on marketing • Identify people with the greatest interest, involvement and leadership capacity in order to ensure ownership and continuity of activities • In case of viability, continue business and sort legal registration
Community shop (Santo António)	<ul style="list-style-type: none"> • More monitoring and business development • Work with more fish traders in store management

	<ul style="list-style-type: none"> • Better define the purpose of the money generated, either in the purchase of new products or in revenue sharing
Salting fish (Praia Abade)	<ul style="list-style-type: none"> • Reconsider the approach with the association's fish traders in order to assess how to work together • Invest in promoting teamwork
Production and sale of artisanal soap (Praia Abade)	<ul style="list-style-type: none"> • Focus on marketing • Training in business management • Division of tasks and work with small groups between (3 - 5) people • In case of viability, continue business and sort legal registration
General recommendations	<ul style="list-style-type: none"> • Raise environmental awareness (Burras, Hospital Velho, Abade) on more sustainable fishing practices using Lapa and Campaign as a model • Involve young people/ children of fishers and fish traders in the project activities • Define a clear strategy for working in different areas of Hospital Velho for their greater involvement in the activities of future initiatives • Promote synergy among agendas of various partners (e.g. Regional Government plans for each community) to join efforts • To promote associativism / cooperatives using Santo António as a model

5. Mapping Principe's fish biodiversity using Baited Remote Underwater Video

A. What was the goal of this activity?

Baited Remote Underwater Video (BRUV) is a non-invasive technique for studying fish fauna (for example, their presence/absence, relative abundance and behaviour). We used this methodology to better understand:

- 1) geographical variations in fish biodiversity around the island: do fish assemblages differ according to area (NE, E, SE, SW, W and NW)?; and
- 2) variations in fish composition associated to habitat: are different species found in different types of habitat?

This information can be used to provide fisheries management recommendations, identifying areas that need special protection and designing management measures that are suitable for each specific area (for example, based on habitat-type and fish composition).

B. What has been done in this activity?

The BRUV method consists on using an underwater camera with a bait to survey fish species. The devices used in this study consisted of a frame holding the camera 35cm over the seafloor, a cage with bait located 120 cm in front of the camera and a GoPro camera facing forwards, towards the bait (Figure 6). The bait used was always “Fulu fulu” (*Auxis thazard* and *Euthynnus alletteratus*), a small species of tuna often caught by fishers in Principe. At each sampling point, a BRUV device was left sitting on the seafloor for 90 minutes (due to battery life restrictions), tied with a long rope to a buoy in the surface, marking the position of the camera. Videos are watched afterwards by trained observers and the species captured on camera are recorded using a standardized protocol.

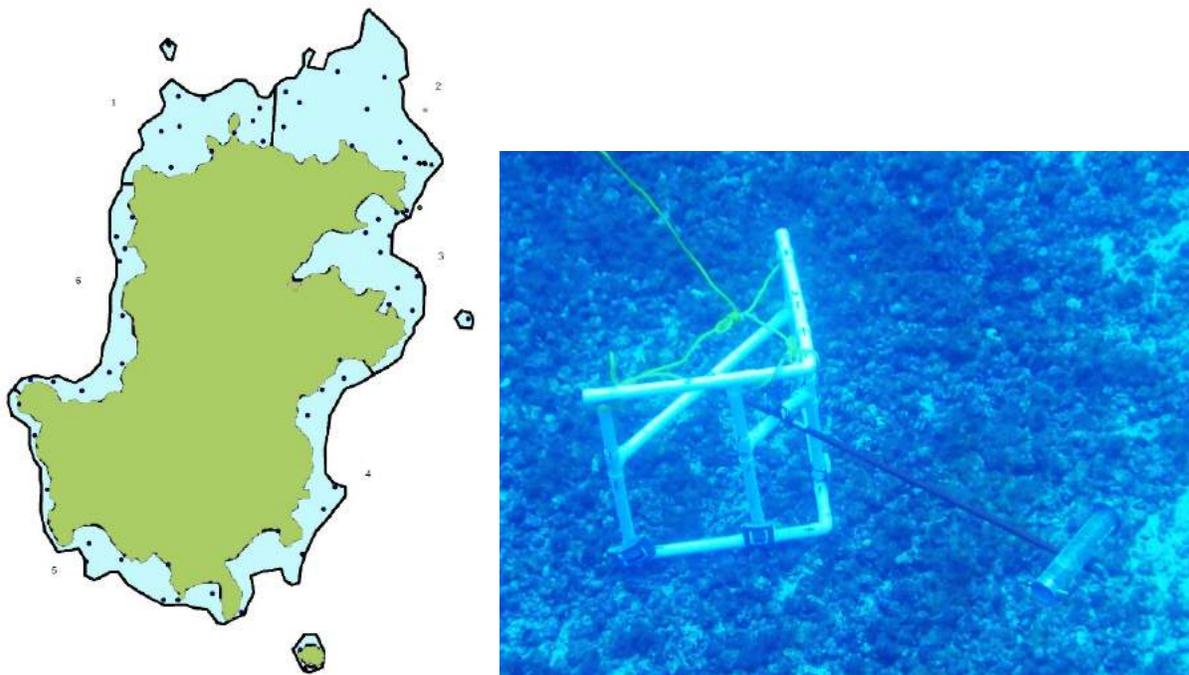


Figure 6. A) Study-area, divided in six quadrants (numbered 1 to 6). Each of the sampling points is marked in the map with a dot. B) BRUV device underwater.

The study was limited to a maximum depth of 25 metres due to low visibility below that. The area between 2 and 25-metre deep around the island was divided in six quadrants (NE, E, SE, SW, W and NW) of equal size. Ten sampling points were randomly allocated in each of them, setting a minimum distance between them of 400 metres, totalling 60 sampling points. This sampling was conducted twice: one period in July-August 2018 and another one in December 2018-January 2019.

C. What did we find?

Detailed analysis of the data is still ongoing and will be undertaken during March and April 2019. A brief, preliminary analysis using 48 sampling points suggests that rocky habitats are more diverse and display a higher number of individuals than sandy habitats or maerl beds (Figures 7 and 8). Further analysis will be done to assess whether the different areas of the island (NE, E, SE, SW, W and NW) show differences in fish species composition (presence or absence of specific species), diversity or relative abundance.



Figure 7. Different habitats found in Principe Island. A) Rocky reef, with corals (marked with an arrow). B) Sandy habitat, with a Brown African Snapper (*Lutjanus dentatus*) attacking the bait cage. C) Maerl bed, with a nurse shark (*Ginglymostoma cirratum*) approaching the device.

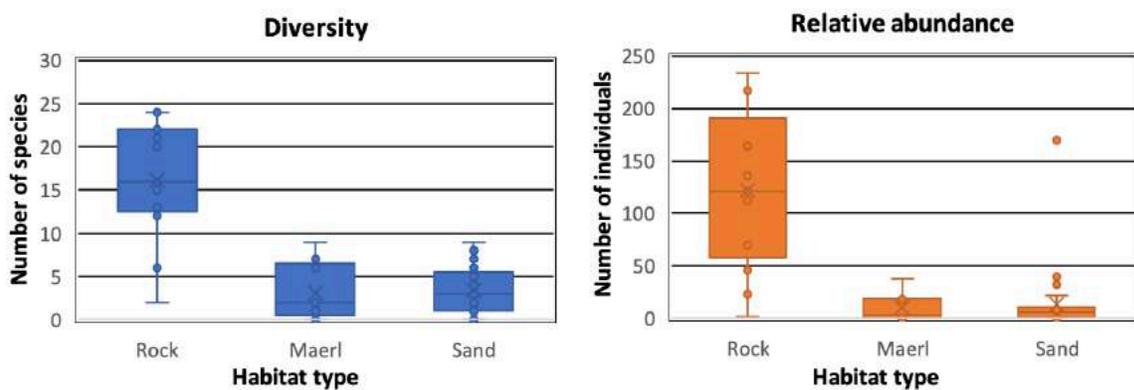


Figure 8. Differences in diversity (number of different species per sampling point) and relative abundance (number of individual fish per sampling point). Each of the sampling points (N=48) is represented by a dot in the box-and-whiskers diagram, and the boxes mark the range of values at which most of the observations are concentrated. In most rocky habitats between 13-22 different species have been recorded, and 50-200 individual fish. In contrast, in almost all sandy habitats and maerl beds, less than 10 different species and 25 individual fish were recorded.

D. What have we learnt?

BRUVs have demonstrated to be a relatively low-cost, robust methodology for sampling fish fauna, making it a suitable tool for monitoring marine environments in Principe. When compared to other methods, benefits include being a non-invasive technique (for example, scientific fishing requires harvesting) and BRUV field-work and data collection does not require intensive training or previous fish identification skills and permits a permanent record of observations (for example, underwater visual census require experienced SCUBA divers and accurate identification of fish species underwater). In fact, the video material from BRUVs can be used for training students, technicians and researchers on fish identification, as well as being useful for outreach and environmental awareness activities. In addition, several points can be sampled simultaneously, only limited by the number of BRUV devices, allowing a very intensive sampling with relatively low fuel cost.

However, video analysis is highly time-consuming, requiring 3-5 hours for each ninety-minute video. Likewise, observer tiredness needs to be considered, not allowing for more than 2 videos to be analysed per day. Furthermore, an exhaustive training on fish identification needs to be delivered to the observers, as the species are not often easily identifiable and characteristics such as behaviour or type of swimming might need to be used to distinguish between species. Robust storage of videos, which can easily amount to several terabytes per sampling season, might also be considered and budgeted for.

E. Next steps and recommendations

This methodology will be continued in Principe over the next five years to detect potential long-term changes in fish composition, as well as expanded to São Tomé. Potential improvements of the study might include:

- adding another five BRUV stations (we currently use five) would allow to sample ten points simultaneously, potentially reducing the overall effort and fuel cost in half (however, we would need to consider the size of the boats and the maximum amount of equipment to be transported each time);
- sampling the same points in the morning and in the evening to spot potential differences in fish composition (for example, the low number of sharks found in the study could be related to the time of sampling amongst other reasons, as sharks are more active at dawn and sunset);
- the use of stereo video systems (using two cameras per device) to obtain, for example, fish size measurements; and
- the use of specialized software for processing videos.

Information on fish distribution around the island can be used to provide fisheries management recommendations. For example, understanding the distribution of species of conservation concern would allow to protect the areas or habitats occupied by these species, for example, by limiting the use of certain fishing gears that target these species in their areas.

6. Study on maturity of Golden African Snapper (*Lutjanus fulgens*)

A. What was the goal of this activity?

The Golden African Snapper (*Lutjanus fulgens*) is one of the 4 species of snappers of the genus *Lutjanus* present in Principe Island. It is caught in high numbers by the island's artisanal fishers and is highly valued for consumption and trade by the local population. With this study we aimed to better understand the reproductive biology of this poorly understood species to provide recommendations for a better management of the fishery. Specifically, we aimed to estimate: *length and age at first maturity* (length at which they reach, on average, sexual maturity for the first time); *spanning season* (months with a higher proportion of sexually mature fish); *growth rates* (how much fish grow per year) and *fecundity* or *reproductive potential* (number of eggs this species can produce at certain sizes).

With this information we aim to provide recommendations that could contribute to a better management of the fishery, such as: **1)** potential protection of the spawning season; **2)** avoiding catching small-sized individuals that have not had the opportunity to reproduce yet; **3)** estimate the maximum sustainable catch yield: based on the reproductive potential of the species and the growth rates, estimate the biomass of *L. fulgens* that could be fished yearly without compromising the long-term population's capacity to recover.

B. What has been done in this activity?

From April 2018 to March 2019, 655 fish were sampled and analysed. Each month, fish was bought directly from fishers in 4 communities (Hospital Velho, Abade, Santo António and Campanha), aiming to collect a sample size of at least 30 fish of each sex. A short landing survey was conducted to collect information on fishing gear, fishing ground and catch time.

For each fish, weight, length and gonad (the reproductive organs) weight measures were recorded, as well as sex and a visual estimation of maturity stage. Gonads were preserved in formaldehyde for its histological analysis at the University of Exeter (to be done during March and April 2019). The following samples were also collected for future studies: *otoliths* (estimation of age), *stomach content* (analysis of diet) and *fin clips* (genetic analysis). In addition, a standardised picture of the whole fish was collected to understand variations in fish shape (Figure 9).



Figure 9. A) Standardised picture of *Lutjanus fulgens*. B) Two volunteers from Hospital Velho processing the fish directly at the landing sites, while waiting for the canoes to arrive. C) Processing fish at the laboratory in Belo Monte hotel. D) Histological analysis of the gonads: gonads extracted in the field are processed and observed at the microscope. The picture shows a section of a late-maturing ovary, with the mature eggs marked with an asterisk. E) Otoliths are part of the auditory system of the fish. Otoliths grow concentrically, adding a new ring every year. Using a microscope, the rings can be counted to estimate the age of the fish.

C. What did we find?

Based on a preliminary analysis undertaken with 598 gonad samples, length at first maturity is estimated to be 27.4 cm for female and 27.8 cm for male. The spawning season, both for male and female, is likely to be during the months of August and September, at the end of the colder, drier season “*gravana*”. This is evidenced by a higher number of mature females found during this period and a higher Gonado-Somatic Index (GSI is an index that measures the size of the gonads in comparison to the rest of the body). Ongoing analysis at the University of Exeter will allow producing final estimates, to be available in April 2019.

Table 6. Stages of male and female maturity used for classifying the gonads in this study.

	F1	Immature Small ovaries, often clear no blood vessels present	Immature Small testes, clear and threadlike	
	F2	Early maturing Small ovaries, blood vessels reduced but present	Early maturing Small, threadlike testes	
	F3	Late maturing Enlarging ovaries, blood vessels more distinct.	Small testes but easily identified	

	F4	Ripe Large ovaries, blood vessels prominent. Individual oocytes visible macroscopically	Ripe Large and firm testes	
Picture not available	F5	Spent Flaccid ovaries yet still large, blood vessels reduced but present	Spent Small, flaccid testes, no milt released with pressure	

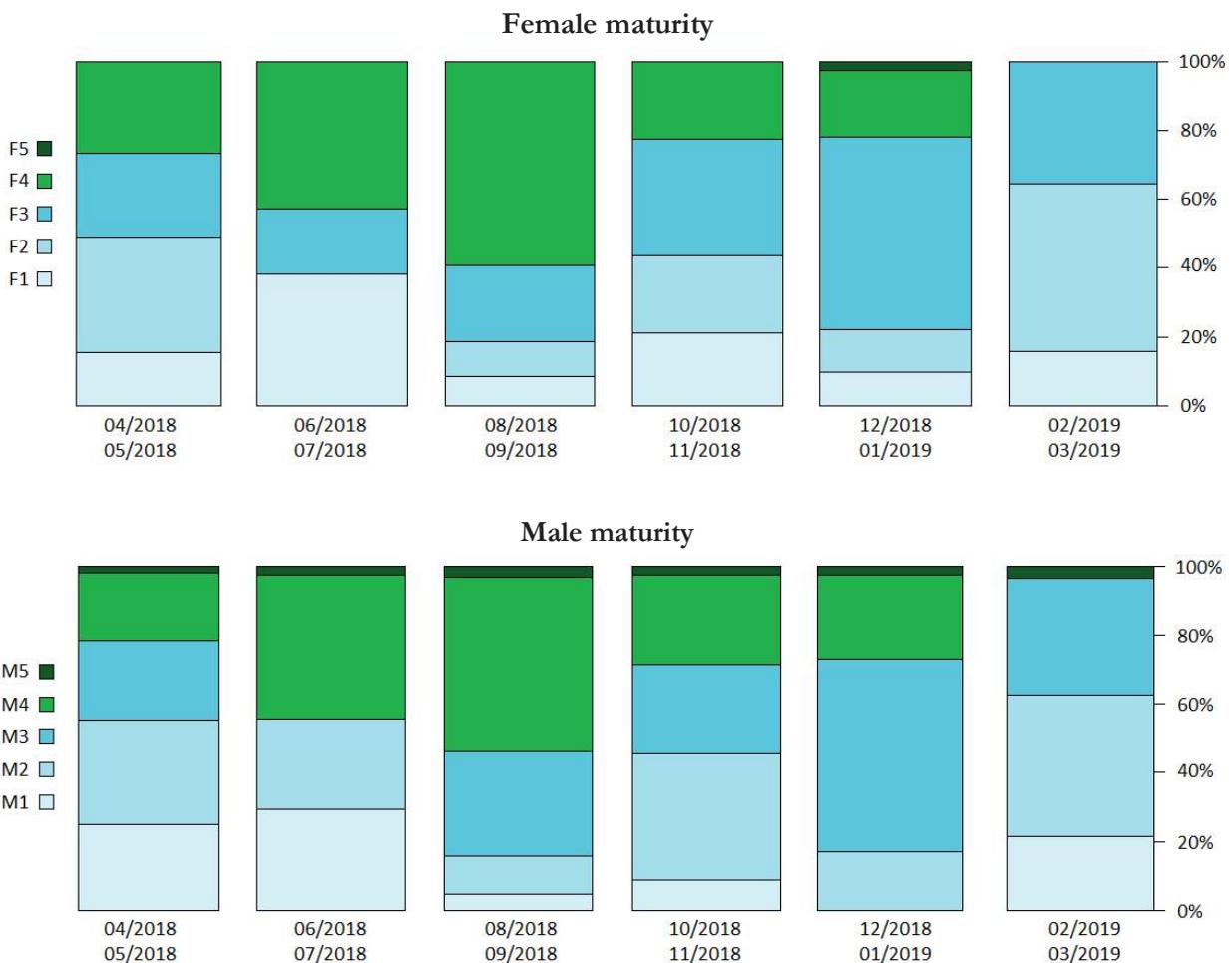


Figure 10. Proportion of mature (green) and immature (blue) male and female individuals. Although mature females and males are found from April to January, the proportion of mature fish is higher in August and September, suggesting that the spawning season might be happening during this time of the year.

D. What have we learnt?

For more efficient sampling, it is essential to understand which fishing gears and techniques target the species of interest and which communities and fishers use those gears and techniques more often. Likewise, it is important to understand any potential cycles that might correlate with the catch of the species of interest (for example, demersal fish catch is strongly correlated with the moon cycles).

Presence of the researchers at the landing sites when buying the fish facilitates engagement from the fishers and fish traders. In addition, processing the fish directly at the beach while waiting for the canoes is possible, and it also contributes to making fishers and fish traders more interested in the work. However, it is necessary to have proper cooling devices (for example, a cooling box with ice) and some protection from the sun to avoid wastage of fish.

Challenges for conducting this study in the island includes the scarcity of chemical compounds necessary for the fixation of the samples (such as formaldehyde, kindly provided by the Fisheries Department), or facilities for the histological analysis of the samples, which requires transporting the samples to be processed and analysed abroad. Work with technicians, interns and volunteers demonstrated that there is high capacity

within the communities to learn and implement the methodology quickly and precisely, being computer literacy the only aspect that would probably need extra attention for training technicians or researchers that are able to conduct the field components of the study independently.

E. Next steps and recommendations

The preliminary results from in this study suggest that reducing fishing effort for this species during the spawning season (August and September) is recommended. Understanding which fishing techniques (including gear type, hook size, bait type, etc), phases of the moon cycle and fishing grounds are used for fishing this species would be useful for protecting the species without affecting other types of fishing. Although some of this information has already been collected through landing surveys, a more exhaustive and systematic analysis would be recommended. For example, information on bait types, hook size and phase of the moon cycle has only been collected through informal and opportunistic interviews with the fishers, and a more systematic approach would be recommended.

Preliminary findings suggest that fishing *L. fulgens* smaller than 27 cm is not recommended, as they have not had time to reproduce yet. Understanding which fishing gears and techniques catch these small individuals more frequently is recommended. A potential option for management could be avoiding these fishing gears.